The future of European competitiveness

Part B | In-depth analysis and recommendations

SEPTEMBER 2024

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PART B | SECTION 1

Sectoral **policies**

1. Energy

The starting point

Energy is a key driver of the European Union's competitiveness gap vis-à-vis other world regions. This has been the case since the early 2000s, but the gap has recently deteriorated as a result of the energy crisis. Structural reasons are at the core of this gap and have been exacerbated during the last two years.

TABLE OF ABBREVIATIONS

AAE	Ancillary Activities Exemption
ACER	Agency for the Cooperation of Energy Regulators
AI	Artificial intelligence
AMR	Advanced modular reactor
BMWK	German Federal Ministry for Economic Affairs and Climate Action
CCfD	Carbon contract for difference
CCUS	Carbon capture, utilisation and storage
CEF	Connecting Europe Facility
CfD	Contract for difference
CO_2	Carbon dioxide
DSO	Distribution System Operator
ECB	European Central Bank
ECOFIN	Economic and Financial Affairs Council configuration
EIA	Energy Information Administration
EIB	European Investment Bank
EMU	Economic and Monetary Union
ENTSO-E	European Network of Transmission System Operators for Electricity
ENTSO-G	European Network of Transmission System Operators for Gas
ESMA	European Securities and Markets Authority
ETS	Emissions Trading System
EV	Electric vehicle
HTGR	High-temperature gas-cooled reactor
IEA	International Energy Agency
IPCEI	Important Project of Common European Interest
IRA	Inflation Reduction Act
ITCO	Inter-TSO compensation
JKM	Japan Korea Marker
JOGMEC	Japan Organization for Metals and Energy Security
KOGAS	Korea Gas Corporation
LCOE	Levelized cost of electricity
LFR	Lead-cooled fast reactor
LNG	Liquified natural gas
LW-SMR	Light water reactor technology
MFF	Multiannual Financial Framework
MoU	Memorandum of Understanding
MSR	Molten salt reactor
NFC	Non-financial corporates
NPV	Net present value
OTC	Over-the-counter
PPA	Power purchase agreement
PV	Photovoltaic
RAA	Renewable acceleration area
RED	Renewable Energy Directive
RES	Renewable energy sources
SEA	Strategic environmental assessment
SFR	Sodium-cooled fast reactor
SMR	Small modular reactor
TSO	Transmission System Operator
TTF	Title Transfer Facility
TYNDP	Ten-Year Network Development Plan
VAT	Value-added tax

THE EU'S COMPETITIVENESS GAP

The EU suffers from a major gap compared to its trade partners in terms of the competitiveness of energy price levels, which vary widely between Member States. Price volatility is also a significant factor, hampering energy-intensive industries and the entire economy.

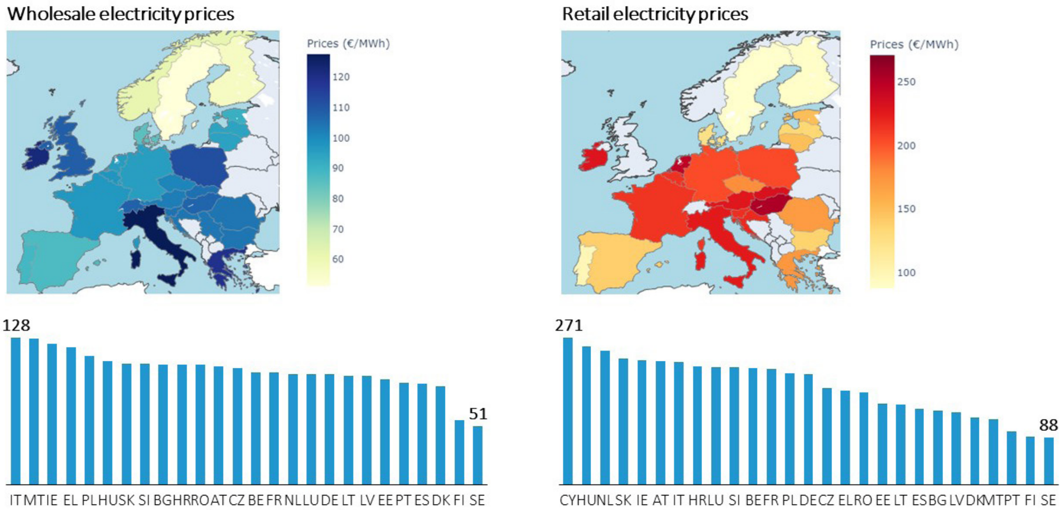
Gas retail and wholesale prices are currently between three to five times the prices in the US, while historically, prices in the EU have been two to three times higher than those in the US. **Electricity retail prices – specifically those for industrial sectors – are currently two to three times those in the US and China.** Historically, retail electricity prices in the EU have been up to 80% higher than those in the US while moving around the same level as in China.

FIGURE 1
Gas and retail price gap for industry

Source: European Commission, 2024. Based on Eurostat (EU), EIA (US) and CEIC (China), 2024.

The energy crisis has exacerbated differences in prices across EU Member States. While in the past retail electricity prices for industry converged over time in the EU, the energy crisis reversed this trend. This is in large part due to the heterogenous national measures applied by Member States to address the crisis and the unequal impact of Russia's weaponisation of the EU's energy supply. These factors also impacted retail energy prices paid by consumers, which ranged from more than EUR 250/MWh in some Member States to less than EUR 100/MWh in others. The spread between the highest and the lowest energy prices in EU Member States doubled in 2022 and rose again by 15% in 2023.

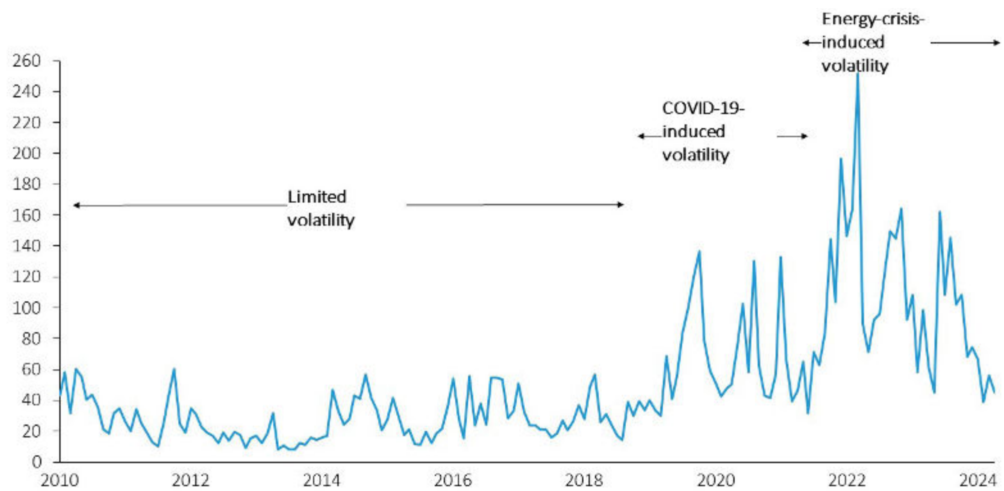
FIGURE 2
Electricity wholesale and industrial retail prices across Member States
EUR/MWh, 2023



Source: European Commission, 2024. Based on Eurostat, S&P Global and ENTSO-E, 2024.

The EU's competitiveness gap compared vis-à-vis its trade partners is not only related to very high prices, but also to the high level of volatility and the unpredictability of prices in EU compared to other world regions. After almost a decade of limited price volatility, in late 2019 and early 2022 volatility in natural gas markets increased significantly, driven first by the COVID-19 pandemic and later by the energy crisis [see Figure 3]. This translated into high volatility in electricity markets also affected by lower output from hydro and nuclear energy in 2022. High degrees of volatility in energy markets, which appear to have become more structural, pose a real threat to the EU's competitiveness. High volatility creates uncertainty, increases price of hedging, and can be detrimental to investment decisions in the power sector. This generates even greater uncertainty, including from the point of view of the security of supply, and raises the cost of the energy transition (due to the required hedging). Furthermore, high volatility in energy markets can lead to irregular government revenues and public investment.

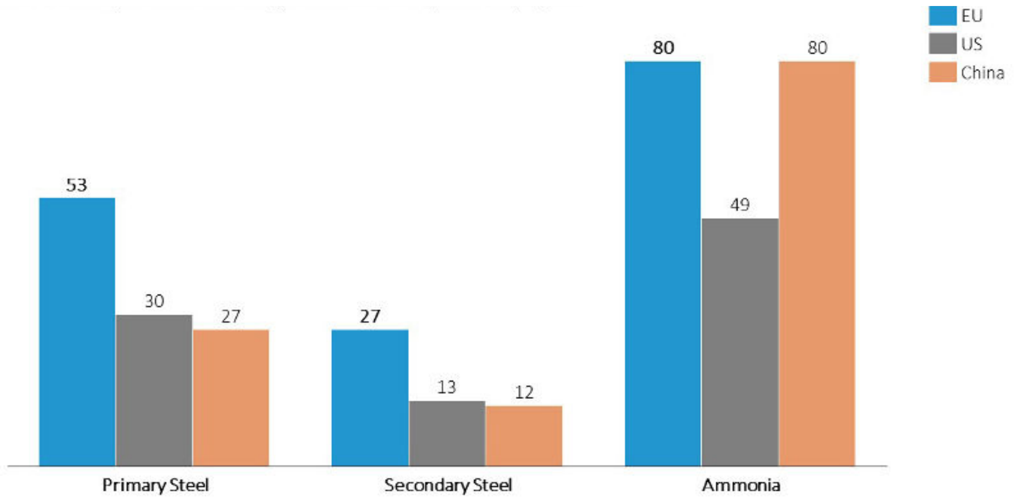
FIGURE 3
Volatility of natural gas prices
TTF month ahead, %



Source: European Commission, 2024. Based on S&P Global, 2024.

High energy prices impact overall investment, cascading progressively throughout the whole economy. In 2023, around 60% of European companies said energy prices were a major impediment to investment — more than 20 percentage points above US companies[i]. Higher prices in the 2021-2023 period had an important impact on public welfare and budgets. As depicted in Figure 4, industrial sectors – in particular, energy-intensive industries – are especially sensitive to changes in the price of natural gas and electricity as they represent a substantial share of consumption [see the chapter on energy-intensive industries for a more complete analysis]. Energy costs are the decisive factor determining the competitiveness of these activities in the EU compared to other world regions.

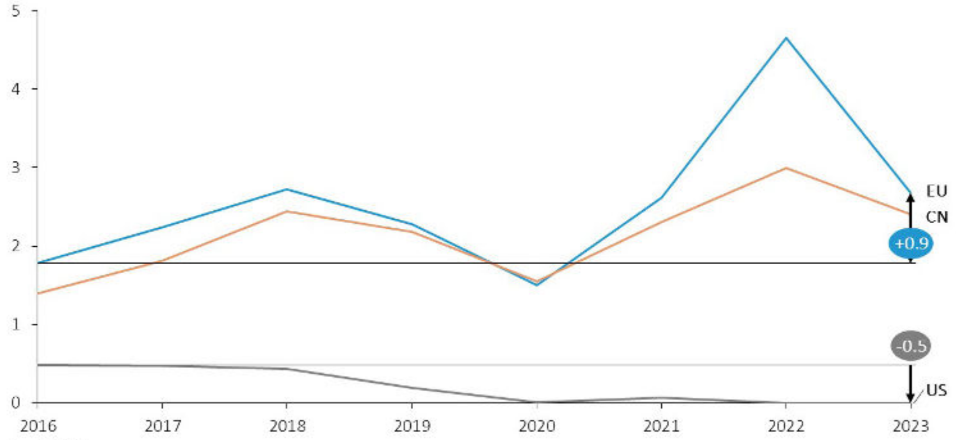
FIGURE 4
Impact of energy prices in key industrial sub-sectors
Share of fuel expenditures in average levelized cost of production, %, 2022



Source: IEA, 2024.

Finally, the combination of a high share of imports and high prices results in a major drag on resources in the EU compared to its competitors. According to the International Energy Agency (IEA)[ii], the EU's fossil fuel energy import bill increased from EUR 341 billion in 2019 to EUR 416 billion in 2023 (approximately 2.7% of GDP) [see Figure 5]. These funds could be better used by the EU to invest in infrastructure, innovation, education, and other areas, which are essential for developed economies to keep their competitive edge in global markets. In 2023, total EU payments for imported fossil fuels (coal, gas and oil) amounted to EUR 390 billion. This was 90% higher than the historical 2017-2021 average, primarily driven by higher prices as volumes were on average only up by 7%. EU payments for Norwegian fossil fuels exceeded EUR 50 billion both in 2022 and 2023, around three times higher than the 2017-2021 average, mainly driven by price increases as volumes have increased by only two thirds. EU payments for Russian fossil fuels almost doubled in 2022 from past levels reaching more than EUR 120 billion, before decreasing back to under EUR 30 billion in 2023 (down 60% compared to 2017-2021 average) as a result of unprecedented diversification efforts[iii].

FIGURE 5
Net imports of fossil fuels as a share of GDP
% of GDP



Source: IEA, 2024.

THE ROOT CAUSES OF THE EU'S COMPETITIVENESS GAP

Multiple issues, from the availability of endogenous resources to infrastructure development and market rules, are at the core of the EU's competitive gap. Main causes include:

1. The EU's dependency on gas imports and exposure to spot markets.

The EU is the biggest global gas and Liquified Natural Gas (LNG) importer, yet its potential collective bargaining power is not sufficiently leveraged[01]. This is notable especially in the case of pipeline gas, where the possibility of rerouting gas flows is more limited as shown by the latest unsuccessful efforts by Russia. Total EU imports of natural gas dropped from 334 bcm (93% of its needs) in 2021 to 290 bcm in 2023. Moreover, gas trade flows were diversified to reduce dependency on Russia, with Russian imports into the EU dropping from 40% in 2021 to 8% of total gas imports in 2023. Despite this, in the EU natural gas is bought by a myriad of public and private actors without leveraging Europe's market power.

During the 2022 crisis, intra-EU competition for natural gas between actors willing to pay high prices contributed to an excessive (and unnecessary) rise in prices. This increase in prices in the context of constrained flows due to infrastructure bottlenecks did not result in additional supply. At the peak of the crisis, internal bottlenecks in the grid and internal competition within the EU to buy and store gas before the winter drove prices much higher than in Asia (in July-August 2022, TTF averaged EUR 40/MWh above the Japan Korea Marker (JKM)). If European companies had access to prices linked to the Henry Hub delivered on a cost-plus basis, the theoretical gain for the European economy would have been in the order of up to EUR 50 billion, with enormous savings for public budgets and a lower impact on the overall economy.

As net importers of gas, Japan and Korea share similarities with the EU, yet notable differences exist. In Korea, the state-owned Korea Gas Corporation (KOGAS) retains a de facto monopoly, importing approximately 90% of the country's LNG, helping in principle to bargain on imports and to minimise costs generated along the value chain. In Japan, the state-owned Japan Organization for Metals and Energy Security (JOGMEC) invests in the upstream production of fossil fuels and minerals worldwide. JOGMEC provides equity capital and liability insurance to Japanese companies for upstream projects and LNG-receiving terminals, ensuring in principle secure access to energy at prices nearer production cost.

01. AggregateEU is a first step in demand aggregation allowing the pooling of demand, the coordination of infrastructure use and negotiation with international partners, fostering more centralised EU joint purchasing to further leverage the EU's market power.

The EU is currently more dependent on spot markets for purchasing natural gas than its competitors. Long-term gas contracts running in the EU in 2022 represented 82% of its total gas imports (compared to 91% in 2019). However, when considering long-term LNG contracts, the share (of total LNG imports) reached only 60%[iv]. While a shift to global LNG markets is needed to reduce this dependency, it risks making the EU subject to volatility in global LNG gas markets.

With the reduction of pipeline supply from Russia, more gas is being bought on LNG spot markets (as LNG has partly replaced pipeline gas) both in the EU and globally. In 2023, 42% of EU gas imports was imported as LNG compared to 20% in 2021. Traditionally, LNG prices were higher than pipeline gas on spot markets (not only due to liquification and transportation costs[02], but also because of the need to compete with other destinations). In 2022, US LNG shipments were around 50% more expensive than average pipeline gas imported into the EU[v].

Even gas bought in long-term contracts is largely indexed to spot markets. Before and after the crisis, non-EU companies were more active in signing long-term contracts than European companies. One of the main reasons is the reluctance of gas-intensive industries to sign long-term contracts on the retail market to reduce obstacles in case of delocalisation, fuel switch or improving energy efficiency. This uncertainty leads gas importers to rely on the spot market and to easily adjust their import portfolio in relation to final gas demand.

Spot markets in the EU increasingly reflect global developments and are influenced by supply disruptions and demand peaks in Asia. Although with no impact in the short term, recent decisions by the US government to limit the development of LNG export capacity could result in lower natural gas prices in the US over the medium term (due to abundant domestic supply) and higher prices in global markets. This would raise the Henry Hub to the TTF spread[vi].

While the EU's need to import natural gas will gradually diminish, this will take time. According to the IEA, the EU's demand for natural gas is expected to drop from its demand of 330 bcm in 2023 by 8%-25% by 2030[03]. However, a gap stands between what the EU has secured contractually and what will be imported over time[vii,viii].

2. Marginal gas and coal power prices impact electricity prices.

The EU has a relative high share of natural gas in its power mix and a diminishing share of coal. This provides the required flexibility and firm power, with disparities across Member States. In 2023, the EU produced 2710 TWh of electricity. Almost 45% of this came from renewable sources. Fossil fuels made up 32.5% and nuclear electricity over 20% of total production. Gas was the main fossil fuel used to generate electricity (14.7%), followed by coal (12.7%).

Market mechanisms in the EU are based on marginal spot pricing. In the EU's well-functioning, interconnected Single Market, natural gas drives the price during a much larger share of hours in proportion to the share it provides of the power mix. Natural gas was the price-setter 63% of the time in 2022, despite being only 20% share in the electricity mix [see Figure 6]. Since the second half of 2021, a stronger correlation has been observed between gas and electricity prices. Two correlating effects have resulted in higher prices induced first by gas power plant efficiency (less efficient plants setting the most expensive price) and second by gas regularly being the marginal power plant in electricity price-setting. High gas prices therefore mean high electricity prices at least until the mid-2030s, when fossil fuel generators will be increasingly displaced in the power mix. While gas only directly impacts a limited part of the economy (gas-intensive industries represent around 4% of the EU's total GDP[04]), its role in electricity generation means that price increases in natural gas can impact the whole economy.

02. Considering a final gas price of around EUR 35/MWh imported as LNG from the US to North-Western Europe, liquefaction represents around 15%-20% of the final cost, transport around 10%-15% and regasification a few percent only.

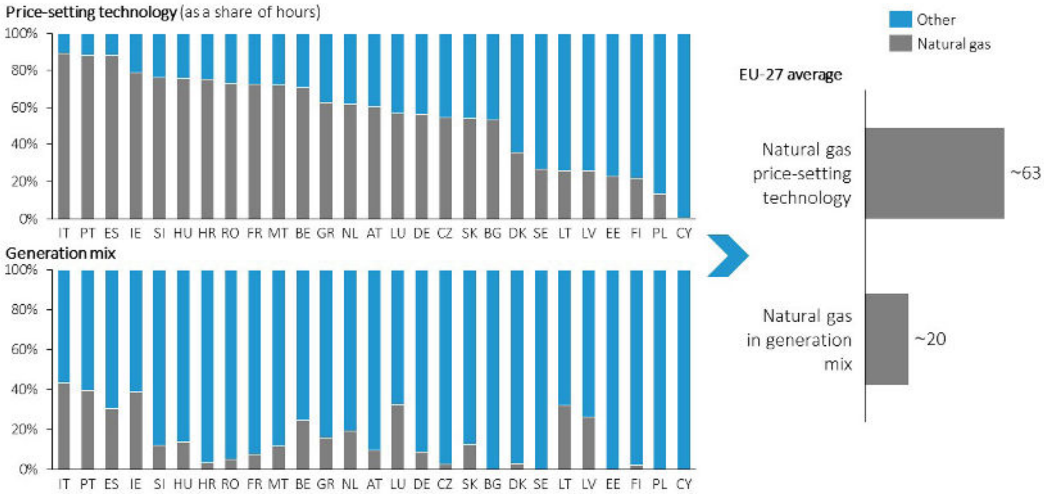
03. Stated Policies and Announced Pledges scenario in World Energy outlook 2023. Annualised natural gas demand 2023 based on Eurostat.

04. Summing 2021 gross value added as a percentage of the total for the chemicals, non-metallic minerals, metal and paper industries. Based on Eurostat.

FIGURE 6

Price-setting technology per Member State and their generation mix

%, 2022



Source: European Commission, JRC, 2023.

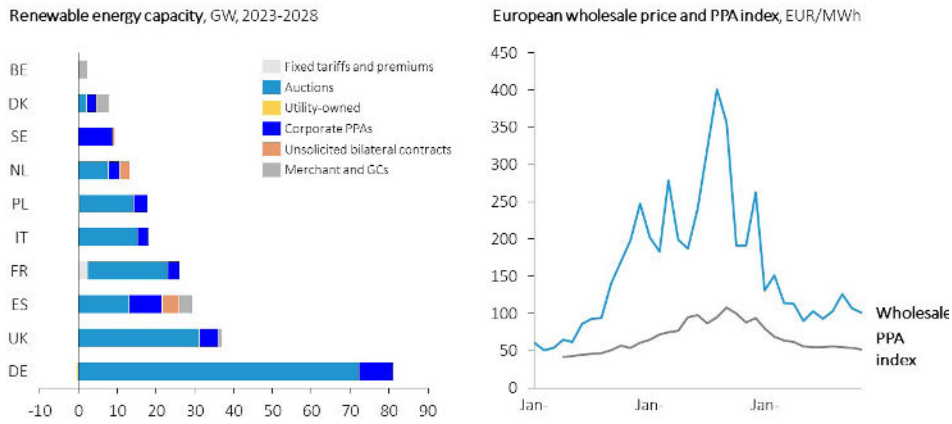
Significant differences in wholesale energy prices also exist among Member States, driven partially by different mix and network developments. Lower prices are related not only to having more inframarginal sources (e.g. like renewables) in the system, but also to adding more diversified (in terms of different technologies) and cheaper generation (e.g. renewables, hydro, nuclear). Considering the differences in day-ahead prices between Spain and Germany in 2023, it seems evident that a diversified energy mix (renewables, hydro, nuclear, LNG import capacity, etc.) can deliver lower prices and offer a competitive advantage. Another illustrative example is a comparison of prices in Italy and Sweden during the recent gas crisis, during which Italy's prices consistently ranked amongst the highest in the EU, while Sweden's were amongst the lowest. Regions suffering from higher prices also include those in Central and Eastern Europe with a higher share of energy-intensive industries, with disparities at wholesale level being passed on to industrial retail.

3. Underdeveloped long term contracts solutions (like Power Purchase Agreements markets) hinder benefits from increasing renewable energy sources (RES) roll-out.

More stable long-term contracts, such as Power Purchase Agreement (PPAs), have the potential to reduce the exposure and hedge industry against high and volatile prices, providing price certainty for large industrial players. With the PPA price index below wholesale prices, corporate PPAs may support renewable electricity procurement in many European countries [see Figure 7].

FIGURE 7

Europe renewable electricity capacity procurement by type, and weighted average European wholesale price and PPA index



Source: IEA and Pexapark (PPA index), 2023.

Contracted PPAs increased in the EU by 40% in 2023[05] compared to 2022 with the increase concentrated in Spain and Germany, supported by demand from the IT industry[ix]. The European Investment Bank (EIB) estimates the commercial PPA market to account for between 140 TWh and 290 TWh by 2030[06]. Some Member States (e.g., Sweden, Spain) offer best practices in the EU, with strong pipelines to meet renewable targets, a clear market appetite for PPAs to reduce exposure to merchant risk and a high participation of diverse (corporate, utility) offtakers. Regulatory measures to drive maturity in these PPA markets include i) contract standardisation, lowering transaction costs and broadening the pool of offtakers, ii) pooling supply and demand, and develop hybrid PPAs (incorporating flexibility assets), allowing for more tailored offtake structures and mitigate price risk, and iii) minimise distortions of the State aid programmes on PPA market.

However, the increased use of PPAs has not yet been significantly developed in the EU. One of the main reasons lies in financial conditions. The lack of financial guarantees for counterparty risk, together with limited market (including price, profile costs, liquidity, etc.) risk appetite, companies' credit worthiness, a lack of standardisation and complexity are all factors limiting the use of PPAs in the EU. Despite their anticipated benefits, only marginal volumes have been contracted as hybrid PPAs, PPAs for green hydrogen production and multi-buyer PPAs (demand aggregation between smaller players), calling for further measures. Concerning the companies seeking and entering into PPAs, the majority are contracted by the information technology sector, where energy is not a primary input. For energy-intensive industries, the uptake is still nascent.

The US started its PPA market earlier, which is at consistently higher levels than the EU. Cumulative PPA volumes remain double in the US compared to the EU. 2023 has been the first year during which there was more capacity in new PPAs in the EU compared to the US (BNEF data until November 2023). Industrial players increasing the share of electricity consumption covered by renewable PPAs will also require new investments in energy efficiency, more flexible production processes, fuel switching and industrial re-location. SMEs individually do not consume sufficient electricity or have the long-term visibility or in-house capabilities to sign PPAs. But a new market for multi-buyer PPAs is emerging, which can also help to address the credit issues faced by both project developers and buyers to receive access to financing.

In parallel, self-consumption is consistently driving additional growth in EU solar power deployment. Residential, as well as commercial and industrial sector installations primarily intended for self-consumption represent two-thirds of EU solar power installations every year[x]. Self-consumption offers companies the opportunity to capitalise on the affordability of solar power to reduce their energy bills. Despite the availability of cheaper solar panels and a supportive EU legislative framework, obstacles have arisen in limited grid access. While self-consumers tech-

05. The EU contracted 16 GW of PPAs in 2023, including 2 GW from IT industries.

06. This is equivalent to around 10% and 23% of 2030 solar and wind generation respectively.

nically don't require grid reinforcement for solar panel installation, the proliferation of these installations in a specific distribution area poses balancing challenges for system operators, also leading to additional network costs translated to the final energy bill. These challenges result in delayed network connections in Member States.[07]

4. Higher carbon costs than other regions in the world.

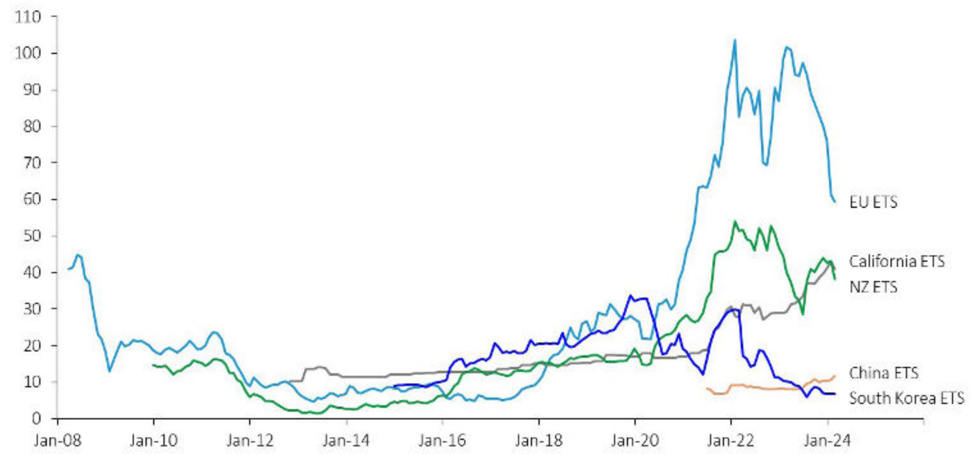
As power generation falls under the scope of the EU's Emissions Trading System (ETS), its carbon intensity is priced in electricity generation costs. As marginal price-setters are often a carbon-intensive technology, they embed carbon intensity in the price (amounting to EUR 20-25/MWh for gas-fired generation in EU[08] [see Figure 8]). Carbon costs accounted for around 10% of the EU industrial retail electricity price in 2023.

This is a high and volatile cost in the EU. In California, this cost stands at around EUR 10-15/MWh (while most other US states do not have an emissions trading scheme) and at less than EUR 10/MWh in China[09].

FIGURE 8

Development of global carbon prices

ETS historical price developments, USD per tonne



Source: Rystad Energy, 2024.

5. Higher volatility and non-transparent financial markets for energy.

Financial (e.g. concentration in trading markets) and behavioural aspects of gas derivative markets (e.g. algorithmic trading) can, especially in combination with tighter market conditions as in the EU, exacerbate volatility and amplify the impact of demand and supply shocks or perceived shocks. A few non-financial corporates (NFCs) undertake most trading activity. Recent evidence presented by the Authority (ESMA) suggests that there is significant concentration at position and trading venue level and that concentration increased in 2022[xi]. The short positions held by the top five non-financial corporates increased considerably (by almost 200%) between February and November 2022.

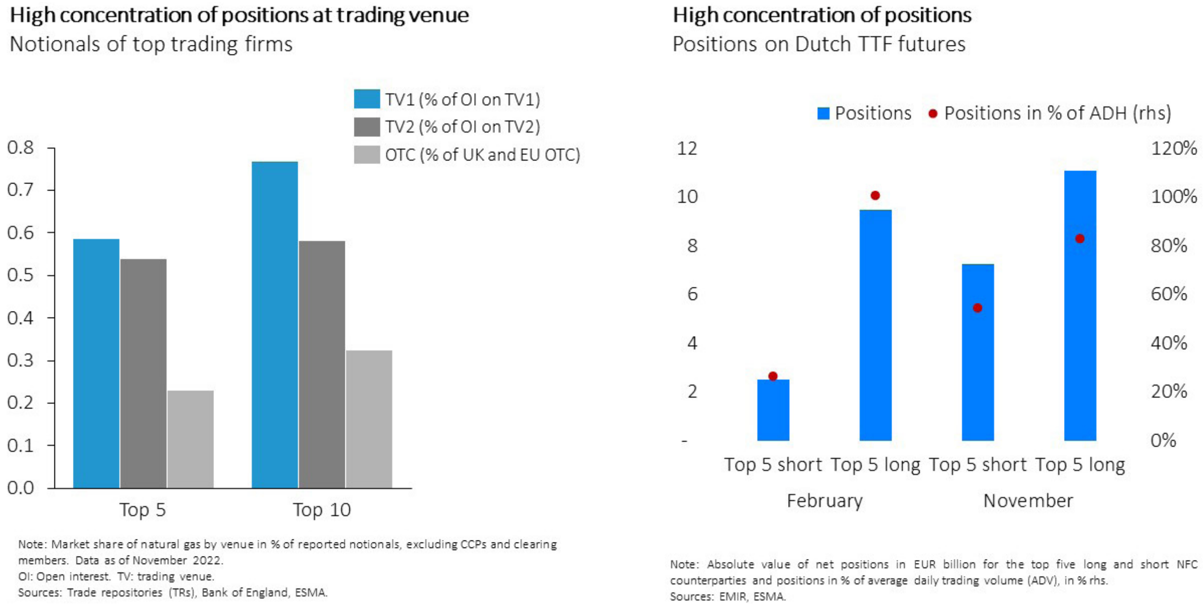
07. The lack of network capacity prompted Hungary to ban the connection of self-consumption systems to the grid, reverting the measure only a few months afterwards.

08. Considering 55% efficiency and EUR 55-70/tonne price.

09. Costs for China are estimated assuming coal power plants set the price using an emissions intensity of 0.85 tCO_2/MWh, a plant efficiency rate of 41% and a calorific value of 7.58 MWh/tonne. Costs for California are estimated assuming gas power plants are setting the price, using an emissions intensity of 0.37 tCO_2/MWh and a plant efficiency rate of 55%.

FIGURE 9

Market concentration in EU gas derivatives markets



Source: ESMA, 2023.
Note: ESMA trade repositories (TRs) cover data from EU traders only.

The market is characterised by a high degree of concentration, with a few NFCs accounting for most derivatives trading activity. ESMA and the European Central Bank (ECB) have identified liquidity and concentration risks as among the main vulnerabilities in energy futures trading, along with the fragmentation of transaction data and data gaps. The heavy reliance on centrally cleared instruments requires market participants in commodity derivatives to post initial margin[10]. The use of margins results in significant cashflow requirements for commodity derivatives market participants which may in turn increase concentration in such markets.

While regulated financial entities (e.g. investment banks, investment funds, clearing market participants) are covered by conduct and prudential rules, many entities trading commodity derivatives can rely on exemptions, including an exemption from the authorisation as a supervised investment company. This exemption applies provided that the entity's derivatives trading activity remains ancillary to the main commercial business of the entity at the level of the group (the Ancillary Activities Exemption (AAE)). The main beneficiaries of this exemption, especially on natural gas derivatives markets, are both EU-based energy utilities and non-EU commodity trading companies. Over the past few years, energy companies have increasingly assumed the role of market-makers in energy commodity derivative markets. This is coupled with the high degree of concentration of the market, where a handful of companies controls more than 50% of total notional value of derivatives outstanding. According to the ECB, the AAE may present a challenge to financial stability.

Moreover, the legal delineation between the surveillance of future and spot delivery of energy leads to a divide in competences and the fragmentation of supervision between energy and financial authorities, as well as causing fragmentation in data sets available.

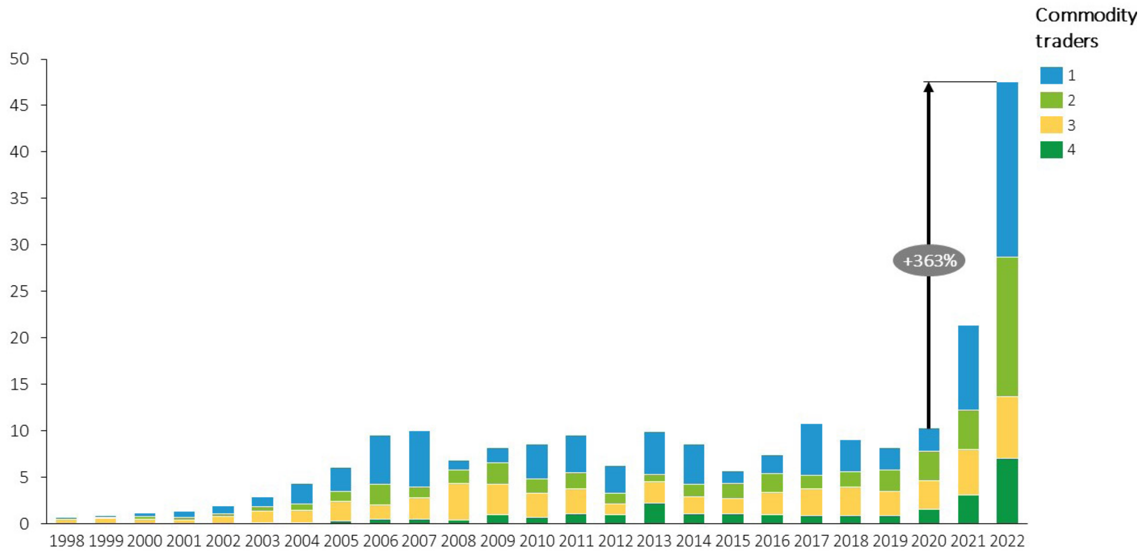
In an unprecedented surge, net income from major commodities traders witnessed remarkable growth, doubling in 2021 and more than quadrupling in 2022 compared to historic levels [see Figure 10]. This extraordinary financial performance underscores the dynamic nature of the commodities market during this period, with traders capitalising on favourable and volatile market conditions to make profit.

10. These initial margins are designed to mitigate credit risk among central clearing participants. The daily exchange of variation margins – additional margin requirements that vary in line with the daily valuation of the derivatives contract – intend to reduce the losses on a derivative position that clearing counterparties would suffer in the event of one of them defaulting.

FIGURE 10

Net income of the world's top commodity trading houses

Net income (USD billion)



Source: Bloomberg and Blas, J., 2023.

6. Physical network bottlenecks may increase during the energy transition.

Physical network bottlenecks on both natural gas and power prevent a real Single Market from emerging. The integration of electricity and gas markets across Europe has proven to reduce price variation across Member States and to bring significant cost savings for consumers – including industry – estimated at approximately EUR 34 billion a year only for electricity[xii]. But multiple bottlenecks are still preventing its full benefits from being captured.

As an example, during the energy crisis, gas infrastructure congestion arose. This followed the need to re-route gas flows away from historical East-West routes designed to channel Russian pipeline gas, to predominantly West-East routes channelling LNG imports. Limited LNG import infrastructure and cross-border interconnections aggravated gas price spikes leading to historically high spreads between different EU markets (to above EUR 100/MWh in the summer of 2022, from spreads regularly below EUR 1/MWh in the past). Competition for scarce capacities lead to additional costs paid on top of regular network tariffs with the Agency for the Cooperation of Energy Regulators (ACER) reporting EU Transmission System Operators (TSOs) congestion revenues rising from EUR 55 million in 2021 to EUR 3.4 billion in 2022[11].

In parallel, the EU's power network infrastructure is confronted with existing and new challenges driven by the electrification of the economy. Grids need to adapt to a more interconnected, decentralised, digitalised and flexible electricity system. Grid costs are expected to increase sharply in the next decade in the EU, mainly due to increasing infrastructure investment requirements and to prevent associated rising grid losses. For example, the TenneT Transmission System Operator expects German grid fees to increase by 185% by 2045[xiii].

While wind and solar have relatively complementary intermittent production profiles[12], unbalanced deployment of the two technologies across the EU (exacerbated by the wind industry facing more difficulties) could exert additional pressure on the grid. Moreover, as geographical areas with optimal renewable energy generation do not necessarily align with where demand is located, grids will become more constrained and incapable to fully transmit all available renewable electricity.

11. ACER, 10th ACER Report on Congestion in the EU Gas Markets, 2023.

12. Wind generation typically occurs more at night hours and during winter time, compared to solar generation occurring typically during day hours and summer time.

This asymmetric deployment may massively increase the need for redispatch (adjusting generator schedules to achieve a physically feasible dispatch). **Up to 310 TWh of renewable generation could be curtailed due to these limitations in the grid by 2040.** This is up to ten times higher than in 2022. Redispatch costs could range from between EUR 50 billion to 100 billion by 2040, more than 20 times higher than in 2022[xiv].

The bulk of grid investments will be within borders, both at the transmission and distribution levels, but interconnections will also play a fundamental role. The IEA's 'Grid Delay Scenario' estimates that an insufficient deployment of grids globally would limit the uptake of renewables, increase emissions and result in twice as much gas and coal use by 2050[xv]. Substantial investment in distribution and transmission grids, estimated by the European Commission to amount over EUR 500 billion this decade[xvi], would be necessary. The grids challenge is not only a planning or an investment one. There are very long-term investment projects and complex permitting processes are resulting in project delays and cancellations, withholding necessary investment.

In particular, transmission grids will need to connect large and growing amounts of intermittent renewable generation with consumption centres. Regarding transmission grids, the European Network of Transmission System Operators for Electricity's (ENTSO-E) Ten-Year Network Development Plan (TYNDP) estimates that in the next seven years cross-border transmission infrastructure should double, with an additional 23 GW of capacity being incorporated by 2025 and a further 64 GW by 2030[xvii].

Interconnectors are essential to achieve EU renewable energy and decarbonisation objectives. Diverse generation mixes and weather patterns across Europe create an opportunity for greater renewables integration provided that Member States can rely on cross-border trade to enhance the security of supply, reduce overall system costs and limit reliance on back-up plants and flexibility[13]. Additionally, cross-border trade plays a key role in stabilising electricity prices by mitigating volatility. During the energy crisis resulting from Russia's weaponisation of the EU's energy supply, price volatility would have been around seven times higher if national markets had been isolated[xviii]. As Important Projects of Common European Interest (IPCEIs), interconnectors are eligible for funding at the EU level from the Connecting Europe Facility (CEF).

Addressing system needs leads to a reduction of costs of about EUR 9 billion/year in 2040, which far outweighs the cost of investing in Europe's grid of EUR 6 billion/year for 2040[xix]. Distribution grids need to expand significantly to modernise and accommodate the new resources (distributed renewables, electric vehicle charging infrastructure) in a smart and digitalised way. Around 40% of Europe's distribution grids are over 40 years old and need to be modernised. At the same time, distribution grids will have to connect new resources adding flexibility into the system. Simulations highlight an almost doubling of curtailment (i.e., an additional 62 TWh annually – equivalent to the total energy produced by new solar capacity created in 2023) between a distribution grid full flexibility scenario and a scenario with no flexibility characterised by grid constraints. Industry estimates that around EUR 375-425 billion of investment in distribution grids will be necessary by 2030[xx].

The demand for grid components (e.g. cables, converters and substations) is also set to surge and exceed manufacturing capacity in Europe. It will be necessary to renew over 7 million km of power lines across all voltage levels by 2050 for distribution and transmission, as well as over 43,000 km of additional cables at transmission level[xxi]. Despite the EU grid manufacturing industry's global leadership, grid project promoters flag long and growing lead times for procuring specific grid components – sometimes of several years, even for the most urgent IPCEIs[xxii]. Supporting the EU grid manufacturing industry and addressing current barriers (e.g. a lack of standardisation, access to raw materials, security risks associated with third-country providers) is essential to reduce delays linked to the grid component supply chain and enable the adequate roll-out of grid infrastructure.

7. A lengthy and uncertain permitting process for new power supply and grids.

Permitting represents a significant bottleneck for the development of the required infrastructures. Both the development of power generation (like renewables) and grids are investment projects that require several years between feasibility studies and project completion. In some Member States, the entire permit-granting process for

13. The case of Denmark (where wind power represents more than half of the electricity mix) is illustrative. Once Denmark produces enough electricity with wind, it exports it to other countries. In the case where wind power is not sufficient, it relies on hydro and nuclear from neighbouring countries.

large renewable energy projects can take up to nine years (permitting for solar projects can take up to two years on average and wind farms can take up to nine). While the EU has developed initiatives to shorten permitting (both in Article 122 emergency proposals and included in the RED III Directive), the implementation of permitting at the national and regional levels still faces significant hurdles, for example stemming from lacking administrative capacity and digitalisation.

National and European environmental legislation results in complex requirements delaying the impact assessment of a project for the construction and operation of renewable energy installations and the electricity grid. Grids permitting also needs to advance in parallel to renewables deployment to enable decarbonisation and avoid it from becoming the next bottleneck. For example, the German Agency for Onshore Wind Energy (Fachagentur Windenergie) reports an increase in the delay for grid connection after approval for wind projects in Germany from one year in the 2011-2017 period to two years in from 2018 to 2022[xxiii].

Concerning renewable energy sources (RES) permitting[xxiv], long and complex permitting procedures are one key bottleneck for renewable energy deployment. Large variation exists between Member States, with the analysis of environmental impact representing a significant share of the duration of the permitting process:

- For rooftop photovoltaic (PV) systems, the length of the process varies between a month and half in Malta and 10 months in Bulgaria.
- For ground-mounted PV systems, reported duration varies from between one year in Bulgaria to 4 years and 6 months in Greece. Greece, Ireland and Spain have processes lasting more than three or even four years.

For onshore wind, in most Member States the permitting process lasts around six years. Latvia (with 2 years and 8 months) and Finland (with three years) have the shortest processes. The longest processes were reported in Greece and Ireland with eight and nine years respectively. Almost no Member State manages to realise permitting within two (or three) years, as stated in the RED II. It must be emphasised that the durations set out in RED II include the time needed to clear legal challenges and to complete the environmental impact assessment. Best practices for dissemination could be found in the following areas:

- Online tools and digitalisation (Netherlands, Italy, Portugal, Spain).
- Environmental impact assessment (Italy, Lithuania, France, Portugal).
- Simple notification or small-scale PV (Czech Republic, Bulgaria).
- Overriding public interest principle (Germany, Czech Republic, France).
- Land use and acceleration areas (Lithuania, Bulgaria, Romania, Portugal, Spain).
- Positive silence for RES projects (Portugal, Spain).
- Reducing bureaucracy (Germany)[14].

However, there are some positive elements. Several Member States have experienced double-digit increases in the volume of permits issued for onshore wind since the entry into force of the 122 Emergency Regulation on permitting[xxv].

14. The German Federal Ministry for Economic Affairs and Climate Action (BMWK) has established 'Reality Checks' as an instrument for targeting a noticeable reduction in bureaucracy. Under a 'Reality Check', close dialogue is held with experts from the businesses and administrations concerned to identify obstacles and potential solutions for individual scenarios and investment projects. The first pilot in 2022 on the 'Installation and operation of PV systems' signalled that, among other aspects, mostly the multitude of regulations and their interplay is perceived as a burden, more systematic inclusion of experts from business practice and enforcement authorities is needed, and noticeable reductions in bureaucracy require a cross-level bundled and cross-department reduction of obstacles (i.e. not only selective changes to legal provisions).

BOX 1

Permitting and the Emergency Regulation

Wind Europe's overview of the evolution of capacity showed positive developments in France, which during the first three quarters of 2023 significantly increased the amount of wind capacity receiving a permit. Belgium's Flemish Region permitted 300 MW of additional wind capacity in the first eight months of 2023, surpassing the total capacity permitted during 2022. A record 5.2 GW of new permits for onshore wind were issued in Germany during the first nine months of 2023 and 2.44 GW of new capacity was added8. In this regard, Germany has indicated that the volume of permitted wind onshore projects this year is expected to grow by 75% compared to last year. The time savings at project level amount to approximately two years.

Moreover, in the case of grids the impact of the Emergency Regulation on permitting has been significant. Since the national implementation of the Emergency Regulation, in Germany alone 440 km of transmission grids were approved during Q2 and Q3 2023. By June 2024, a total of 1,772 km will have been approved.

8. Higher and non-homogeneous taxation and subsidies.

Energy retail prices in the EU for industry are impacted by taxes, levies and charges. Each of these serves distinct purposes[15]. When combined, they can account for a substantial portion of the final cost paid by consumers and are higher relative to other regions.

In 2022, approximately EUR 200 billion of overall taxes and network charges were collected in the EU from all electricity and gas consumers (approximatively EUR 40 billion from industrial sector). Of this, approximatively EUR 85 billion were taxes collected within the EU from all electricity and gas consumers (with approximatively EUR 18 billion from the industrial sector, including EUR 13 billion from industrial electricity consumption alone)[16].

Commodity costs, in particular, (including CO_2 costs paid by carbon-intensive electricity producers) accounted for 55% of overall household electricity retail prices in 2022 and 78% of industrial prices. Excluding the CO_2 costs paid by producers (which are estimated to lie in the range of 15-20% the commodity costs in 2022), generation cost is in the range of 45% for households and 65% of industrial retail prices. The residual costs were approximately equally shared between the network and taxes.

Significant variation exists among Member States concerning taxes, reaching above 30% at the highest end, while some Member States apply levies below 5%, or even negative levies [see Figure 11]. Environmental and renewable taxes for electricity and gas across the EU are where the greatest disparities between Member States can be observed.

In addition, the EU's fragmented approach to State aid risks undermining the Single Market and disadvantages smaller Member States that can't afford to participate in a subsidy race. By the end of 2022, EUR 93.5 billion of crisis State aid measures predominantly linked to energy was granted to EU companies, of which 76% was granted by Germany, 9% by Spain and 5% by the Netherlands[xxvi].

In contrast to the EU, the US does not levy any federal taxes on electricity or natural gas consumption, but has higher network charges. The average US industrial electricity price was EUR 80/MWh in 2022, with the

15. Levies are taxes applied to energy consumption. Network charges cover the costs of maintaining and operating energy infrastructure. Environmental and renewable taxes aim to promote the adoption of cleaner energy sources. Value-added tax (VAT) is not relevant as it is, as a rule, recoverable by businesses.

16. Estimations based on Eurostat data, multiplying the non-recoverable tax rate for industry by overall non-household consumption, and total taxes rate for household consumption with associated consumption. For network charges, consumption from households, industry and businesses were multiplied by the respective average network cost. The gas industrial estimate includes gas power generators.

commodity cost estimated[17] to account for 62% of the total retail price and network charges for the remaining 38% (the US does not levy any federal taxes on industrial electricity and gas prices but might embed some local fees in network charges)[xxvii],[xxviii]. With the Inflation Reduction Act (IRA), the US also provides long-term tax breaks to support investments in clean technologies and self-generation, leading to an overall reduction of the tax burden on industry.

BOX 2

A breakdown of the EU-US industrial price gap

Industrial retail prices for electricity in the EU are more than two times higher than those in the US. According to an IEA analysis, the cost premium is mainly explained by additional power generation costs (fuel, operation and maintenance, investment), explaining nearly half of the gap. Further cost differences consist of taxes, with no taxes paid by the industry in the US, and CO_2 costs, which do not exist in retail pricing in the US. While the share of the price gap linked to network, retail and transport costs seems comparable between the EU and US, this is mainly due to the latter costs, as network charges are lower in the EU. The remaining difference is explained by other cost differences and fees embedded in electricity prices, such as the costs passed to customers due grid congestion, additional wholesale rent and contractual arrangements.

FIGURE 11

Differences in the share of taxes and levies for electricity

Share of taxes and levies paid by non-household consumers for electricity, first half 2023, %

Note: Negative differences are driven by subsidies and allowances in the respective Member State. Such "negative taxes" could come from various fiscal incentives, such as a tax refund that consumers receive.

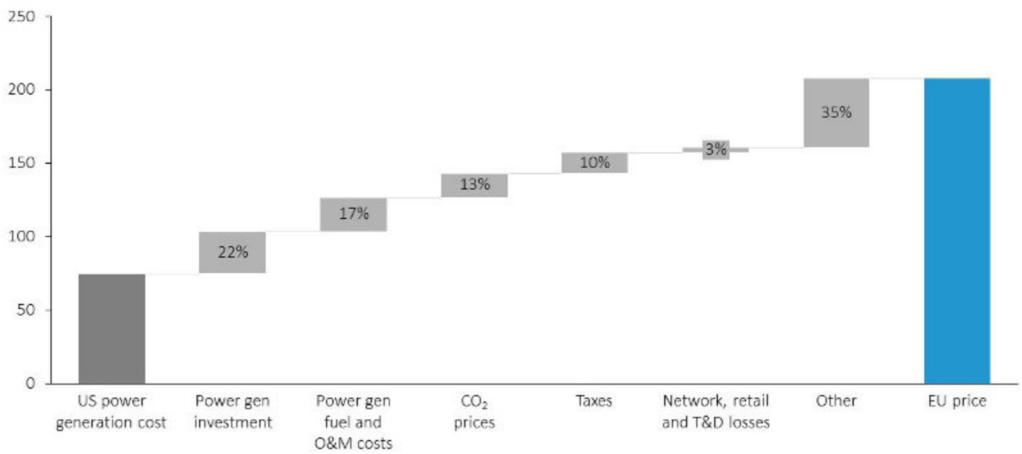
Source: Eurostat, 2023.

17. Based on official US EIA data for all types of consumers (including residential and industrial). No official data is available for the breakdown of electricity bills by component for industrial customers only. The specific share of network charges for industrial consumers may be slightly lower on more limited costs related to distribution grids.

FIGURE 12

Breakdown of the industrial electricity price gap compared to the US

EUR/MWh, % of the price gap, 2023



Note: In 2023, the commodity component was higher than usual historical values. The "other" category mainly captures effects of grid congestion and additional rent in wholesale markets, as well as other contractual arrangements that cannot be clearly disentangled.
Source: IEA, 2024.

THE PERSPECTIVE MOVING FORWARD

Without adequate action, the EU's competitiveness gap is expected to persist or increase, driven by a lack of cheap domestic fuels and limited fiscal resources. The decarbonisation of the energy system is an opportunity for the EU in reducing its dependence on fossil fuels to ensure its competitiveness, the affordability and security of supply. However, it will take time to reap the full benefits of the energy transition. Future crises may impact the EU in different ways than the 2022-2023 energy crisis. While this crisis was driven by the weaponisation of fossil fuel supply by Russia, future crises might come from the need to deal with bottlenecks in electrification and the intermittency of the system bringing up system costs. The EU must, therefore, be prepared to deal with an energy system that may be less flexible, requires massive investment to avoid bottlenecks and may experience higher and volatile prices in the future.

BOX 3

Decarbonisation pathways and system costs

The EU's energy decarbonisation is characterised by a shift from carbon-intensive and fossil energy to cleaner technologies, including the electrification of end-use consumption, an increase in the share of renewable energy in the total mix and new low-carbon molecules to achieve climate neutrality by 2050. According to modelling by the European Commission, the share of clean energy in the total energy mix is expected to increase from around 30% today to around 75% in 2040[xxix].

The EU's decarbonisation pathway does not follow a 'one-size-fits-all' approach[xxx]. Member States pursue diverse approaches tailored to their specific energy systems. France, for instance, has a significant reliance on nuclear energy. An anticipated two-thirds of the share of its total energy mix is expected to come from renewables by 2040 and a quarter from nuclear power. By contrast, Germany is forecast to become more reliant on renewables, including a greater use of hydrogen, CCUS and energy storage.

Regardless of Member States' individual approaches, a common set of challenges arises linked to the rapid electrification of the economy. Issues such as grid and system integration, flexibility, storage, redispatch and demand flexibility are crucial considerations.

The energy transition will lead to a change in the total cost structure of the power system. While variable costs are projected to decrease (due to less fossil fuels in the system), annualised CAPEX and fixed OPEX will increase due to the replacement of fossil-based generation by renewables and clean flexibility assets, electrification of the economy and uptake of infrastructure and grids.

Policy decisions should as such not solely be based on the levelized cost of electricity (LCOE) associated with each project or technology, but should account for the increasing overall system cost associated with the decarbonisation of the economy. Variable renewable energy generation alone does not represent firm power, and significant investments are needed in networks and flexibility to accommodate an efficient integration in power systems. Cost comparisons for policy decisions should as such be on the basis of the equivalent firm power[xxxi], promoting a balanced and resilient energy ecosystem while minimising overall system costs.

The decarbonisation of the energy system and the green transition could enhance EU competitiveness in two ways. First, it has the potential to radically decrease import dependency. The 2040 Climate Target Plan indicate between 190 bcm and 240 bcm of gas imports by 2030, compared to 334 bcm in 2021. Second, it could foster the massive deployment of clean energy sources with low marginal generation costs, such as renewables and nuclear.

BOX 4

The relevance of 'new nuclear' for the future of the energy system

Currently, twelve Member States[18] use nuclear energy to produce low-carbon electricity at 100 power reactor units (96 GW total installed net capacity). This accounted for around 23% of the EU's total electricity production in 2023. This figure was 34% in 2004. The EU's nuclear power plants are aging, and new construction has significantly slowed.

Nuclear energy can contribute alongside the widespread deployment of renewables and other technologies to meeting the EU's climate goals and shoring up the security of supply. At the same time, the deployment of nuclear energy helps to ensure a reliable supply and to promote the EU's leadership in the nuclear industry. Nuclear energy has the advantage of being a source of energy which is neutral in the output of greenhouse gases, non-intermittent and with long cycles on its supply chains limiting dependency risks. 'New nuclear' could further play a role in integrated energy systems with a high penetration of renewables by providing flexible generation[19]. Moreover, the new generation of nuclear technologies can contribute to building a competitive technological supply chain in the EU.

In analysing the role of nuclear, three different areas for action need to be distinguished:

- **Extending the lifetime of the existing fleet of reactors to maintain low carbon supply, provided the safety case can be demonstrated.**
- **Building new nuclear reactors using established technologies.** To make nuclear power a cost-efficient energy source, costs need to be kept under control (the LCOE of nuclear has increased by 46% from USD 123/MWh in 2009 to USD 180/MWh in 2023 according to data from Lazard and BNEF, above the LCOE of other most common clean power sources).
- **Bringing a new generation of nuclear reactors to the market, including small modular reactors (SMRs)[20].** This would only have an impact on supply in the medium term as most deployment plans in Europe are expected from the next decade onwards.

18. Belgium, Bulgaria, the Czech Republic, Finland, France, Hungary, the Netherlands, Romania, Slovakia, Slovenia, Spain and Sweden, with France responsible for almost 50% of the EU's total generation.

19. The European Commission's EC REF2020 scenario estimates the contribution of nuclear to a net-zero power system in 2050 to be 11.8%.

20. Small modular reactors (SMRs) are defined in terms of their electrical output which, by definition is below 300 MW, while current reactor designs reach electrical outputs between 900 MW and 1700 MW.

There is a growing interest in SMR development globally with over 80 SMR designs at different stages of development in 18 countries around the world. Countries such as the US, the UK, Canada, Japan and the Republic of Korea are actively developing their own designs. Russia and China already connected their first SMRs to the grid in 2019 and 2021 respectively[xxxii]. In the EU, several Member States expressed interest in deploying SMR technologies and called for collaborative action to support their efforts. Compared to traditional large nuclear power plants, SMRs may offer an economy of numbers, rather than economy of scale, and several potential benefits:

- Manufacturing serial, standardised, identical components allows the SMR industry to predict and optimise deployment cost efficiencies.
- A smaller power output gives these reactors a reduced environmental footprint and lifts some siting restrictions implied by large reactors.
- Some AMR designs can also allow for high-temperature heat generation, supporting the decarbonisation of industrial sectors.

Nuclear fusion is as a disruptive technology that holds the potential to revolutionise the energy landscape in the second half of this century. Fusion requires light hydrogen atoms to be heated at an extremely high temperature, forcing them to fuse and release huge amounts of energy. It could play a pivotal role as a low-carbon, climate-friendly, affordable and safe energy solution based on an abundant and accessible supply of fuel material[21]. The ITER project located in France was initiated in 2006 by the EU in collaboration with international partners (China, India, Japan, Korea, Russia and the US. It has propelled the EU to the forefront of global fusion research, investing billions of euro in the industry's supply chain and research. Despite notable progress in global fusion research, its practical deployment remains several decades away, necessitating further concerted effort and investment to bring this revolutionary energy source to market.

It will take time before we see a major downward effect on energy prices played by decarbonisation. In the short-term, the challenge Europe will face is that the full benefits of the clean transition for EU competitiveness will only materialise when renewables combined with nuclear are regularly price setting and relevant investments in grids, storage and flexibility are completed (and amortised), so that the system can be managed in a cost-efficient way. In the medium term, fossil fuel generation needs to be significantly displaced from the power mix by renewables in combination with adequate investment in infrastructure, flexibility and storage solutions to have a beneficial impact on prices.

By 2030, even with the share of renewables expected to increase from 46% to 67% in the EU's power generation mix, the hours during which fossil-fuel-based generation sets price are expected to remain largely the same as in 2022[xxxiii] . In the meantime, renewables will help to progressively replace the most expensive gas power plants, containing high prices. However, as more renewable generation is deployed, expectations on increased price cannibalisation[22] and price volatility may deter investments in renewable energy and slow the energy transition. It is therefore key that the uptake of renewables is accompanied by adequate investments in grids, flexibility and storage.

Flexibility needs will increase significantly from now until 2050. These needs would equal to 30% of total electrical EU demand in 2050, up from 24% in 2030 and 11% in 2021[xxxiv].

At the same time, the shift to a decarbonised energy system will also impact other components of the energy bill. These include network charges which finance the massive grid updates required for the green transition, flexibility charges, and taxes and levies which finance public investment in renewables, storage and shoring up the security of supply.

21. Most of the fusion reactor concepts in development will use a mixture of deuterium and tritium, two hydrogen isotopes. Deuterium can be extracted inexpensively from seawater and tritium can potentially be produced from the reaction of fusion-generated neutrons with naturally abundant lithium.

22. Price cannibalisation occurs when abundant renewable energy generation, such as wind or solar, leads to a decrease in the short-term price of electricity and reduces the market revenues of renewable generators.

Finally, future crises and challenges might be different to the last energy crisis. In the future, tensions in the natural gas market are expected to ease. According to the IEA's latest forecast, global LNG supply is expected to grow by 25% between 2022 and 2026. 70% of the supply increase is forecast to be concentrated in the years 2025-2026[xxxv]. At the same time, natural gas demand in the EU is projected to decrease due to decarbonisation efforts to 190 bcm by 2030, applying downward pressure on prices. While there may be abundant supply of gas in the second half of this decade, with an increase in global LNG capacity foreseen, the EU should not stop its transition but accelerate with this opportunity. The EU thus needs to learn the lessons of the recent energy crisis, as tensions might appear in power markets driven by other reasons like bottlenecks in the electrification of the economy and system costs.

Renewables need to keep up with the demand for electrification, despite permitting issues, the increased cost of capital and potential supply chain challenges. According to industry estimates[xxxvi], the cost of building offshore wind farms increased by 40% (in 2023) in the EU over the course of the past two years. Rising interest rates also negatively affect investments, with a 3.2% increase in interest rates estimated to raise the cost of offshore projects by 25%[xxxvii].

Accelerated renewable energy deployment will not bring the expected benefits if the network becomes the next bottleneck. Furthermore, grids, flexibility and storage solutions must advance in parallel to enable decarbonisation. For every euro spent on clean power in Europe during the 2022-2040 period, EUR 0.9 of grid investment will be required to achieve the EU's climate ambitions[xxxviii]. The massive investments needed (grid investments alone will require around EUR 90 billion each year between 2031 and 2040) may increase the bill for households and companies, unless appropriate planning and financing models are developed.

Artificial intelligence (AI) has huge potential to accelerate the EU's transition to a cleaner, more decentralised energy system, while improving energy efficiency and system reliability. As energy systems become more complex and integrated between energy carriers and end use sectors, there is a greater need for more powerful tools to plan and operate energy systems as they keep evolving. However, the deployment of AI comes with challenges, for example from a security perspective and significant increase in power demand. Data centres alone are responsible for 2.7% of the EU's electricity demand (up to 65TWh in 2022). By 2030, their consumption is expected to rise by 28%[xxxix].

BOX 5

AI use cases and challenges in the energy sector

- **AI solutions already provide more than 50 use cases in energy systems today, from grid maintenance to load forecasting, highlighting the versatility and potential impact of the technology.** With estimates of the market value for AI applications in the energy sector ranging up to USD 13 billion[xl], the energy sector is one of the sectors with the greatest potential to benefit from the capacity of AI to boost efficiency and accelerate innovation.
- **Predictive algorithms can be used to forecast energy generation and demand, enhancing the integration of renewables in the energy system.** Machine learning aids in aligning variable supply with fluctuating demand, in balancing power generation and loads, and optimising the value of renewables and grid integration. Moreover, AI-driven insights allow companies to shift peak consumption times, reducing reliance on external power sources and promoting load shifting and 'peak shaving' practices.
- **AI algorithms can support the planning, optimisation and predictive maintenance of energy grids, assets and usage.** AI aids grid operators in determining system needs based on forecasts of the deployment of additional generation and demand assets, as well as optimal locations for new power infrastructure. AI-enabled schemes can continuously monitor and pre-emptively identify potential faults in energy assets, as well as predict maintenance needs based on historical performance data. AI technologies may also be integrated in building management systems optimising energy use in buildings and industry, providing a better overall experience to consumers through personalised energy services.

- **AI can improve energy business decisions, trading and customer relations.** Energy companies can use AI algorithms to process real-time pricing data, demand and supply trends, enabling them to make informed and profitable trading decisions. AI solutions can further collect and analyse consumption data, to design better consumer-centric products, such as smart tariffs. Moreover, it can facilitate demand response, as well as empowering consumers to improve their (home) energy management, for example by providing personalised energy use recommendations or energy efficiency upgrades.

To further leverage the power of AI, however, several key factors and measures may be needed to support the uptake of solutions in the electricity grids and the energy sector at large:

- **Addressing intrinsic challenges posed by AI technologies, especially when applied in critical infrastructures, such as energy.** Challenges include data privacy concerns, cybersecurity risks, market manipulation, a lack of accountability when something goes wrong, the traceability of decision making, a lack of transparency and the risk of potential loss of control. The EU's AI Act represents a first step towards tackling these issues.
- **The widespread use of AI comes with a significant increase in energy consumption.** In the EU, data centres (incl. those needed for AI) are expected to represent over 3% of total power demand by 2030. As these technologies continue to advance, the demand for electricity will sharply increase to power data centres storing vast amounts of data and facilitating complex computations, signalling an increasing need to map the effects of AI's energy use and wider environmental impacts. Today, mainly only big tech companies are investing in computing power to handle AI workloads, primarily using renewable energy, but also other low-carbon sources and solutions like microgrids or advanced software managing energy demand[xli].
- **Factors that might hamper the deployment of AI solutions in energy need to be addressed.** The digitalisation of the energy system is a prerequisite for the increased use of AI. Integrating AI in today's outdated energy infrastructure is a highly complex task. Training AI models requires access to data through interoperability and standardisation. Furthermore, workers and consumers will need a new set of skills to fully benefit from AI technologies. Finally, a well-functioning ecosystem of innovators, developers and deployers need to be established to ensure the uptake of AI solutions.

Hydrogen production and imports will need to play a specific role in decarbonising hard-to-abate sectors, such as transport, chemicals and metal industries, as well as to enable industry to source hydrogen from renewable-rich regions. The EU faces the multifaceted challenge of realising the full potential of hydrogen energy. First, the levelized costs driven by electrolyser CAPEX and power prices are very high, which currently make the economic case challenging without subsidies. Second, the transportation of hydrogen is costly. The infrastructure needs to be further developed and competitive industrial clusters need to be established.

Citizen engagement is essential for a successful transition. Without targeted support, social inequalities might increase as the cost of the transition can disproportionately affect low-income households and a rise in energy poverty, increase citizen's alienation, and create SME disruptions. For example, the 2040 Climate Target Plan shows that the evolution of energy costs for households is characterised by an increase of capital-related costs in purchasing more efficient appliances and enhancing the energy insulation of dwellings, illustrating how the lack of support programmes could slow down the pace of the transition and risk leaving vulnerable households, industries and territories at bay. Well-designed support frameworks are thereby critical for ensuring that the energy transition is just and inclusive, as well as economically beneficial as the increase in investments allows savings on energy purchases further down the road.

BOX 6

Recent measures to increase security and limit high prices

Following the energy crisis, significant steps have been taken to address the impact of energy prices on European companies' competitiveness. They include:

- Temporary energy tax reductions, state subsidies, price caps, revenue caps, financial market regulation and efforts to reduce demand.
- Efforts to transition away from Russian fossil fuels – the sanctions packages and REPowerEU plan have set a clear path to phase out the EU's dependency on Russian fossil fuels.
- Launching gas demand aggregation through the EU Energy Platform as a first step to leverage the EU's market power to secure supplies at cheaper prices from the limited global sellers.
- Reinforcing data and benchmarks with the establishment of the ACER LNG benchmark.
- Promoting storage with a framework requiring targets for mandatory filling.
- Guaranteeing more stable prices for consumers and revenue streams for investors. To achieve this, the use of long-term contracts as a driver of renewable deployment is being promoted. An obligation to use two-way contracts for difference (CfD) for direct price support has been introduced and the use of power purchase agreements (PPAs) is being promoted in the design of the electricity market.
- Improving permitting with the revised Renewable Energy Directive (RED) and the emergency regulation to speed up procedures.
- Developing the European Grid Action Plan.
- Promoting flexibility by allowing non-fossil fuel flexibility solutions, such as demand response and storage to better compete with natural gas power generation.

Despite these promising measures, greater efforts will be needed to tackle the effects of high energy prices on the EU and it companies' competitiveness.

Objectives and proposals

To address the competitiveness challenges the EU faces, two objectives should be pursued in parallel:

- First, the cost of energy must be lowered for the final user. The cost benefits of decarbonisation should be anticipated and transferred to all consumers.
- Second, decarbonisation must be accelerated. To achieve this, all available technologies and solutions (e.g. renewables, nuclear, hydrogen, batteries, demand response, infrastructure roll-out and energy efficiency and CCUS technologies) must be leveraged by adopting a technology-neutral approach and by developing an overall cost-efficient system.

The proposals covered in this section aim to: i) maximise endogenous low-cost resources; ii) ensure competitive sourcing and potential for diversification; iii) maintain appropriate incentives to attract the required financial resources; iii) review the segmenting of markets and shift to price structures closer to costs; iv) harmonise treatment (e.g. taxation, surcharges and State aid) in particular for the sectors exposed to international competition.

The proposals are organised in three groups – proposals for natural gas, the electricity sector and 'horizontal' proposals.

NATURAL GAS PROPOSALS

Key proposals in the natural gas sectors will enable the further leveraging of the EU's market power to translate benefits to consumers and transition to green gases in a cost-efficient way.

FIGURE 13

	SUMMARY TABLE – ENERGY: NATURAL GAS PROPOSALS	TIME HORIZON[23]
1	Establish partnerships with reliable and diversified trade partners, also reinforcing long-term contracts.	ST
2	**Encourage a progressive move away from spot-linked sourcing.**	MT
3	**Reinforce joint procurement.**	ST
4	Further develop selective strategic import infrastructures and improve the coordination of storage management across Europe.	MT
5	Improve the quality of data and forecasts.	ST
6	**Limit the possibility of speculative behaviours: financial position limits, dynamic caps, an EU trading rule book and an obligation to trade in the EU.**	ST
7	Progressively decarbonise moving to H2 and green gases in the industry when cost-efficient.	LT
8	Ensure natural gas price formation mechanisms are more cost-reflective of different sourcing conditions.	MT
9	Facilitate industries exposed to international competition to get access to competitive energy sourcing.	ST

23. Time horizon is indicative of the required implementation time of the proposal. Short term (ST) refers to approximately 1-3 years, medium term (MT) 3-5 years, long term (LT) beyond 5 years.

1. **Establish partnerships with reliable and diversified trade partners, also reinforcing long-term contracts.**

The first important steps to act in a coordinate way at the EU level would be to:

- **Develop a comprehensive strategy at the EU level, coordinate with Member States on how to manage natural gas during the transition and on how to secure natural gas (from where, volumes and conditions) for the next 20 years.** This should guide partnerships and strategic infrastructure development. Today, this is left to Member States and to global markets with each Member State maintaining its own security of supply. During the energy crisis, Member States exchanged on their natural gas strategies in the Gas Coordination Group and in the Electricity Coordination Group, respectively. These discussions mainly focused on short-term crisis developments. There is no clear, explicit strategy at the EU level regarding where gas should be sourced from during the energy transition and how to deal with the remaining volumes of imported Russian gas. The concept of the EU's security of supply needs to be developed over the long term. A review of the Security of Supply Framework is needed considering new exposure on global markets, alongside a coordinated EU approach on security of supply investments. In terms of governance, the Council of Ministers for Energy would be well placed (as the ECOFIN does for economic governance) to manage this.

- **Build partnerships with reliable and diversified trade partners, including long-term agreements to cover base quantities for progressively decreasing import needs towards 2050.** This would help to reduce exposure to global spot markets (privileging pipeline gas for the final molecules). Following the work done under REPowerEU, a closer strategic relationship should be developed to ensure long-term sources of supply, diversification and a new approach to the security of supply (including cybersecurity and protecting communication between TSOs). Future imports would be concentrated first on secured and affordable pipeline gas, which would be cheaper if sourced at 'production cost plus mark-up', while maintaining the flexibility and the option of LNG sourcing. Long-term agreements with partners should be explored (e.g. Norway) to secure preferential fixed prices and guaranteed volumes over several years to be contracted by private companies. Long-term agreements in the form of Memoranda of Understanding (MoUs) between the EU and international partners should provide an umbrella framework for the signing of private contracts. Gas infrastructure in the EU should be adapted to ensure associated volumes can be imported and distributed across the Union. It is important that these contracts are signed by those companies that are closer to the end user and deal with actual physical flow (either industries or TSOs) to avoid intermediary mark-up that could increase prices.

- **Domestic production could also play a key role in ensuring security of supply and to avoid being affected by geopolitical developments, supplying the last molecules of gas in the 2040s and 2050s.** Domestic production in the EU has rapidly decreased in recent years, having halved in the past ten years and reduced by 7.2% year over year in 2022 alone. Despite this, it is important for Member States to assess the role that domestic supply plays concerning the EU's security of supply and price stabilisation.

2. **Encourage a progressive move away from spot-linked sourcing.**

- **To reduce the EU's exposure to the volatile spot market and leverage potential downward pressures on prices, it would be beneficial to promote the signing of long-term contracts by European companies which incorporate pricing formulas reflecting less spot indexation.** If mitigating policies are not developed, Europe's exposure to the spot market could remain in the years to come. Global LNG markets may experience periodic cycles of oversupply and scarcity, depending on market uncertainties such as the evolution of gas demand in emerging economies, investment cycles in production countries or geopolitical events, making it advisable to retain diversity, be it in pricing, contract period or sources. Regarding pricing, measures could include:
  - **The indexation of contracts should move to formulas closer to a fixed pre-determined cost**, rather than betting on spot market stability during the next two decades.
  - **Based on an in-depth analysis providing greater transparency on gas production costs by partner countries and standard transport rates, a Commission recommendation could propose to move towards a coordinated EU approach of 'production cost plus mark-up' for EU industries when nego-**

tiating contracts with third countries. The recommendation could also offer clarity to industries on how to secure long-term contracts directly with exporters to avoid (to the extent possible) intermediaries and spot market purchase.

BOX 7

Price formation of US LNG into natural gas in the EU

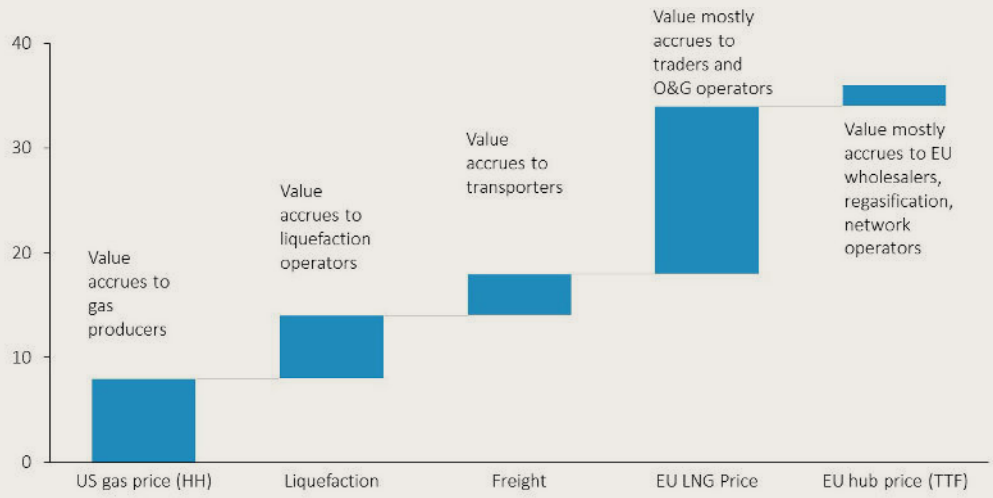
US LNG leaves the United States priced in relation to the Henry Hub, but is largely sold in Europe at a price linked to the much higher TTF price. The cargo acquires huge value on the journey from North America to Europe. This cost is paid by European consumers, benefitting mostly traders and importers.

According to the IEA, the European Union saved USD 70 billion over a decade because its imports were gradually priced away from oil and towards TTF[xlii]. But the prices observed in 2021 and into 2022 have changed this. In December 2023, Henry Hub gas prices were less than a quarter of European gas prices. Even accounting for the costs of transporting LNG to Europe, the price was still around half the price of European gas. This shows that the cost premium linked to spot indexation is around half of production and transport cost pricing. This margin accrues mostly to large energy companies and commodity traders manage the transport of gas from the US to Europe.

FIGURE 14

Value chain of US LNG sold to Europe in December 2023

EUR per MWh



Source: European Commission, 2024. Based on S&P Global, 2024.

3. Reinforce joint procurement.

The EU Energy Platform could develop financial instruments (grants, loans and guarantees):

- **Support joint purchasing via procurement.** The current EU instrument AggregateEU does not do joint purchasing but aggregates demand. At present, it functions as a matchmaking tool, matching the aggregated demand with available supply in the market. In the future, the EU Energy Platform could go a step further and ensure the joint procurement of gas. A single EU buyer entity (supported financially and acting on behalf of EU companies) could purchase pipeline gas and/or LNG (indexed to the Henry Hub, for instance) for base quantities and run auctions for its volumes at predetermined fixed prices ("production cost plus mark-up") to EU companies, respecting EU internal competition. These contracts would be the concrete implementation of the MoUs with foreign governments. Aggregating demand profiles (e.g., linked to energy-intensive industry demand), would facilitate the management of short-term fluctuations in the market. Pursuing such a model could make the risks of the energy transition (e.g. diminishing volumes of gas demand falling faster in some countries compared to others, stranded long-term contracts) more manageable.

- **Provide insurance against market swings.** The Platform could develop a government-supported hedging mechanism to protect companies signing long and medium-term contracts from extreme market volatility. Companies could pay a fee to access this instrument. In return, any gas bought under this instrument might be sold to end consumers in Europe on a cost-plus basis. A major risk for any European company signing a long-term contract is that the gas might not be needed in the end (or cannot be sold at profit to someone else). Financial products backed by the public sector could be developed to protect buyers from these risks (e.g. a change in commodity prices beyond the horizon where hedging is possible, or a drop in demand that leaves companies paying a penalty for not buying gas they have contracted to do so). A collective guarantee from Member States could back these products. Costs for Member States would then only materialise if extreme events such as these occur. This scheme could lower prices quickly and shield the EU economy.

4. **Further develop selective strategic import infrastructures and improve the coordination of storage management across Europe.**

- **Member States could further coordinate the strategic filling of natural gas storage for upcoming winters to avoid EU operators competing among each other.** The EU should leverage its Storage Regulation running until 2025 by extending it. The coordination of storage filling (at least, a strategic part of its storage) between Member States should be done in a way that it limits the risk of simultaneous filling and possibilities for suppliers to leverage rigid and overt targets to inflate prices.

- **Provide State counter-guarantees to de-risk gas storage in Ukraine and complement EU gas storage solutions.** Ukraine holds significant and competitive gas storage capacity that could be further used by the EU (around 10% of EU storage capacity). The EU could further leverage available capacity in Ukraine to support its storage needs by de-risking assets based on State counter-guarantees. Further storage capacity would help the EU to balance seasonal demand variation and reassure markets on scarcity risks during winter, helping to further reduce and stabilise prices.

- **Develop selective strategic import infrastructure.** With the development of LNG import infrastructure (70 bcm of new regasification capacity deployed between 2022 and 2024) and reverse flows, the major risks that occurred in the market due to the drastic reduction of the supply of Russian gas seem to have largely been mitigated. However, some additional infrastructure may still be needed to further diversify the EU's supply[24]. Moreover, strategic import infrastructures may need to be reconverted in the future to use or process emerging energy transition fuels[25]. Financing should be subject to an option value approach that considers investment scenarios and their likelihood (e.g. that the infrastructure is reconverted at some point in time), rather than using a current net present value (NPV) approach.

- Further develop a clear strategy to optimise the reconversion, retrofitting and decommissioning of existing infrastructure. Given the interaction between power and natural gas markets, network developments need to be considered in an integrated manner. This could help to avoid stranded assets, maintain flexibility and fit infrastructure needs for alternative renewable and low-carbon gases for the green transition (e.g. for hydrogen, biomethane, CCUS power generation), including on the necessary best practices on financing levels.

24. Up to 30-40 bcm mainly from additional regasification units.

25. i.e. renewable gases, fuels and precursors, such as bio-gas, hydrogen, ammonia and methanol.

5. Improve the quality of data and forecasts.

There is significant scope for improving the quality, interoperability, dissemination and timely availability of energy data and statistics to allow the EU to provide more market certainty during the energy transition. The availability of reliable and consistent data represents a central element to deliver a successful energy transition.

- Map and address the needs and gaps concerning energy data to enable policy-makers to support the energy transition, as well as the monitoring of the security of supply and affordability. Mapping should also focus on outlining the shortcomings regarding the granularity and timeliness of data.

Centralise all public and open energy data sources (e.g. ENTSO-G, ENTSO-E, ACER and Eurostat) in a common hub or platform for energy data. This could provide greater accessibility and dissemination of existing quality public data to support a better understanding of energy markets by industries. It would also stimulate better harmonisation of EU data and further coverage from reporting actors. The US Energy Information Administration could provide a blueprint for these efforts.

6. **Further regulate financial markets for energy** under a single EU trading rule book and limit the possibility of speculative behaviours: financial position limits, dynamic caps, and obligation to trade in the EU.

- **Further integrate the regulatory and supervision framework for financial markets for energy.** The aim of integrated market supervision is to ensure that trading in energy derivatives can withstand expected higher levels of price volatility (resulting in higher and more frequent margin calls) without a loss of trading volumes (preservation of liquidity), and increase the overall resilience of energy trading. To this end, as a first step cooperation between ACER and ESMA should be further deepened building on exchanges of information and the standardisation of monitoring and supervision.

- **Moving forward, a coordination body comprised of energy and derivative market regulators at the European level (ACER and ESMA) should coordinate integrated supervision of energy and energy derivatives markets.** The supervisory college would remove any possible overlap or duplication of supervision between energy and financial regulators, and could also remove layers of intermediate supervision at the national and sometimes regional levels. This supervisory college would have both the investigative and policy powers necessary to prevent, detect and prosecute anticompetitive conduct, market abuse and other practices which disrupt orderly trading in energy.

Integrated market supervision would furthermore enable better monitoring of price signals across various energy trading markets, including a harmonised approach to share market data. It would also increase transparency on transactions and positions, as well as ensuring similar organisational and operational safeguard measures are in place for spot and futures markets. Moreover, it would extend basic requirements of the MiFID 'trading rule book' to spot markets, anticipate unusual trading patterns and allow for quicker and more efficient remedial action.

Further policy and supervisory coordination powers at the EU level include:

- **The power to revise financial position limit rules (e.g., impose stricter limits, envisage different limits depending on the type of traders, extending the position limits to physically settled derivatives, etc.) or other position management measures necessary to support orderly pricing, clearing and settlement of energy futures.** Position limits are set to prevent market abuse or market manipulation (e.g. a large position holder 'cornering the market'). Their aim is to support orderly pricing and settlement conditions, including preventing market-distorting positions, and to ensure convergence between the prices of derivatives in the delivery month and spot prices for the underlying commodity. Position limits in the EU do not apply to the spot market for the commodity that underlies the derivative. In the US, energy commodities subject to position limits alongside agricultural commodities include Henry Hub natural gas contracts, gasoline and crude oil. Currently, the position limits for Henry Hub contracts are set at 2,000 contracts. While in the EU there exist position limits for financial derivatives, physically settled derivatives traded in an organised trading facility are, unlike the in the US, not subject to position limits.

- **The power to revise existing regulation on price limits** (e.g., impose stricter limits, less discretion for trading venues to set limits, more or less frequent update of the lookback period, etc.). These measures could ensure a maximum price range (either up or down from the previous day's settlement price) for a given futures contract in each trading session.

- **The power to initiate or approve additional liquidity and risk management requirements vis-à-vis unregulated participants in centrally cleared energy derivatives markets.** Trading activities should be undertaken by companies trading in the EU. As a minimum, all market participants (irrespective of domicile) need to report their trades (and positions) to the regulators in the EU.

- **The power to require and collect transaction and position data related to over-the-counter (OTC) energy derivatives, such as energy forwards or swaps from all futures market participants.** EU regulators do not have a view of the OTC positions that participants in regulated futures exchanges have open at any given time (implying that these OTC positions are not aggregated into any position management controls or, ultimately, the calculation of position limits).

- **The power to initiate or approve dynamic caps that cater for circumstances of extreme price levels, especially in situations where EU energy spot or derivatives prices significantly diverge from global energy prices (building on the experience of the Market Correction Mechanism[26]).** During the energy crisis, in august 2022 EU natural gas prices diverged from global gas prices (reaching a spread of EUR 100/MWh). This was not justified as supply was constrained and EU actors paying additional funds did not increase the volumes of gas into the EU.

- **A review of the 'ancillary activities exemption'.** Beneficiaries of the ancillary activities' exemption operate in both spot and derivatives markets[27]. Non-financial (typically energy) entities can trade in energy derivatives without being authorised as investment companies (the so-called 'ancillary activity exemption'). They are therefore not subject to the same level supervision and stringent requirements. While prices in gas spot and derivative futures markets are intrinsically linked by spread order books and arbitrage, there are also times when, for various reasons, spot and futures markets can diverge. During the crisis, concerns were raised about the potentially distortive conduct of some large players. Bringing them under the scope of financial regulation may increase market transparency and reduce the risk of misconduct.

7. Progressively decarbonise moving to H2 and green gases in the industry when cost-efficient.

Industrial energy demand relies on fossil fuels to provide heat and as a feedstock to produce chemicals, fertilisers and plastics. Where feasible, direct electrification is the most energy and cost-efficient way to replace fossil fuel consumption, concerning for example heating needs. Biomethane or clean hydrogen can offer decarbonised options to replace fossil fuels as high-temperature heat or feedstocks. Large-scale production of clean hydrogen and its deployment to replace fossil fuels is not expected to become energy or cost-efficient in the medium term. As discussed in the chapter relative to Energy Intensive Industries, policy support is needed to allow industrial offtakers to provide minimum levels of hydrogen, and to allow them to make the necessary investment decisions to decarbonise their industrial processes during this decade.

To support the early production and deployment of hydrogen, Member States could use the revenues from ETS allowances to further decarbonise. ETS revenues are already being used to promote hydrogen and CCUS deployment under the Innovation Fund, which provides grants for both technologies. In addition, the green premium offered by the Hydrogen Bank is already being deployed to this end to promote hydrogen production.

The development of hydrogen infrastructure connecting industrial offtakers with producers will also be critical. Refineries and fertiliser plants are already large hydrogen consumers. However, the hydrogen they consume is produced

26. In December of 2022, the EU adopted the Market Correction Mechanism as a dynamic cap linked to global prices activated in case of extreme natural gas prices. The fact that prices are linked to global developments is meant to ensure that the EU does not pay more than what is needed to attract natural gas. The mechanism was extended again in December of 2023 for one additional year, and it could be further extended in the future to avoid the amplification of external supply shocks in the EU.

27. While the US also has exemptions for the energy sector, they are based on the type of transaction rather than the type of business.

using natural gas (mostly local). Replacing this fossil-based supply of hydrogen would typically require large-scale electrolysers (gigawatt-scale – the equivalent capacity of a nuclear power station), which would require several gigawatts of power. It is therefore critical that hydrogen infrastructure is available to industrial offtakers.

This is important for two reasons. First, the availability of infrastructure will allow hydrogen production in locations where renewables are abundant and it is cheaper to produce. Second, it will enable a more liquid, competitive market offering lower prices to producers and consumers respectively.

8. Ensure natural gas price formation mechanisms are more cost-reflective of different sourcing conditions.

- **European gas prices that reflect the cost of different sourcing conditions are essential to foster the EU's competitiveness, given the price disparities between different sources.** During the energy crisis in 2022, the EU created an LNG benchmark based on real deliveries approximating the actual cost of LNG in the EU. Building on the ACER benchmark, which offers a credible EU LNG price reference for contract indexation and hedging strategies, new benchmarks on EU pipeline import prices and on EU industry purchasing prices could help to ensure price formation mechanisms that best reflect sourcing conditions. This could also support more competitive gas contract indexation, hedging strategies and enhance negotiation power (by promoting transparency) for EU industry and other gas consumers. Greater transparency concerning industry purchasing prices and pipeline import prices would also support more tailored policies and joint purchasing.

- **Fully enable the harmonisation of rules to improve the cost-reflectivity of network tariffs.** Currently, cross-border gas trading between market actors located in different Member States is charged several times (at injection, withdrawal and also at entry and/or exit area borders), depending on the number of political or system borders the gas is deemed to cross. This results in the so-called 'pancaking' of network tariffs. The implementation of new mechanisms, similar to the Inter-TSO compensation (ITC) mechanism for electricity, might better reflect true network costs[xliii].

- **Further investigate antitrust under EU competition policy (e.g. a sector inquiry) in electricity and gas markets, as well as concerning EU energy imports.** This could help to deter anti-competitive behaviours and tacit collusion among companies.

9. Facilitate industries exposed to international competition to get access to competitive energy sourcing.

- **Develop price comparison tools referencing industrial retail prices offered by different retailers in Member States to increase transparency and retail market competition.** More transparency on contracts offered by retailers could increase the competitiveness of industrial players not sourcing natural gas themselves directly, and improve informed decisions on decarbonisation opportunities. Retailers may have greater incentives to pass on a fall in wholesale prices to protect their market share in more competitive and transparent markets.

ELECTRICITY PROPOSALS

Key proposals in the electricity sectors should help to accelerate the supply of cheaper power generation sources (enabling the development of renewable energy, while maintaining and expanding nuclear and hydropower supply). Moreover, these proposals would help to decouple the remuneration of renewables and nuclear power from fossil-fuel generation (like natural gas) through long term contracts (e.g. PPAs and two-way CfDs) to limit the impact of fossil fuel commodity price variations on electricity prices. In addition, they would support the development of the required grids and flexibility infrastructure to avoid bottlenecks or intermittency leading to higher energy prices, while minimising overall system costs.

FIGURE 15

	SUMMARY TABLE – ENERGY: ELECTRICITY PROPOSALS	TIME HORIZON[28]
1	**Simplify and streamline permitting and administrative processes to accelerate renewables, flexibility infrastructures and grids deployment.**	ST/MT
2	**Foster network upgrades and investments in grids to address the electrification of the economy and avoid bottlenecks.**	ST/MT/LT
3	**Decouple the remuneration of RES and nuclear from fossil-fuel generation though long-term Contracts (PPAs and 2-way CfDs) to limit the impact of natural gas on electricity prices.**	ST/MT
4	Support PPAs for industrial users.	ST
5	Encourage self-generation by energy-intensive users.	ST
6	Reinforce system integration, storage and demand flexibility to keep total system costs in check with a competitive uptake of renewables.	ST/MT
7	Facilitate industry exposed to international competition to get access to competitive EU energy sources.	ST
8	Maintain nuclear supply and accelerate the development of 'new nuclear' (including the domestic supply chain).	ST/MT/LT
9	Promote the role of carbon capture, utilisation and storage (CCUS) technologies as one of the tools needed to accelerate the EU's green transition.	MT/LT

1. Simplify and streamline permitting and administrative processes to accelerate renewables, flexibility infrastructures and grids deployment.

In the short term, by implementing current provisions and reinforcing Member States' administrative capacity, Member States need to:

- **Transpose and implement existing legislation on renewables permitting.** Greater focus is needed on digitalising national permitting processes across the EU and on supporting the roll-out of training for national renewables permitting authorities.
- **Address renewables permitting authorities' lack of resources.** For instance, administrative fees for procedures should be reinforced to ensure permitting authorities have adequate capabilities (e.g. staff) to deliver prompt project permitting.

28. Time horizon is indicative of the required implementation time of the proposal. Short term (ST) refers to approximately 1-3 years, medium term (MT) 3-5 years, long term (LT) beyond 5 years.

- **In the medium term, stronger legislative action at the EU level can be taken to accelerate permitting for related infrastructure and flexibility projects and the networks necessary to integrate additional RES capacities into the energy system.** It will be necessary to improve permitting for grids at the transmission level, but also at distribution levels, where there is a clear weakness at the EU level (i.e. no clear planning or permitting deadlines).

- **The EU should make renewable acceleration areas (RAAs) and strategic environmental assessments the rule for renewables expansion (replacing individual environmental assessments per project).** The EU would develop legislation so that when a macro- environmental assessment in a specific region in the EU is made, all projects applying in the region would be green-lighted in a more shorter time span (except in Natura 2000 regions).

- **The EU should consider other targeted updates to relevant EU Environmental legislation (i.e. the Environmental Impact Assessment Directive, the Birds, Habitats, Water Framework and potentially the SEA Directive) for renewable energy installations and grids.** Consider including limited (in time and perimeter) exemptions in EU environmental directives (e.g. the Habitats Directive, the Birds Directive) until climate neutrality is achieved. Exemption requirements need to be met under certain conditions (e.g. installations do not endanger the population and mitigation measures).

- **The revised legislation should appoint last-resort national authorities to ensure the permitting of projects in case there is no answer from local authorities after a pre-determined time** (e.g. 45 days).

- **It could extend acceleration measures from the Renewable Energy Directive (RED) and emergency regulation to heat networks, heat generators, hydrogen infrastructure (including storage) and CCUS infrastructure.**

- **EU-level auctions for cross-border flexibility and renewables capacity.** Due to their size, some projects (e.g. large offshore wind in the North Sea) could apply for an EU procedure, bypassing those at the local level. A 28th regime for large projects, cross-border schemes for procuring flexibility and joint Member State cross-border auctions for renewables could significantly reduce costs and improve the efficiency of cross-border electricity flows.

2. Foster network upgrades and investments in grids to address the electrification of the economy and avoid bottlenecks.

- **Develop a comprehensive strategy at the EU level coordinated with Member States for strategic infrastructure development needs (e.g. intra and extra-EU interconnectors, hybrid offshore projects) and financing related to the extra-EU import of electricity and other clean energy sources.** This would help promote access to affordable energy sources and a more diversified EU energy system. Given the interaction between power and other energy vectors (such as natural gas, hydrogen, heat and carbon), network developments need to be considered in an integrated manner. A planning exercise could be developed at the EU level on grid and flexibility needs foreseeing what needs to be built in the next 20 years, building on ENTSO-E ten-year plan. Given the scale of the challenge related to electrification, the current ENTSO-E ten-year plans delivered at the national level would have to be reinforced.

- **Steer a deeper coordination between national and cross-border network operators and grid planners** to ensure investment efficiencies, including a greater harmonisation of the Network Development Plans. Coordination should include anticipatory investment forecasts to avoid duplication of efforts and ensure that investments come online in a timely manner, without creating bottlenecks, as well as ensure efficient outcomes at the lowest cost.

- **Simplify permits to facilitate the buildout of grids, including by digitalising local and national procedures to grant permits.**

Regarding relevant EU interconnections, the EU could:

- **Provide a 28th regime for interconnections.** A single procedure could be developed for Important Projects of Common European Interest (IPCEIs), shortening the length of national and local procedures integrating them into a single process. For offshore grids, which are to expand significantly, novel approaches such as the designation of dedicated regional entities to develop them, should be explored.
- **Establish a permanent European coordinator in charge of assisting in obtaining and/or delivering the necessary permits.** The coordinator would also be responsible for monitoring progress in the permit granting process and facilitating regional cooperation to ensure political backing for cross-border infrastructure from all Member States concerned.
- **Reinforce the EU budget tool exclusively dedicated to interconnections.** The delivery of interconnections requires EU delivery mechanisms. Relevant EU interconnection projects have been developed also with the support of the Connecting Europe Facility (CEF), funding approximately 30% of the infrastructures falling under CEF, for a total of approximately €6.9 billion of EU co-funding [xliv]. In the context of the next Multiannual Financial Framework (MFF), the EU should reinforce this mechanism. Funds disbursed to specific Member States instead of to concrete projects do not always lead to the desired outcome. Projects for interconnections supported by the CEF should benefit from a 28th regulatory regime that allows simplified procedures and permitting and would avoid the possibility of projects being blocked by individual national interests. There should also be a need to develop governance at the EU level to deliver projects of common European interest delivering European public goods to avoid the current stalemate in interconnections in several European regions.
- **Ensure an equitable distribution of costs in collaborative investment frameworks to realise cross-border infrastructure projects** for which benefits can extend beyond the Member States physically hosting the projects. Such investments need to be fair, based on a principle of equitable distribution of costs, while costs and benefit analyses as well as cost sharing and allocation activities need to be based on sound technical calculations. For new offshore hybrid interconnector projects, build on the guidance on collaborative investment frameworks for offshore energy projects[xlv] to ensure Member States, national regulatory authorities and system operators reach cost-sharing agreements for achieving EU countries' regional offshore renewable targets.
- **Develop innovative financing models and competitive mechanisms to support the uptake of grid and interconnector deployment which is not directly translated into an increase in prices for the consumer (pay-back mechanisms).** Given that grids are long-term investments with a very lengthy amortisation (an average economic lifetime of 20-50 years), their character defined by natural monopolies and the delivery of European public goods, make them a natural candidate for financing mechanisms using long-term debt. Together with the EIB and National Promotional Banks, the Commission should develop financial instruments mobilising private capital for grid investments to limit the extent to which their costs are translated into higher prices for consumers or into higher financing from public budgets. These instruments could include:
  - Public guarantees to de-risk long term loans for private capital investors and tackle refinancing risks associated to the long economic lifetime of grid assets.
  - A dedicated financial product provided for example by the EIB to support grid investments (e.g. syndicated loans diluting the risk for private long-term financing).
  - Equity or quasi-equity financing as an additional type of financial solution. Implementing a model with a higher private participation requires changes in legislation, redefining responsibilities across different entities such as regulatory bodies and transmission and distribution companies to limit risks associated to privately owned critical infrastructure.
  - All avenues for greater cost-sharing between Member States that are set to directly benefit grid deployment should be pursued to make new interconnectors financially feasible.

- **Foster the standardisation of key grid components to lower their cost, accelerate deployment and increase manufacturer output by encouraging economies of scale and interoperability.** Building on the European Grid Action Plan, relevant stakeholders (TSOs, DSOs and manufacturers) should develop common grid equipment standards to be deployed across the EU to address delays and inefficiencies resulting from a lack of standardisation in current grid-related procurement in the EU.

3. **Decouple the remuneration of RES and nuclear from fossil-fuel generation though long-term contracts (PPAs and 2-way CfDs) to limit the impact of natural gas on electricity prices.**

- **Decouple the remuneration of RES and nuclear from fossil-fuel generation** by building on the tools introduced under the new Electricity Market Design (e.g. using PPAs and two-way CFDs). Moreover, develop an enabling framework to progressively extend PPAs and CFDs to all renewables and nuclear assets in an harmonised way. Ensure long-term competitive (where possible) mechanisms to contract resources, anyways closer to costs.

- **Keep the marginal pricing system to ensure the efficient balance of the energy system**. This would help to send accurate price signals driving generation and consumption at the right time and location in the short term.

- **During periods of crisis, foresee a cap on market revenues for inframarginals** as the one introduced during the crisis with an article 122 regulation. At the same time, it must be ensured that the cap level preserves operators' profitability and does not hinder investment in renewables.

4. **Support PPAs for industrial users.**

- **The EIB and National Promotional Banks could provide counter guarantees and specific financial products for industrial users' PPAs**. Small consumers or suppliers often have limited access to PPAs. They have difficulties without a proper credit rating in demonstrating their bankability and ability to honour obligations. Increasing the availability of guarantees for financial counterparty risk is therefore key.

- **Increase the availability of guarantees for financial counterparty risk.** Where diversified sets of providers and contractual conditions help to minimise the risk of breach or default, guarantees could further benefit offtakers by lowering credit risks.

- **Ensure long-term competitive (where possible) mechanisms and develop national market platforms to contract resources and pool demand between generators and offtakers.** The PPA market has the downside of being less transparent than organised markets. Member States can address this by creating national market platforms and by pooling demand and the supply of PPAs between generators and offtakers which currently have little access to the PPA market. Where necessary, this can be combined with the above guarantees to cover financial counterparty risk for PPAs entered using such platforms. Additionally, supporting upfront investments from PPA buyers could limit generators' resort to loans, significantly reducing the cost of the project, especially in a context of high interest rates.

- **Foster the pooling of demand by industrial consumers** for renewable power to lower operating costs through corporate PPAs, for instance under the supervision of a public body acting as a single buyer and seller for participating companies, mitigating costs of matching industrial demand with variable renewable generation profiles.

- **The customisation of PPAs to buyers' consumption profile and its bilateral nature restrains the reselling of PPA contracts and limits the uptake of markets where PPAs can be bought and sold.** Moving beyond standardised voluntary PPA contracts, the EU could develop standards for PPAs to enable the uptake of PPA markets. Efforts should also focus on allowing the uptake of a European PPA market by standardising contracts among Member States and lifting cross-border flow barriers.

5. **Encourage self-generation by energy-intensive users.**

- **Member States should transpose and implement existing legislation, guidance and recommendations.** Member States should also continue promoting and removing barriers to self-consumption as foreseen in the Renewable Energy Directive (RED) and the Electricity Market Design (EMD) Regulation.
- **Develop an enabling framework aiming to adapt network tariffs for self-generation to more accurately reflect its overall system cost.** Network tariffs should ensure self-generation is fairly remunerated to foster its development given its benefits for the grid and the EU's decarbonisation. In parallel, network tariffs should ensure they maintain a financial incentive by reflecting the overall system cost. This will help to encourage the self-consumption of energy produced (including through energy-sharing initiatives[xlvi]), rather than its injection into the grid which could lead to increased balancing costs for consumers.
- **Foster an enabling framework for a flexible connection agreement under which system operators can connect industrial consumers even when the system lacks sufficient capacity to cover their full consumption.** Under this system, industrial players would plan to cover their own supply through self-generation and storage at times when their consumption exceeds the capacity of their grid connection. The framework should ensure that industrial players are appropriately compensated for the constraints associated with flexible connections by offering lower network charges and shortening connection delays, reducing their overall energy costs.

6. **Reinforce system integration, storage and demand flexibility to keep total system costs in check with a competitive uptake of renewables.**

- **Ensure integrated planning among renewables, flexibility, battery, storage, hydrogen and other energy actors to prevent inefficient investment.**
- **Ensure competitive bidding procedures for renewable auctions** including non-price criteria that enhance system integration. Competitive renewable auctions should ensure the rapid, efficient and sustainable deployment of renewables, strengthening the competitiveness of the sector. Well-designed auctions and in particular the inclusion of non-price criteria rewarding quality and system integration can support a competitive industry while keeping system costs in check.
- **Develop a mapping of EU flexibility needs and a strategy fostering investment in flexibility assets.** Alongside this, renewables uptake should be coordinated so that the significant increase in their generation can be accommodated for, while limiting the impact of flexibility requirements on end electricity prices. Eliminate barriers to flexibility, both short-term and seasonal, and stimulate the uptake of emerging technologies, such as demand response, advanced storage solutions and the digitalisation of the grid. Companies can be incentivised (e.g. through payments) to produce mainly when there is enough supply and electricity prices are lower. In addition, households can offer demand-side flexibility to shift energy consumption in time. Compared to other markets worldwide, the participation of energy-intensive industries in flexibility and demand response in the EU is still underdeveloped. In a market environment dominated by volatile renewables, their participation has the potential to significantly reduce price exposure.
- **Create a standard compensation mechanism for industrial demand flexibility to financially boost the competitiveness of EU industry.** Industrial demand response may reduce overall energy system costs, benefit the integration of renewables and enhance overall grid flexibility, while reducing energy costs for industry. While some Member States have introduced mechanisms in that sense, these are not standardised and the market price of 'voluntary demand flexibility' is not clear from the perspective of the Single Market.
- **Accelerate the authorisation process of capacity mechanisms and flexibility instruments and ensure that the design of these mechanisms are standardised structural components of the electricity market.** This includes ensuring appropriate financial incentives and regulatory requirements are in place to incentivise flexibility solutions, such as batteries and demand reduction. Increased clean flexible capacity and affordability will encourage wider adoption of renewable energy sources, enable energy storage, balance supply and demand, and ensure grid stability.

- **Further progressively develop[29] locational price signals in electricity markets reflecting the local value of energy.** Price formation in electricity should in future better reflect the underlying network constraints, rather than national borders. Market projections show that stronger locational price signals can reduce the cost of operating future European electricity systems. Information on locational price costs should be available to market participants, and could steer decisions for supply, demand (e.g. industry) and infrastructure investments. Progressively introducing locational price signals in power systems would gradually reduce the need to curtail renewable generation whilst activating expensive fossil-fuel generation for redispatch. A step in this direction could be for such locational signals to be introduced in renewable auctions and in the design of network charges. A broader shift towards locational pricing would have to be combined with the necessary transitional arrangements to manage the impact in specific regions which currently still suffer from insufficient generation and infrastructure bottlenecks.

- **Incentivise (e.g. through the correct compensation mechanism for consumers) the large-scale roll-out of bidirectional charging for electric vehicles (EVs).** This will help to ensure that the EU's growing EV fleet becomes a flexibility asset for the grid, lowering overall system costs.

7. **Facilitate industry exposed to international competition to get access to competitive EU energy sources.**

- **Require suppliers to supply a predefined minor share of their publicly subsidised production through PPAs at 'production cost plus mark-up' to specific industries exposed to international competition**. This could also be presented as a release of CfDs.

- **Develop price comparison tools referencing industrial retail electricity prices offered by different retailers in Member States.** This could help to increase transparency and retail market competition.

8. **Maintain nuclear supply and accelerate the development of 'new nuclear' (including the domestic supply chain).**

- **In the short term, adopt a cost-efficient approach to the extension of nuclear assets (in full respect of safety and security concerns).** The vast, majority of nuclear assets have already built and amortised. Therefore, it can make sense to extend their lifetime to benefit from lower generation costs in the power mix. In other cases, the extension of assets would require a significant investment effort. This effort should be commensurate with the expected benefits for the economy, for instance its potential to enhance the security of supply and reduce energy prices.

- **In the medium to long term, develop EU industrial value chains for the cost-efficient deployment of established nuclear technologies and 'new nuclear' (SMRs and AMRs), for the instances that Member States would like to pursue these technologies.** In 2024, the Commission launched the European Industrial Alliance on Small Modular Reactors to facilitate and coordinate stakeholder cooperation at the EU level for the development, demonstration and deployment of SMRs as a viable and competitive technological solution to decarbonise the European energy system. The first projects are expected to be delivered in the 2030s.

- **Allocate additional financial support to R&I in new nuclear technologies like SMRs, including from the EIB.**

- **Facilitating and coordinate future research and innovation needs, particularly for AMRs.** This should be achieved under the Euratom Research and Training Programme and by establishing a nuclear skills academy.

- **Support national nuclear safety regulators, including by developing an enabling framework for standardisation and for regulatory sandboxes.** This would ensure a smooth and robust licensing process, and help to reduce site-specific costs, as well as risks for investors.

29. Locational price signals reflect supply and demand conditions and help in guiding investments and locate demand and supply. The introduction should be progressive and include mitigating measures across different areas exposed to different price dynamics.

9. Promote carbon capture, utilisation and storage (CCUS) technologies as one of the tools needed to accelerate the EU's green transition.

In the years to come, it will be essential to avoid the lock-in of the EU's fossil-fuel power generation fleet in the EU's energy system.

- **This could be achieved through retrofitting, while increasing the flexibility of the energy system to cater for a growing share of renewables generation.** In the case of bioenergy, 'negative-emission' power plants could even be envisaged. However, for this solution to be developed at scale, further support is required for bioenergy to become cost-competitive.
- **ETS revenues could help to support the development of CCUS solutions in those sectors under the scope of the ETS, including power generation.** ETS revenues could be used to provide capital support or premium payments to fill the current competitiveness gap vis-à-vis the market price without deploying CCUS.

HORIZONTAL PROPOSALS

Additional proposals consider taxation, price support schemes, innovation and the governance of the energy sector from a 'horizontal' perspective.

FIGURE 16

	SUMMARY TABLE – ENERGY: HORIZONTAL PROPOSALS	TIME HORIZON[30]
1	**Lower and level the energy taxation playing field and the strategic use of taxation measures to reduce the cost of energy.**	ST/MT
2	Harmonise price reliefs and avoid distortions in the Single Market.	ST/MT
3	Foster innovation in the energy sector.	MT/LT
4	**Develop the governance needed for a true Energy Union.**	MT

1. Lower and level the energy taxation playing field and the strategic use of taxation measures to reduce the cost of energy.

- **Propose a common maximum level of surcharges (including the different taxes, levies and network charges) across the EU.** Legislative reform in this area is subject to unanimity, but cooperation among a sub-set of Member States or guidance on energy taxation may also be considered.
- **Propose tailored tax credits linked to the uptake of clean energy solutions by industry or accelerated depreciation regimes for such investments.** A harmonised EU legislative framework would address the State aid concerns of such a measure. By making these tax credits transferable (as is done in the US), they would become even more appealing to companies and investors.

2. Harmonise price relief and avoid distortions in the single market

- **National interventions in energy markets should be limited**. During the energy crisis, all Member States introduced national measures to support their citizens and the economy, and mitigate security of supply risks. ACER calculates that more than 400 emergency measures were adopted during the 2021-2023 period for both electricity and gas[xlvii]. Interventions by Member States during the energy crisis were for the most part made unilaterally and in a non-coordinated manner. ACER's assessment of the emergency measures in electricity markets found that Member States' interventions in retail and wholesale markets have a negative impact on market integration.

30. Time horizon is indicative of the required implementation time of the proposal. Short term (ST) refers to approximately 1-3 years, medium term (MT) 3-5 years, long term (LT) beyond 5 years.

These uncoordinated Member State measures artificially increased price divergence and altered cross-border trading patterns (e.g. by artificially redirecting electricity flows across borders) as a result of changing drivers of wholesale prices or shortages. Retail market interventions have in some cases strengthened the role of dominant incumbents and reduced consumer choice. The energy crisis has shown that uncoordinated approaches by Member States can affect the resilience of the electricity system, also in neighbouring countries. Therefore, coordination and collaboration on approaches to emergency measures, and eventually a related governance architecture, is necessary to avoid unintended, counterproductive effects in neighbouring Member States.

- **The Commission should develop State aid guidelines harmonising the type of support that is allowed to be provided through State aid, so that it does not distort the Single Market.** This should apply in particular to inframarginal existing assets in line with the revised Electricity Market Design proposal. Where the above tools are not sufficient to ensure competitive pricing in the short term, Member States should be given the opportunity to intervene and provide price relief. Conditions for such price relief have to be harmonised at the EU level to ensure a level playing field between Member States (avoiding relocation due to the uneven spending capacity of Member States or an unclear approach to what is allowed under State aid guidelines). EU State aid rules would have to be modified to provide price support[31]. To avoid negative budgetary implications, price relief must be targeted to the economic sectors most exposed to international competition. A sector list would have to be established at the EU level, which reflects two criteria: i) extra-EU trade intensity as a measure of exposure of the sector to international competition; and ii) energy-intensity as a means of identifying sectors for which energy represents the greatest share of their value added. Examples of similar sector lists already exist in EU legislation. The extent of possible price relief should be limited and of temporary nature. Member States should not be able to guarantee an end price for their industry, but should offer a percentage discount on the normal market price. This will ensure that relative price differentials between different national markets are preserved. Price relief should be designed to preserve incentives for the necessary flexibility of industrial demand and energy efficiency investments.

- **Propose guidance to harmonise electricity grid tariff methodologies within the EU to achieve a higher degree of alignment and to limit distortions to the level playing field for industries and new technologies (e.g. batteries and electrolysers) within the EU**. With the anticipated rise in network tariffs due to the electrification of the economy, differences in national tariff structures will further affect the level playing field over time, calling for a higher degree of alignment on the nature and conditions of grid tariff exemptions and degressive tariff structures.

3. Foster innovation in the energy sector.

According to the IEA, 35% of the greenhouse gas reductions needed to keep the 1.5 °C scenario will come from technologies not currently available on the market.

- **Concentrate, increase and speed up R&I funding under the EU budget for key technologies delivering more affordable energy to reach greater scale.** Synergies need to be explored between the missions and partnerships under the successor programme of Horizon Europe, alongside private funding. This would concern in particular:
  - Large-scale batteries. Advancements in battery technology are crucial for the transition to renewable energy. Improved battery capacity and affordability (e.g. through front-to-meter batteries) will encourage the wider deployment of renewables. The capacity of battery energy storage systems is expected to quintuple between now and 2030[xlviii].
  - Low-emission hydrogen production and carbon capture.
  - Innovative grid technologies allow to increase the utilisation of the grid and help in achieving network buildout targets, by increasing the capacity of single power lines, providing a better understanding of the real time conditions of power lines, through actively steering power flows on the network, and by providing a better

31. Currently, such interventions are mostly limited to reductions of RES charges and the compensation of indirect ETS costs.

understanding of the real time stability of the power system. Assuming a reasonable coverage of innovative technologies, estimates show that the capacity/line length of the wider network could for example be improved by 20 to 40%[xlix]. Through different cost structures, innovative grid technologies however still face barriers compared to conventional grid technologies, requiring an update of regulatory incentives and solutions to foster the roll-out of innovation and provide major benefits to the system.

- Cheaper renewables technology (e.g. for wind and solar energy), including the development of larger turbines, large-scale offshore wind parks and floating offshore wind energy technology.

- Maritime energy.

- **Promote innovation in competitive bidding procedures for renewable auctions,** including non-price criteria that promote innovation, either incremental or disruptive innovation, fostering the development of new solutions that can either decrease energy costs or strengthen the competitive position.

- **Develop a comprehensive international intellectual property strategy and protect promising patents and innovation of relevance to the EU.**

- **Help to bring innovative solutions to market faster by deploying regulatory sandboxes.** Regulatory sandboxes allow the testing of innovative technologies in a controlled environment, including by supporting deep-tech research by energy and clean energy start-ups.

- **Leverage the potential of artificial intelligence (AI) to drive the twin green and digital transitions of the EU's energy system.** By using AI solutions, the energy system would gain new capabilities offered by emerging digital technologies and could reap additional benefits speeding up the EU's decarbonisation and the decentralisation of the energy system.

- **Develop an overarching EU innovation strategy for nuclear fusion energy and support the creation of a public-private partnership to promote its rapid, economically viable commercialisation.** The partnership should aim to create a stable and predictable ecosystem for industrial innovation, leveraging the ITER project, while ensuring a clear technology development roadmap. The deployment of fusion energy will require public and private investment to act in synergy.

4. Develop the governance needed for a true Energy Union.

- **Revise the governance of the Single Market for energy to ensure that decisions and market functions of cross-border relevance are taken and carried out centrally.** Insufficient governance triggers unjustified delays in the transition and creates extra cost for electricity consumers and companies. The current framework for the governance of the internal energy market has evolved from a system where national regulators oversaw their respective systems without their regulatory decisions having a direct impact on neighbouring Member States. Many regulatory powers and decisions are still dependent on bodies established at the national level. However, the increasing degree of market integration and the growing challenges posed by the energy transition already demonstrate the limitations of this system. The increasing market integration required for the green transition over the coming years (e.g. helping to fill crucial gaps in cross-border, common infrastructure) will exacerbate these limitations. Moving forward, given the role of energy as an European public good, it will be necessary to develop a more integrated governance system to increase efficiencies in investment trade-off decisions, for example for the integration of renewables, grids and storage to ensure firm power and lower total system costs.

- This could draw inspiration from the EU's Economic and Monetary Union (EMU). This new framework may have the following components:

  - **Central regulatory oversight over all processes and decisions of direct cross-border relevance.** A stronger, more robust institutional framework would entail strengthening the monitoring, investigation and decision-making powers at the EU level with the possibility of providing full regulatory oversight over all decisions and processes of direct cross-border impact affecting Member States.

- **Tasks of a regulatory nature to be performed by regulators.** The current system still reserves a number of tasks and responsibilities of a regulatory nature to private bodies with commercial interests. This is largely for historical reasons due to the way in which today's liberalised energy market has emerged from a series of fully regulated national systems. All tasks of a regulatory nature should be performed by regulatory agencies acting in the public interest. A good example is the way in which the binding regulatory requirement to ensure 70% of transmission infrastructure is used for cross-border trade is currently policed directly involving ENTSO-E, a body which represents the different owners and operators of transmission infrastructure at the national level.
- **Central functions must be performed centrally.** Several key functions for the operation of an integrated European market are currently still performed by a series of national bodies. A good example is the operation of the algorithm underlying EU market coupling in electricity, which is currently managed by several market operators established in different EU Member States on a rolling basis. This not only limits the speed at which the necessary changes to this algorithm can be made, but also makes appropriate regulatory oversight over such a key function very difficult in practice. The reform should therefore ensure that central market functions of relevance for an integrated market are performed centrally and subject to proper regulatory oversight.

ENDNOTES

i EIB, EIB Investment Survey: European Union overview, 2023.

ii IEA, Net imports of fossil fuel as a share of GDP, 2024.

iii Eurostat, COMEXT, 2024.

iv Cedigaz, 2024.

v Di Comite, F., Pasimeni, P., Decoupling from Russia: Monitoring Supply Chains Adjustment in the EU, 2023.

vi The White House, Statement from President Joe Biden on Decision to Pause Pending Approvals of Liquefied Natural Gas Exports, 2024.

vii IEA, World Energy Outlook 2022, 2022, p. 391.

viii ACER, Analysis of the European LNG market developments, 2024.

ix Pexapark, European PPA Market Outlook 2024, 2024.

x SolarPower Europe, EU Market Outlook for Solar Power 2023-2027, 2023.

xi ESMA, TRV Risk analysis – EU natural gas derivatives markets: risks and trends, 2023.

xii ACER, ACER's Final Assessment of the EU Wholesale Electricity Market Design, 2022.

xiii TenneT TSO, Electricity Investments in Transmission Infrastructure, Impact on Grid Fee Development, 2024.

xiv Thomassen, G., Fuhrmanek, A., Cadenovic, R., Pozo Camara, D., Vitiello, S., Redispatch and Congestion Management, 2024.

xv IEA, Electricity Grids and Secure Energy Transitions, 2023.

xvi European Commission, Commission Staff Working Document implementing the Repower EU Action Plan: Investment needs, hydrogen accelerator and achieving the bio-methane targets (SWD(2022) 230), 2022.

xvii ENTSO-E, System needs study – Opportunities for a more efficient European power system in 2030 and 2040, 2023.

xviii ACER, 2023 Market Monitoring Report, 2023.

xix ENTSO-E, What are the concrete benefits for Europe of investing in its cross-border transmission grid and storage infrastructure?, 2024.

xx Eurelectric, Connecting the dots: Distribution grid investment to power the energy transition, 2021.

xxi European Commission, Commission Staff Working Document for a Regulation of the European Parliament and of the Council on establishing a framework of measures for strengthening Europe's net-zero technology products manufacturing ecosystem (Net Zero Industry Act) (SWD(2023) 219), 2023.

xxii European Commission, Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions: Grids, the missing link - An EU Action Plan for Grids (COM/2023/757), 2023.

xxiii Fachagentur Windenergie, Quentin, J. Typische Verfahrenslaufzeiten von Windenergieprojekten, 2023.

xxiv European Commission, Directorate-General for Energy, Tallat-Kelpšaitė, J., Brückmann, R., Banasiak, J. et al., Technical support for RES policy development and implementation – simplification of permission and administrative procedures for RES installations (RES Simplify) – Final report, 2023.

xxv European Commission, Report from the Commission to the Council on the review of Council Regulation (EU) 2022/2577 of 22 December 2022 laying down a framework to accelerate the deployment of renewable energy (COM/2023/764), 2023.

xxvi European Commission, Directorate-General for Competition, Competition State aid brief, 2023.

xxvii US Energy Information Administration, Electricity explained - Factors affecting electricity prices, 2023.

xxviii OECD, Taxing Energy Use 2019: Country Note United States, 2019.

xxix European Commission, Commission Staff Working Document – Impact Assessment Report: Part 1 Accompanying The Document Communication From The Commission To The European Parliament, The Council, The European Economic And Social Committee And The Committee Of The Regions Securing our future Europe's 2040 climate target and path to climate neutrality by 2050 building a sustainable, just and prosperous society (SWD/2024/63), 2024.

xxx Gil Tertre, M., Structural changes in energy markets and price implications: effects of the recent energy crisis and perspectives of the green transition, 2023.

xxxi Helm, D., Cost of energy review, 2017.

xxxii IAEA, Small Modular Reactors: A new nuclear energy paradigm, 2022.

xxxiii Gasparella, A., Koolen, D., Zucker, A., The Merit Order and Price-Setting Dynamics in European Electricity Markets, 2023.

xxxiv Koolen, D., De Felice, M., Busch, S., Flexibility requirements and the role of storage in future European power systems, 2023.

xxxv IEA, Medium-Term Gas Report 2023, 2023.

xxxvi WindEurope, Investments in wind energy are down – Europe must get market design and green industrial policy right, 2023.

xxxvii European Commission, Report from the Commission to the European Parliament and the Council Progress on competitiveness of clean energy technologies (COM/2023/652),2023.

xxxviii Bloomberg NEF, Net Zero Scenario - Europe Needs Clean Power and Grid Funding Balance, 2023.

xxxix Kamiya, G., Bertoldi, P., Energy Consumption in Data Centres and Broadband Communication Networks in the EU, 2024.

xl Indigo Advisory Group, Research on AI and the energy sector, 2023.

xli The Economist, Big tech's great AI power grab, 2024.

xlii IEA, Despite short-term pain, the EU's liberalised gas markets have brought long-term financial gains, 2021.

xliii Pototschnig, A., European gas transmission tariffication: is it really fit for an Internal Gas Market?, 2024.

ENDNOTES

xliv CINEA, Interconnected sustainable energy infrastructure for Europe, 2024.

xlv European Commission, Guidance on collaborative investment frameworks for offshore energy projects, 2024.

xlvi European Commission, Directorate-General for Energy, Energy sharing for energy communities, 2024.

xlvii ACER, ACER's inventory of 400+ energy emergency measures seeks to aid policy makers going forward, 2023.

xlviii McKinsey & Company, Enabling renewable energy with battery energy storage systems, 2023.

xlix Compass Lexecon, Prospects for innovative power grid technologies, 2024.

2. Critical raw materials

The starting point

Critical raw materials are essential to accelerate the transformation required of the EU's economy. Rapid demand growth is putting at risk the global supply-demand balance, with additional challenges posed by the limited diversification of supplies and a high level of dependency in EU supply chains.

MULTIPLE CHALLENGES TO BE ADDRESSED

Raw materials are critical for a broad range of goods. These materials are needed to deliver clean energy technologies for the green transition (e.g. lithium, cobalt and nickel for producing batteries, among other clean energy technologies – see Figure 1), advanced technologies for the digital transition (e.g. gallium for semi-conductors), and defence and space applications (e.g. titanium and tungsten). As an example, one smartphone might contain up to 50 different metals.

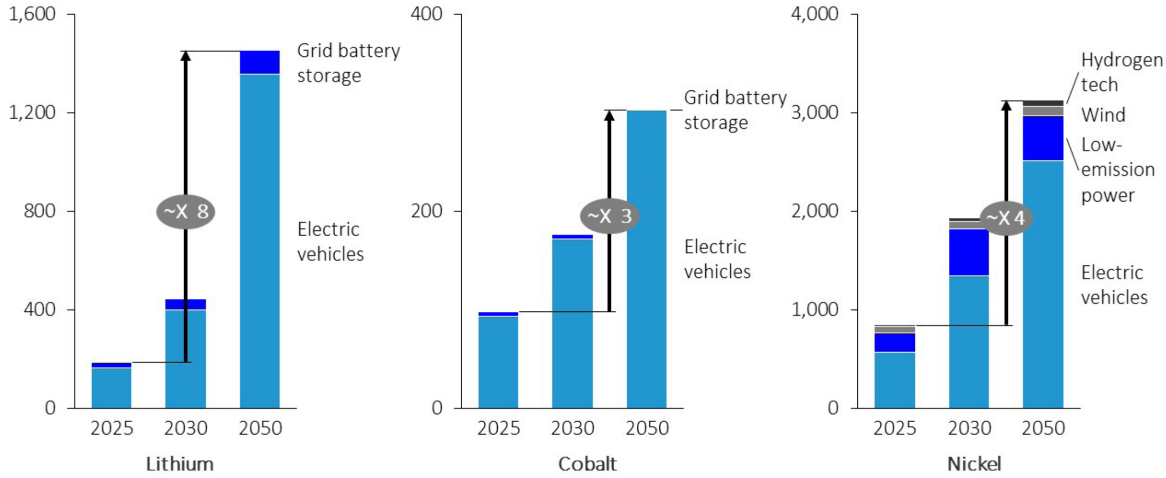
TABLE OF ABBREVIATIONS

CAGR	Compound annual growth rate
CRMA	Critical Raw Materials Act
EBRD	European Bank for Reconstruction and Development
EIB	European Investment Bank
FTA	Free trade agreement
G7	Group of Seven
HREE	Heavy rare earth element
IEA	International Energy Agency
IRA	Inflation Reduction Act
IROPI	Imperative reason of overriding public interest
JOGMEC	Japan Organization for Metals and Energy Security
KOMIR	Korea Mine Rehabilitation and Mineral Resources Corporation
LME	London Metal Exchange
LREE	Light rare earth element
MSP	Minerals Security Partnership
OECD	Organisation for Economic Co-operation and Development
TSI	Technical Support Instrument

FIGURE 1

Demand for selected critical and strategic minerals by usage

IEA Announced Pledges Scenario, in kt.



Source: IEA, 2024.

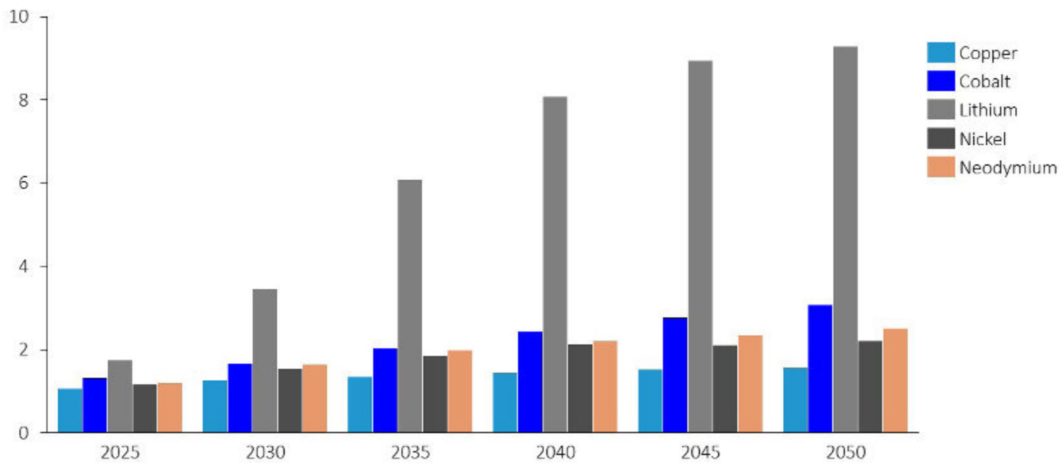
The demand for these minerals has significantly increased in recent years driven by the demand for electric vehicles and other clean technology applications. Demand is expected to continue to grow at a very high rate. The market size of critical minerals for the energy transition has already doubled during the past five years, reaching EUR 300 billion in 2022 according to the International Energy Agency (IEA)[i]. Record deployment of clean energy technologies (e.g. batteries and solar panels) is driving unprecedented growth in demand. From 2017 to 2022, the global market has seen a tripling in demand for lithium, a 70% jump in demand for cobalt, and a 40% rise for nickel. In 2022, the share of demand for these materials for clean energy applications reached 56% for lithium, 40% for cobalt and 16% for nickel (up from 30% for lithium, 17% for cobalt and 6% for nickel five years ago).

Under different scenarios according to the International Energy Agency, demand for clean energy technologies will multiply between two and three times by 2030. This will drive growth in the total demand for selected critical minerals from 25% to over 300%. Mineral demand for clean energy technologies specifically is expected to increase with a factor of 4 to 6 by 2040.

FIGURE 2

Relative demand growth for selected critical and strategic minerals

Growth factor (base=2022), IEA Announced Pledges Scenario



Source: European Commission (based on IEA), 2023.

Investment is increasing, but an adequate supply is far from assured. To cope with demand, investment in critical mineral development is increasing worldwide, mostly outside the EU. Global investment increased by 30% in 2022, following a 20% increase in 2021[ii]. While a host of newly announced projects indicate that supply is catching up with countries' clean energy ambitions, an adequate future global supply is far from assured. Even with an overall balance of supply and demand, products' quality is not guaranteed (concerning batteries, there is an important distinction between technology grade products and battery grade products). Finally, new mining often comes at first with higher production costs, pushing up marginal costs and prices.

A new dependency on critical raw materials concentrated in a handful of providers is emerging with the potential to slow the progress of the EU's green and digital transitions or make them more costly. The supply of mineral value chains is generally very concentrated, especially for processing and refining (e.g. in China). The supply chain of critical raw materials has different stages from exploration and mining to processing and refining, ending with recycling. All are subject to concentration.

In certain cases, the EU is heavily dependent on one or two countries. China holds a predominant position in the global extraction of rare earths, accounting for 68% of the global market [see Figure 3]. In addition, China maintains a dominant role in graphite production, accounting for 70% of global output. Most cobalt production, around 74%, is concentrated in the Democratic Republic of Congo. Similarly, Indonesia contributes a significant share of global nickel production, accounting for 49% of the global market, while Australia accounts for 47% of global lithium production[iii].

Limited progress has been made in diversifying global supply sources in recent years. Compared with the situation three years ago, the share of the top three producers in 2022 either remains unchanged or has increased further, especially for nickel and cobalt.

Regarding refining operations, the market has become even more concentrated over time (e.g. China holds half of all planned lithium chemical plants, Indonesia possesses nearly 90% of planned nickel refining facilities, Chinese firms own 15 out 19 copper and cobalt mines in the Democratic Republic of Congo).

Collusion could become a source of future concern. While there is not yet an organisation of exporting countries for critical raw materials equivalent to OPEC[01], should exporting countries coordinate market power (e.g. on prices or trade), it may hold a significant risk for highly dependent importers like the EU or Japan.

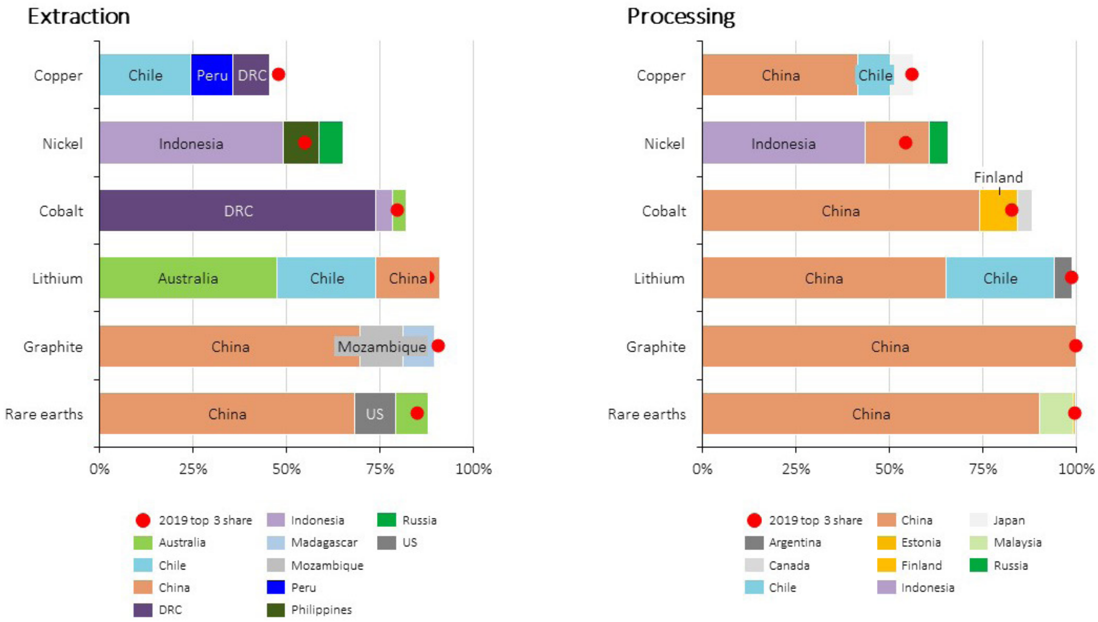
Market concentration and limited diversification are particularly critical in the context of export restrictions. As critical raw materials are positioned upstream in the international supply chain, export restrictions have been introduced to support downstream domestic sectors. Market restrictions have increased fivefold globally since 2009 and around 10% of the global value of critical raw material exports encountered at least one export restriction measure recently. For example, tin, titanium, platinum and cobalt have all been identified as key critical raw materials facing significant export restrictions. Countries with the highest incidence of export restrictions include China, India, Russia, Argentina and the Democratic Republic of the Congo. Noteworthy is China's substantial increase in the number of restrictions, growing by a factor of nine between 2009 and 2020, establishing itself as the country with the most extensive array of export restrictions on critical raw materials.

01. OPEC is an intergovernmental organisation of 12 oil exporting countries.

FIGURE 3

Concentration of the extraction and processing of critical resources

Share of top-three producing countries in total production for selected resources and minerals, 2022



IEA. Based on S&P Global, USGS, Mineral Commodity Summaries and Wood Mackenzie, 2024.

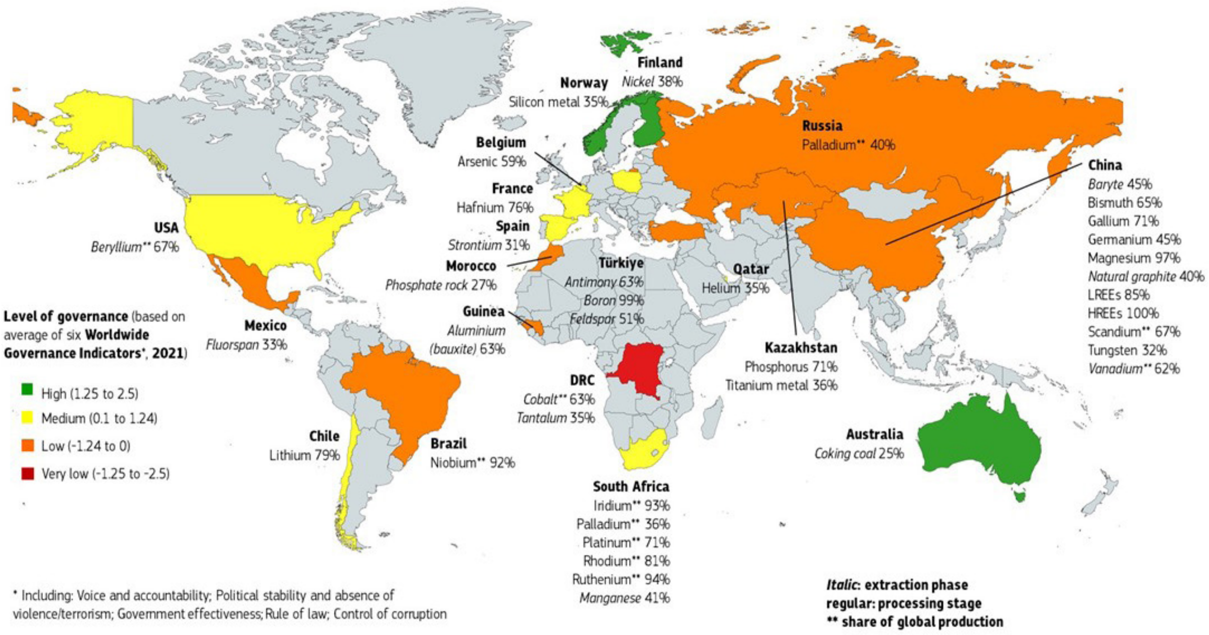
Additional challenges contribute to the vulnerability[02] of supply chains[iv]. As shown in Figure 4, most imports to the EU rely on countries with low governance rankings (governance includes aspects on political stability, government effectiveness, rule of law, control of corruption, and voice and accountability), indicating higher potential risks of supply disruptions. While for fossil fuels, oil stocks and gas storage play an important role in cushioning shocks in the market, there is no similar equivalent for critical raw materials. For instance, stock levels in the London Metal Exchange[03] (LME) remain at historic lows for metals like copper and nickel.

Moreover, while trade restrictions on raw materials often involve bans, quotas, or export taxes, recent measures applied to gallium, germanium, and graphite now operate with case-by-case export permits, including requirements for the final industrial user abroad. A system of individual export authorisations means potential distortive effects could be harder to track, increase market fragmentation, and make targeted measures more likely.

02. Feeding into the definition of the list of critical raw materials, the European Commission provides an indicator for the EU's vulnerability in its raw materials supply by assessing 87 individual raw materials, including heavy rare earth elements (HREE), light rare earth elements (LREE) and platinum, according to their criticality.

03. The London Metal Exchange is a commodity exchange based in London, United Kingdom. It is the reference market for base metals, with over 80% of global trades, offering market participants standardised options and future contracts to mitigate price risks. The exchange also offers contracts on ferrous and precious metals.

FIGURE 4
Major EU suppliers of CRMs and their governance ranking
2023

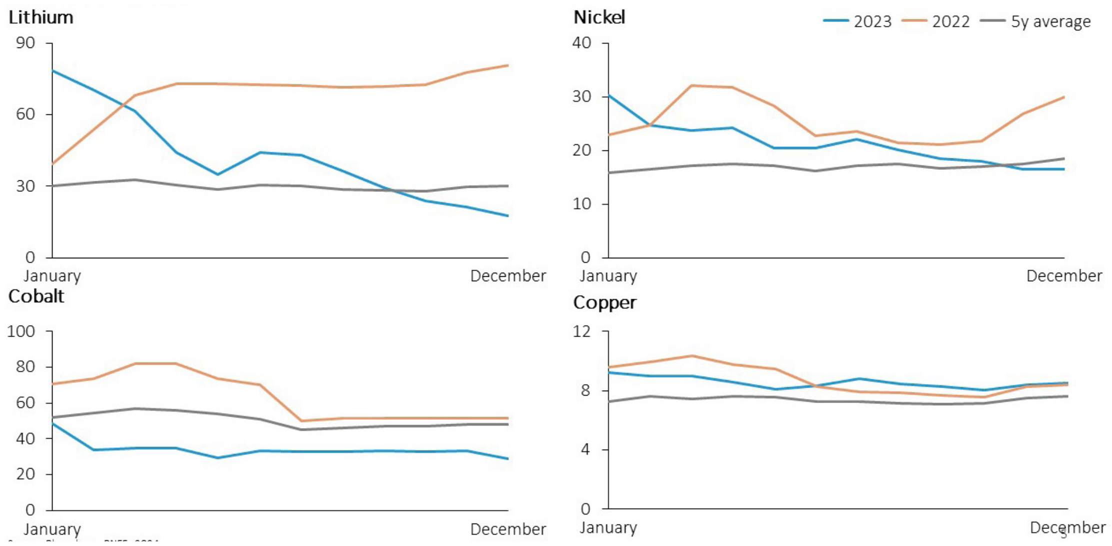


Source: European Commission, 2023.

As a result, the world is entering a more volatile era regarding the price of these materials, with risks of sustained higher prices and volatility. Many critical minerals – notably lithium, but also cobalt, nickel, copper and aluminium already experienced significant price increases between 2021 and 2022. Price increases have been attributed to a combination of rising demand, disrupted supply chains and concerns concerning the tightening of supply. Price increases became more moderate at the end of 2022 and decreased to 2021 levels this year. The surge in prices has, however, been a major factor in reversing, at least temporarily, the trajectory of declining costs for some clean energy technologies like solar panels and wind energy technologies.

According to different scenarios, selected metals may reach historical price peaks and high volatility for an unprecedented, sustained period potentially derailing the twin green and digital transitions[v]. Excessive recent volatility in materials markets represents a serious concern for all investment along the mineral supply chain. Mining companies are generally price-takers and baseload consumers, pushing them to absorb any shocks to prices themselves in order to remain competitive. High volatility creates uncertainty and can be detrimental to growth. It risks becoming a key challenge for investment in the sector in the EU, with the risk of stalling investment along the value chain – from new mining operations to financing in the manufacturing industry. The case of lithium is extreme, with prices increasing twelvefold over two years before tumbling again more than 80%, with the low-price levels now preventing the opening of new competitive mines in the EU. While battery prices and solar panels seem to be stabilising, volatility hampers investment decisions and may create more concentration in the market[vi].

FIGURE 5
Price developments of selected minerals and metals
Thousand USD/Tonne



Source: Bloomberg, BNEF, 2024.

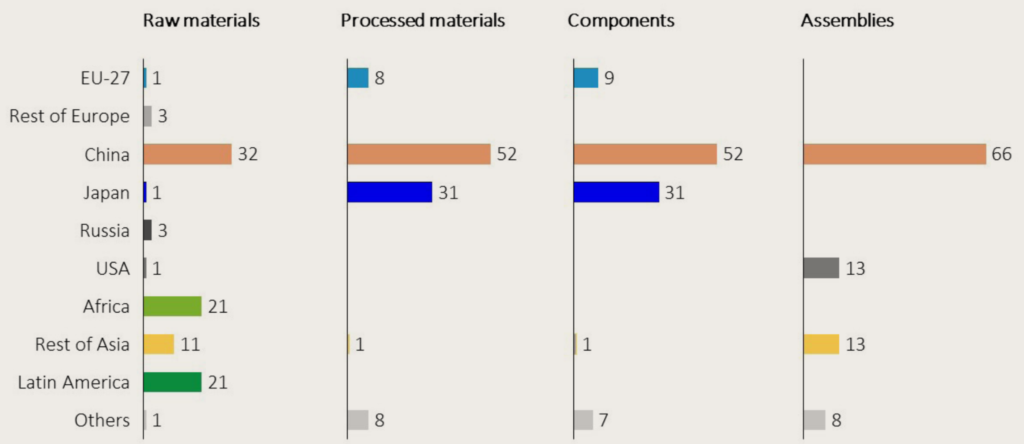
BOX 1

Potential challenges for lithium supplies

Lithium is used in several industrial applications, for example the steel, glass and ceramics industries. The battery industry is the largest consumer of lithium as a critical component in rechargeable batteries for mobile phones, laptops, digital cameras and electric vehicles.

By 2027, S&P Global Market Intelligence anticipates global lithium deficits could arise. In Europe, the threat of supply deficits is compounded by a surging market for battery electric vehicles, which is forecast to grow at a compound annual growth rate (CAGR) of 27% between 2023 and 2027[vii].

FIGURE 6
Li-ion batteries: an overview of supply risks, bottlenecks and key players along the supply chain
%



Source: European Commission, 2020.

THE EU'S COMPETITIVENESS GAP

A twin dependence on both mining and refining may jeopardise the green and digital transitions. Historically, the EU has based its economy on a commodity supply model, where raw materials are extracted from resource-rich nations in developing economies, are processed in other countries (e.g. in China) and then imported either as a refined product or in final goods.

The EU's share of the global production of most critical raw materials is lower than 7%. Unlike fossil fuels, where until recently the EU was dependent only on the commodity, but not refining, the EU exhibits a broader dependence on the processing, refining and manufacturing of critical raw materials. Throughout the supply chain, the EU's overall vulnerability decreases progressively, with a 28% share in global production at the manufacturing stage (declining to 20% when space technologies are excluded)[viii].

Nevertheless, certain technologies, such as solar photovoltaics and batteries, manifest dependencies that extend across the entire supply chain. New dependence on these critical raw materials concentrated in a handful of providers is emerging and potentially slowing the progress of the EU's green and digital transitions or making them more costly.

The Commission identified 34 critical raw materials and 16 strategic raw materials in 2023[ix], as part of the regular review and update of its list of critical raw materials. Critical raw materials on the list combine raw materials of high importance to the EU economy and of high risk associated with their supply. Strategic raw materials are crucial to technologies essential for Europe's green and digital transitions and for defence and space applications, while being subject to potential supply risks in the future.

DIFFERENT APPROACHES PURSUED IN DIFFERENT REGIONS

Other world regions are moving faster to secure critical mineral supplies. In this fast-changing environment, the world of commodities is currently in a race to establish market share faster than the competition. Different approaches are being pursued with governments leading or strongly coordinating and supporting the whole value chain.

China dominates global critical mineral supply chains. The country is the leading source of numerous critical minerals and accounts for almost 70% of the world's output of rare earths. Moreover, it holds a quasi-monopoly on the processing and refining of critical minerals. China's Belt and Road initiative, launched in 2013, also includes active investment in mining assets in Africa, Indonesia and Latin America, and investment in overseas refining and downstream facilities, with the aim of securing strategic access to raw materials. Between 2018 and the first half of 2021, Chinese companies invested USD 4.3 billion to acquire lithium assets, twice the amount invested by companies from the United States, Australia and Canada combined during the same period. China's overseas investment in metals and mining through the Belt and Road Initiative reached a record high of USD 10 billion in the first half of 2023 alone. Current plans are set to double the ownership of Chinese companies of overseas mines containing critical minerals. Recently, China also issued a rare earth regulation to further protect domestic supply, laying out rules on the mining, smelting and trade of critical materials. The regulations say rare earth resources belong to the state, and that the government will oversee the development of the industry around rare earths[x].

The United States has deployed the Inflation Reduction Act (IRA), Bipartisan Infrastructure Act and Defence Funding to accelerate the development of domestic processing, refining and recycling capacity. The United States' model has capacity to act fast and at scale, but it is distributed among different government bodies (the Department of Defence, the Department of Energy, the Bureau of Educational and Cultural Affairs, and the Development Finance Corporation). The US Federal Strategy to Ensure Secure and Reliable Supplies of Critical Minerals provides a framework and actions to address critical mineral supply chain challenges[xi]. These include strengthening national critical mineral supply chains, enhancing international trade and cooperation, and improving access to domestic critical mineral resources. Through the Mineral Security Partnership, the US furthermore analyse projects abroad, involving mining, mineral processing and recycling ensuring access to critical minerals.

Japan, like the EU, is very dependent on other world regions. At the same time, Japan has a significant critical raw materials processing and manufacturing industry (e.g. in the magnet sector). Given the absence of domestic capacity, Japan has pursued the securing of its supply chains through trade, investment in mining projects overseas, stockpiling, innovation and recycling. The Japan Organization for Metals and Energy Security (JOGMEC) plays a very important role (see the Box below). JOGMEC invests equity in mining and refining assets around the world, manages strategic stockpiling and, since the introduction of the recent economic security law, has powers to develop processing and refining facilities within Japan. Japan has been conscious for a long time on the importance of these materials. Since the 2000s, it has developed a more strategic approach focusing on a 'resource diplomacy' to enhance access to overseas mining projects. The government has augmented its capabilities with foreign aid, public finance and trade insurance.

Regarding innovation, Japan has focused on developing more efficient production processes limiting the use of critical raw materials and developing substitute products. Finally, Japan has launched an exercise on the potential of the domestic mining of submarine deposits (e.g. cobalt and nickel). This strategy has proven successful, resulting in the reduction of Japanese reliance on Chinese rare earth supplies from 85% in 2009 to 58% in 2018. Japan has a target by 2025 to reduce its rare earth import reliance on a single supplier nation to below 50%.

BOX 2

The example of JOGMEC in Japan

JOGMEC (the Japan Organization for Metals and Energy Security) identifies the needs of Japanese industry and supports the securing of supplies. JOGMEC has strong intelligence capacities and is able to assess potential supply projects globally.

The agency provides financial support for Japanese companies to develop mining, smelting, refining and recycling projects, performs targeted exploration, purchases and stockpiles critical minerals.

JOGMEC has access to sizable capital of JPY 1,300 billion (as of March 2023), approximately EUR 8.5 billion, and an Expenditure Budget of JPY 1,696 billion (in the 2022 fiscal year), approximately EUR 11.1 billion. It also has 13 overseas offices.

JOGMEC provides funds required for mineral resource exploration projects in the form of equity support or loans to assist Japanese companies, leading to a faster transition to mine development. JOGMEC also provides debt guarantees for development funds loaned by private financial institutions. Moreover, since 2022, equity investment and debt guarantees cover domestic ore processing and smelting businesses.

Following the New International Resource Strategy, Japan's national parliament passed legislation in June 2020 to expand the scope of JOGMEC's financial functions. This aimed to better support Japanese businesses' involvement in upstream projects outside of Japan. Before this reform, JOGMEC's equity activities were limited to exploration, the acquisition of existing development and production assets, and investment in refining activities tied to mining. The scope was broadened to allow for the financing of projects going beyond the exploration phase into the development and production phases.

Currently, JOGMEC ensures:

- EUR 678 million in support through equity investment and debt guarantees for beneficiation, smelting and refining.
- EUR 675 million in subsidies to the public sector for exploration and supply chain resilience.
- The stockpiling of critical raw materials. The Japanese government subsidises the stockpile by paying the interest of the loans taken by JOGMEC to procure the metal, as well as the cost of maintaining and managing the warehouses.

Finally, the Japanese government is also offering grants for critical raw material supply chain resilience under the Economic Security Promotion Act (especially, for battery metals and rare earth magnets).

South Korea's strategy for 'securing reliable supply of critical minerals' builds on earlier governmental actions to reduce its dependency on supplies from specific nations. The strategy identifies 33 critical minerals to ensure economic security and ten further strategic critical minerals to ensure stable supply chains for South Korean high-tech industries.

In addition, the strategy enhances the development of global supply maps and warning systems to notify of supply chain risks. For example, in South Korea, critical mineral stockpiles will be reinforced to suffice for 100 days from current reserves for 54 days. Key measures in the strategy also include strengthening international cooperation and mitigating overseas supply risks, as well as promoting public financial guarantees to support mining firms' investment in critical minerals. South Korea also established the Korea Mine Rehabilitation & Mineral Resources Corp. (KOMIR) in 2021. This government agency is tasked with supporting the stable supply of core mineral resources, managing supply chain risks and dependencies, and developing overseas mining and processing capacity.

Both Canada and Australia have recently introduced respective national critical mineral strategies to position themselves as global sustainable raw materials suppliers. In comparison with the EU, both Canada and Australia have more efficient and faster processes in place to advance their critical minerals production, processing and supply chains. Both have some limited demand for their own strategic technology production and aim to create resilient and sustainable supply chains through international partnerships. Moreover, they want to build further processing capacity and extract more economic value from their own resources.

A LAGGING EU REACTION

The EU is not keeping pace with its competitors. It is lacking a comprehensive strategy covering all stages of the supply chain (from exploration to recycling). Moreover, there is no EU-wide comprehensive approach to critical raw materials encompassing all internal and external tools at the EU level. For example, from lithium and nickel to cobalt and manganese, these metals in their refined forms (in which it would be stockpiled) are not currently used in the EU[xii]. They need to be converted into cathode materials before being usable by battery cell manufacturers. There is a significant amount of planned production capacity in Europe (almost 15% of global battery cell production in 2030). The EU is therefore planning to increase its demand without having secured the supply which will come from the outside, and mainly from China.

Unlike other competitors, like China, the mining and trading of commodities in the EU is largely left to private actors and the market. While China has promoted vertical integration to better control and manage the supply chain, and the United States is dedicating relevant government and diplomatic support (on top of public funding), the EU mainly relies on market conditions for each step of the value chain in a turbulent geopolitical context.

The EU is suffering the effects of fragmented financial support and a lack of dedicated funding for critical raw materials. Several funding sources are available in the EU (both at the European and national level) to develop projects that rely on critical raw materials, from innovation (e.g. Horizon Europe) to manufacturing (e.g. the European Investment Bank).

However, navigating the wide range of EU and national programmes is complex and resource-intensive for EU companies. Unlike Japan, the EU has no funding programme dedicated to the different stages of the critical raw materials supply chain that can compete with the amounts offered in other world regions. Much of the required investment needs to come from the private sector, but the economics of this race require strategic de-risking across the value chain (e.g. through equity) and for a first-mover role to be played by governments and public banks.

The EU has untapped potential in terms of domestic resources and excellence in domestic mining and recycling. Accelerating the opening of domestic mines could enable the EU to meet its entire demand for some critical minerals, alongside reducing dependencies in combination with increased recycling and sourcing from trade partners. Unlike fossil fuels, the EU has deposits of some critical raw materials (e.g. lithium in Portugal). Materials found in retired electric vehicles, windmills and other goods represent a further supply that could be tapped through recycling. Currently, however, the EU remains heavily reliant on raw material imports, rather than exploiting domestic resources.

OPPORTUNITIES FOR THE EU AND RECENT ACTION UNDER THE CRMA

Opportunities lie in the domestic production of critical raw materials, recycling and the EU's excellence throughout the mining and processing value chain. The recently approved Critical Raw Materials Act (CRMA) takes steps in the right direction, but greater efforts are needed.

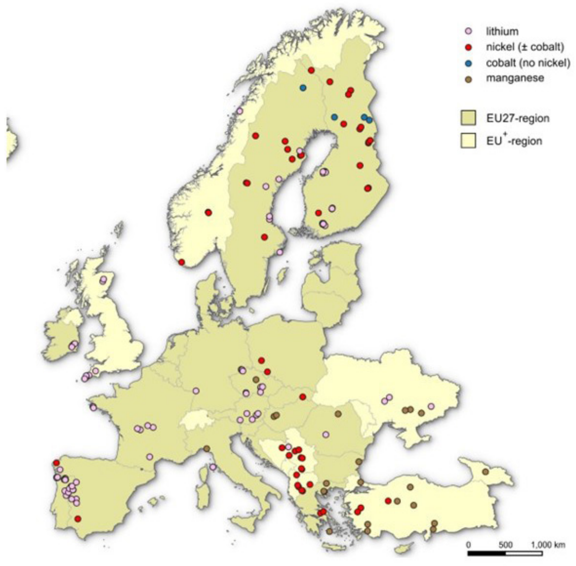
→ The potential of domestic critical mineral production in the EU

Mineral deposits in the EU could drive a surge in domestic supply to meet a significant share of the EU's critical raw material needs by 2030. Figure 7 shows the mineral deposits of select critical minerals in the EU and within its direct sphere of influence.

No rare earths are currently mined in the EU, with China's imports meeting over 90% of the EU's demand. There are, however, plans to open mines in the EU, following most notably the recent discovery of over 1 million tonnes of rare earth oxides in the north of Sweden. While the demand for rare earths is expected to increase fivefold by 2030[xiii] (given their importance for the deep electrification of the energy sector, including use in renewable energy generators and for the uptake of electric vehicles), accelerating the opening of one to two mines in the EU would significantly decrease dependencies.

The current total European lithium resource base of around 20 Mt of contained Li2O is around 60 times larger than the predicted total annual lithium demand in 2050[xiv]. The depletion of domestic lithium mines is therefore unlikely in the short to medium term. While there are currently almost no active operations in the EU to mine lithium minerals[04], several lithium projects are in development or in an advanced stage of investigation, with about five to ten mines projected to open by 2030[xv]. Even with the demand for lithium expected to rise due to the growth of the e-mobility market, domestic lithium supply could meet between 50% and 100% of demand by 2030.

FIGURE 7
Mineral deposits in the EU and in neighbouring countries



Source: Tercienco Research Report, 2024.

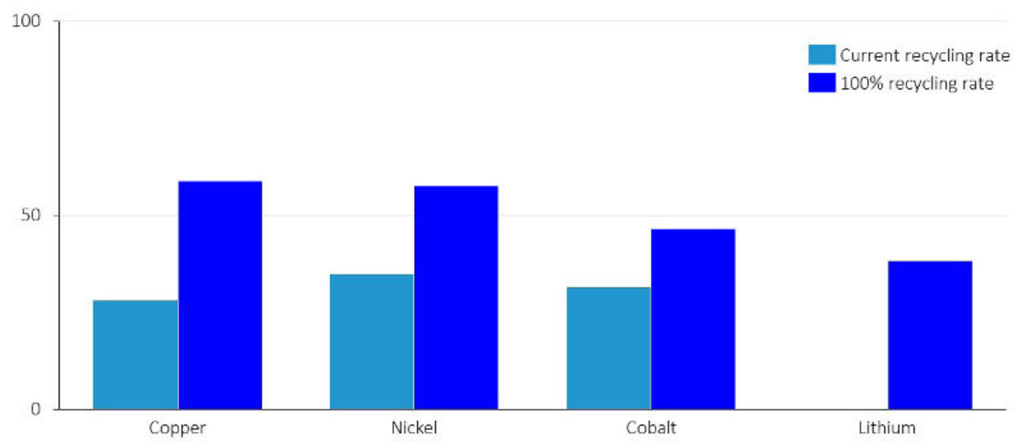
04. EU lithium needs for clean technologies are predominantly met by brine-type mining operations in Chile. Portugal is the only EU Member State to mine and process lithium today, however only in minor quantities used for ceramics manufacturing.

For other raw materials, such as nickel and cobalt, the EU may remain reliant on imports due to limited domestic availability. Estimates indicate that even for these materials, between 15% (cobalt) to 25% (nickel) may be mined domestically if projects are successfully initiated[xvi]. Ensuring adequate domestic production in combination with international partnerships ensuring a stable supply should also decrease dependencies for these materials.

→ The potential of critical mineral recycling

The recycling of critical minerals could be further developed in the EU. While critical mineral mining will still be necessary to secure the supply needed for clean technologies and a clean energy supply, rising recycling rates are projected to play an increasingly important role in meeting future mineral demand. The IEA has estimated that by 2040, recycled copper, lithium, nickel and cobalt from spent batteries could reduce combined primary supply requirements for these minerals by at least 10%. In addition, by maximising recycling, more than half of global demand for select critical minerals could be met in 2050[xvii] [see Figure 8].

FIGURE 8
Share of global demand for selected critical minerals met by recycling
Share of demand met by recycling, World Bank 2050 2-degree scenario



Source: World Bank, 2020.

There are multiple obstacles preventing the Single Market for the circular economy. For most product/material streams (except e.g. certain metals), secondary raw materials are more expensive compared to primary raw materials, and recycling tends to be more expensive than landfilling[05]. The economics however tend to change if the negative environmental externalities associated with the resource-intensive (energy, carbon) production of primary raw materials would be internalised[xviii]. Another obstacle is the lack of investment in infrastructure for circularity. This investment gap not only relates to product design, R&I and circular economy business models, but crucially also to the basic infrastructure for separate collection, sorting, preparing for re-use and recycling. Finally, obstacles with respect to an uneven playing field in terms of waste criteria hinder a Single Market for circularity. This happens across Member States and even regions, with very heterogeneous approaches to the end of waste, leading to a fragmented Single Market with high administrative burden and costs for businesses, and low recycling rates, but also vis-à-vis third countries undermining the integrity of the recycled content obligations and leading to a loss of critical EU recycling capacity since recyclers cannot compete with the subsidised imports.

The EU is building a stockpile of rare earths that could be recycled. Unlike for fossil fuels, significant potential lies in the circular economy to ensure the supply of critical raw materials. The EU is at the forefront of the circular economy and has already increased its use of secondary raw materials (more than 50% of some metals, such as iron, zinc, or platinum, are recycled, covering more than 25% of the EU's consumption[xix]).

Yet, more needs to be done to shore up the supply of critical minerals. The IEA, for example, has estimated that if all batteries are recycled by 2040, this would still only cover 12% of projected demand[xx].

05. For example for concrete, gypsum, ceramics, insulation materials, bricks, glass, certain plastics.

Despite this, significant volumes of scrap and waste materials are currently sent back to China. However, for the critical minerals used in clean technologies and high-tech applications, secondary production still only accounts for a marginal contribution to the total supply.

→ Excellence in EU projects across the mining and processing value chain

The EU demonstrates excellence through several projects across the critical mineral value chain. This includes technological leadership in mining and extraction, the implementation of multi-metal waste approaches, top-class refineries and the incorporation of responsible mining practices. The Nordic countries are world leaders in both relevant advanced technologies and ecological, environmental and cultural practices across their critical mineral supply chain.

Cutting edge mining practices in the EU include the responsible, sustainable and intelligent extraction of mineral resources through the deployment of technologies, such as the electrification of ground and underground transport, remote controlling, and the advanced use of robotics and automation[xxi]. Increasing mining efficiency is accelerated through the use of big data technologies and artificial intelligence. For example, big data optimisation allows for early prediction of failures or support in new mining exploration decisions.

Northern countries are also leaders in processing and refining. Plants in these countries remain competitive with their Chinese counterparts, which are dominating the industry. This is achieved, for example, by implementing advances in automation and by employing a smaller, highly-skilled workforce. Moreover, new process developments, for example flash smelting, allow Nordic refineries to produce products which are less carbon-intensive. For example, the carbon emissions per tonne of nickel produced by the refining industry is at least a factor of 10 to 20 lower in Finland than Indonesia, a main global producer of nickel[xxii].

Established advanced manufacturing processes also send strong investment signals further up the critical minerals supply chain. In the manufacturing sector, developments are taking place at a fast pace, with the European Investment Bank (EIB), for example, providing over EUR 1 billion in financing for Northvolt's battery factory in Sweden[xxiii]. Ensuring the EU's competitiveness in this sector is increasingly assured by the roll-out of advanced technologies and robotics.

The Nordic countries also lead by example in implementing environmentally, ecologically and culturally responsible practices across their mineral supply chain activities. By implementing benefit-sharing models in the mining sector, local communities are integrated and benefit directly from mines. A major share of staff is hired locally, showing a deep commitment to creating a strong local knowledge base, which in combination with excellent and safe working conditions make these interesting employers for local communities.

Moreover, tailing and waste management, multi-metal waste approaches, and biodiversity are aspects addressed seriously from the initial permitting phase to mine closure.

BOX 3

The Critical Raw Materials Act is a first step in the right direction

With the recently approved Critical Raw Material Act, the EU has introduced important actions to ensure a secure and sustainable supply of critical raw materials and significantly lower the EU's dependency on imports from individual supplier nations.

Domestic production, processing and recycling. The CRMA sets 2030 benchmarks to increase domestic production, processing and recycling as a percentage of the EU's consumption. The CRMA requires that EU capacities along the strategic raw materials supply chain satisfy at least 10% of the EU's annual consumption of mined materials, at least 40% of its consumption of processed products and at least 25% of its consumption of recycled material.

Diversification. The regulation also requires that no more than 65% of the EU's annual consumption of each strategic raw material at any relevant stage of processing should come from a single third country.

Permitting. The regulation sets time limits on permitting for projects in mining, recycling and processing for the 16 raw materials considered strategic for the green and digital transitions.

Strategic Projects. The regulation seeks to increase the domestic production of critical raw materials by identifying Strategic Projects that would benefit from faster permitting procedures and EU-facilitated financing. Streamlined, integrated permitting and deadlines (27 months for extraction projects and new mines, 15 months for refining and recycling facilities – compared to processes that take three to five times as long today) to increase the attractiveness of the EU for investment. This timeline will include the public consultation for a project's environmental impact assessment.

Circularity. The regulation contains provisions related to the creation of a strong secondary critical raw materials market in the EU and to ensure a sustainable supply of critical raw materials for EU industry.

The Act establishes the Critical Raw Materials Board that will provide recommendations to the Commission on several topics: the selection of Strategic Projects, the identification of relevant funding sources for Strategic Projects, monitoring, exploration, circularity, stockpiling and public acceptability.

Objectives and proposals

The overall objective is to secure competitive and stable access to commodities, strengthen supply chains and reduce dependency risks to avoid a slowdown of the EU's green and digital transitions.

To achieve this, Europe needs a coordinated strategy covering the entire value chain, from raw materials to final products. This calls for raising the level of involvement of national governments and of the EU, including through trade policies, scale-up financing, the diversification of supply sources and products, the integration of EU producers in global value chains and the promotion of the domestic supply chain.

The proposals are organised according to the main relevant actions of the CRMA and as additional proposals.

FULL AND RAPID IMPLEMENTATION OF THE CRMA

Through the recently approved Critical Raw Materials Act, the EU has introduced significant measures. It is now vital to ensure the Act's rapid, full implementation.

FIGURE 9

	SUMMARY TABLE – CRMA PRIORITY ACTIONS	TIME HORIZON[06]
1	Enhance domestic production, processing and recycling in the EU along the CRM value chain.	ST
2	Support the diversification of supply chains: international strategic partnerships and strategic projects.	ST
3	Simplify permitting procedures: shorten timeframes and develop national programmes.	ST
4	Advance the Strategic Projects.	ST

1. Enhance domestic production, processing and recycling in the EU along the CRM value chain.

- European Commission to decide on Strategic Projects after proposal by project promoters, expert evaluation and advice from the new European CRM Board.
- European Commission to implement critical raw materials supply chain monitoring and stress testing, coordinate (national) strategic stocks and develop a collective purchasing platform with the help of the new CRM Board. CRMA sets risk preparedness obligation on large companies producing strategic technologies.

2. Support the diversification of supply chains.

- Project promoters to identify Strategic Projects in third countries. European Commission to decide on Strategic Projects after expert evaluation and advice from the new European CRM Board.
- For countries with Strategic Partnerships, European Commission to prepare roadmaps and investment projects that could be financially supported from the EU's side (e.g. through the Global Gateway).

3. Simplify permitting procedures.

- Member States to implement the shorter permitting timeframes: 27 months for extraction permits and 15 months for processing and recycling permits).

06. Time horizon is indicative of the required implementation time of the proposal. Short term (ST) refers to approximately 1-3 years, medium term (MT) 3-5 years, long term (LT) beyond 5 years.

- Member States to develop national programmes for exploring geological resources.
- Member States to develop a single point of contact for investors in critical raw materials responsible for facilitating and coordinating their permit granting process[07].
- Member States to consider Strategic Projects in the public interest and give them priority in administrative processing and potential judicial proceedings.
- European Commission to provide technical assistance through the Technical Support Instrument (TSI).

4. Advance the Strategic Projects.

- The CRMA requires the first cut-off date for Strategic Project applications to be no later than three months after its entry into force in May 2024. The selection of the first list of Strategic Projects and issuance of the Commission Opinion with the selected Strategic Projects should take place before the end of 2024.

PRIORITY ACTIONS BEYOND THE CRMA

FIGURE 10

	SUMMARY TABLE – BEYOND CRMA PROPOSALS	TIME HORIZON[08]
1	Develop a comprehensive strategy at the EU level building on the CRMA from mining to recycling.	ST
2	**Establish a dedicated EU Critical Raw Material Platform to deliver on the EU strategy and leverage market power.**	**MT**
3	**Develop financial solutions supporting the critical raw materials value chain.**	**ST/MT**
4	Develop further critical raw materials resource diplomacy for securing supply and diversification.	ST
5	Further develop joint strategies with other global buyers in the G7/OECD (e.g. Japan).	ST/MT
6	**Further promote the untapped potential of domestic resources in the EU linked to better standards and integration with industry at different levels of the value chain.**	**MT**
7	Boost European excellence in research and innovation in alternative materials or processes to substitute critical raw materials in various applications.	MT
8	**Circularity: create a true Single Market for waste and recycling in Europe.**	**ST**
9	Accelerate the creation of a sustainable CRM market in the EU.	ST/MT
10	Develop strategic stockpiles for critical minerals in the EU.	ST
11	Enhance financial market transparency for critical minerals wholesale contracts in the EU.	ST

07. Member States are required to designate their responsible contact points at latest nine months after entry into force.

08. Time horizon is indicative of the required implementation time of the proposal. Short term (ST) refers to approximately 1-3 years, medium term (MT) 3-5 years, long term (LT) beyond 5 years.

1. **Develop a comprehensive strategy at the EU level building on the CRMA from mining to recycling.** While the CRMA lays out a number of individual domestic and international actions to ensure a sustainable and secure supply of critical minerals, the EU should develop a more comprehensive and coordinated strategy covering the entire value chain to:

- Allow the (vertical) integration of requirements across the supply chain, an increase in economic efficiencies and the coordination of the EU's needs at different stages and with international partners. Critical raw materials enter the EU at different stages, from i) initial extraction and mining, to ii) processing, refining and alloying, iii) manufacturing, iv) in actual product use, and v) through recycling and reuse. Furthermore, closure and post-closure activities are relevant steps to be considered in an integrated way. These different stages of the value chain are currently addressed in different European and national policies and legislation, each with varying specific focus points.
- Use the new Economic Security Framework developed between the Commission and Member States to ensure that different pieces of legislation (e.g. environmental, social, competition, economic security) at both the EU and national levels are not in contradiction.

2. **Establish a dedicated EU Critical Raw Material Platform to deliver on the EU strategy and leverage market power.** Building on the experience of AggregateEU and of the Euratom Supply Agency, and considering the successful Japanese model, the EU could create a government-affiliated platform pooling scattered resources. The platform would effectively support the implementation of the defined EU strategy.

In particular, it would:

- Reinforce the annual monitoring of supply chain risks and early alert dependencies building on the CRMA. Specific integrated monitoring capacities and risk assessments could be developed for strategic supply chains, considering updates on (geopolitical) supply chain risks.
- Aggregate demand for the joint purchasing of critical materials (e.g. for industrial users – the model followed in South Korea and Japan) and coordinate the negotiation of joint purchases (like existing schemes for other commodities) with producer countries. An example would be the aggregation of demand from industrial users for lithium used by various industries (not only for Li-ion batteries, but also for glass, ceramics and other products).
- Design financial products to invest in securing upstream supply in the EU and third countries (e.g. equity) by pooling financial resources from different sources, including the EIB, National Promotional Banks, Export Agencies and the industry itself, to secure financing and ensure high investment success rates, while lowering risks associated with investment.
- Manage future strategic stockpiles in the EU. While the CRMA includes a soft request for national stockpiles, the definition of mandatory EU stockpiles could be developed. Stockpiles will provide some certainty of supply to the EU's industries.

3. **Develop financial solutions supporting the critical raw materials value chain.** Mining activities are currently excluded from EU financial support, while manufacturing can only be supported under certain conditions (to a large extent if it relates to clean technologies, such as solar or wind). While the bulk of investment must be supported by private capital, the risk associated with investment in often politically unstable third countries can be too high for individual investors.

In addition, the capital needs to secure supplies are of such volumes that can present a challenge to any industry's liquidity requirements. Building on the EU Platform, new financial solutions could be developed to support de-risking investment along the value chain or to act as an intermediary to pool resources to invest both domestically and internationally.

- **Public-private partnerships.** Forge Strategic Partnerships between governments, private investors and international organisations to create a collaborative fund for financing large-scale cross-border projects. Pooling resources globally can tackle the financial challenges related to major initiatives and promote sustainable energy on an international scale.

- **Mobilise the EIB to provide co-financing and de-risk investment.** Project finance and de-risking tools should be directly aligned with the Strategic Projects across the EU. Moreover, consider adding 'Made in EU' provisions to the EIB loans, provided to for example EV manufacturing and battery cell facilities, to require a minimum amount of processed critical minerals coming from the EU.

- **Engage with the European Bank for Reconstruction and Development (EBRD) to support investment.** The EBRD has created a Mining Strategy that could be used to support critical raw material mining development in its areas of operation and to invest across the whole value chain. The EBRD would be of particular added value in the European Neighbourhood countries for the EU to gain influence or a stake in mines and extracting companies located in their territory.

- **Set up a dedicated 'Fund of Funds'.** Building on the experience of the European Raw Materials Alliance and its investment channel, the EU could bring together Member States, financial institutions, large capital investors, National Promotional Banks and Export Agencies, pooling resources in a Fund-of-Funds-type solution that could then be used to invest along the critical raw materials value chain, in particular in areas currently blocked from receiving EU financial support. This would enable investors to invest in the critical raw materials value chain at integrated, sectoral or regional levels, while mitigating risk exposure. Such a fund could also be used to support the European CRM Platform.

- **A Fund of Funds and a public-private partnerships approach** could also support mining and investing along the critical raw materials value chain within the EU.

- **Use Free Trade Agreements (FTA) and the Team Europe approach to increase leverage.** FTAs and Team Europe cover a wide range of countries. These tools could support EU companies in securing needed supplies.

- **Other financial solutions, such as venture capital and syndication or blended instruments, could be fostered through targeted tax incentives** that could render more dynamic and increase the attractiveness of public investment in critical raw materials.

- **Explore the role of Contracts-for-Difference in ensuring market price** stability, with a fixed reference price guaranteed to a contractual partner, to support private investment.

- **Clean manufacturing relying on critical raw materials can be supported by EU financial solutions, from operational programmes to InvestEU or Horizon Europe.** Other financial solutions would also benefit this segment of the value chain.

- **To secure off-take in EU manufacturing, public financial support for deployment projects, such as wind and solar plants, could be made conditional to a minimum percentage of EU materials being used**, or beneficial terms if such conditions are met (according to a similar approach to the US IRA's incentive for US manufacturing uptake).

4. Develop further critical raw materials resource diplomacy for securing supply and diversification.

- **Politically support (and prioritise) at the EU level efforts with the objective of securing critical raw materials supply.** Although China has the existing advantage in terms of speed and scale for partnerships, the EU can offer more reliable investment with environmental and social criteria, as opposed to greater potential risk of exploitation. This would ensure that critical mineral exporters do not have to choose between trade and their own economic development.

- **Upgrade the Global Gateway to ensure greater involvement of the private sector.** The Global Gateway is the current EU initiative promoting investment (mainly in infrastructure) in third countries in areas key for the EU and its green and digital transitions. While this is a step in the right direction to move from a model of development cooperation towards a partnership approach, it needs to be further focused on the EU's and European industry's strategic interests.

- **Strategic Partnerships should be further pursued and reinforced through concrete projects securing supplies involving the private sector.** The Commission has already established Strategic Partnerships on raw materials with Canada (in June 2021), Ukraine (July 2021), Kazakhstan and Namibia (November 2022), Argentina (June 2023), Chile (July 2023), Zambia and the Democratic Republic of Congo (October 2023), and Greenland (November 2023) on behalf of the EU.

5. Further develop joint strategies with other global buyers in the G7/OECD (e.g. Japan).

- **The EU needs to explore alternative trade policy approaches to increase diversification.** One option is the 'Club approach,' where resource-intensive and resource-rich countries collaborate to diversify critical raw material value chains together to ensure a more stable global market. In its Critical Raw Materials Act, the Commission confirmed its intent to establish a Critical Raw Materials Club. With it, the Commission seeks to complement the US-led Minerals Security Partnership (MSP), a collaboration framework between 13 resource-intensive countries including the EU designed to foster demand pooling alongside value chain investments in resource-rich countries.

- **Moving forward, the creation of a G7+ Critical Raw Materials Club could potentially be an effective instrument for the EU's critical raw materials diplomacy,** help to monitor global needs and support the EU's diversification efforts. G7 allies and partners would facilitate the coordination of market behaviour among members in line with geopolitical and economic security concerns. Along with the US and Canada, the EU could welcome Japan, South Korea and Australia into such a Club[09]. As Europe has had increasingly close trade relations with Japan and South Korea, inviting them both would complement their similar goals of securing critical mineral supply chains and avoiding damaging competition with allies.

  A Critical Raw Materials Club would provide four goods to its members:

  - **Free trade in critical raw materials** extracted and processed in compliance with environmental and social standards.

  - **Joint initiatives in technological transfers, research and development**. The EU could provide cutting-edge equipment to mitigate the environmental and social impacts of mining.

  - **A long-term perspective on fair prices for raw minerals.** This could be in the form of off-take agreements and include provisions on how to adjust prices to evolving market conditions and prevent back-selling via cheaper offers.

  - **A combination of instruments for investment in downstream and energy capacities.** These enable resource-rich countries to refine their raw materials into value-added goods, thus creating new developmental opportunities through industry, jobs and tax revenues.

To ensure the Club's success, it must make a credible up-front funding commitment, with the need for the EU to streamline its international aid and cooperation policies and fragmented development assistance model to fully align them with its raw materials diplomacy.

09. Given their position in supply chains, China, South Korea, Australia and Japan would experience the potential impact of Chinese-led disruptions faster than the United States and the European Union, making them strong economic bellwethers.

6. **Further promote the untapped potential of domestic resources in the EU linked to better standards and integration with industry at different levels of the value chain.** Domestic supplies of critical minerals could meet the EU's demand for some materials by 2030, while significantly decreasing dependencies for others. Europe must have the workforce and know-how to mine and process domestically available critical materials and manufacture technologies with speed and social licence.

   This can be done by putting in place better standards and integrating with industry at different levels of the value chain, including European capacity in mining, processing, manufacturing and the recycling of raw materials and clean technologies.

   Key measures could include:

- **A review of competition rules.** Currently, competition rules make it difficult to vertically integrate projects along the value chain. However, there is growing evidence that to promote investment in new sectors, the guarantee of off-take for a period of time is critical to the final investment decision (e.g. for a lithium processing factory close to Li-ion factories).
- **Permitting and Strategic Projects.** Focus on cutting red tape and fast-tracking critical projects, while continuing to hold industry to high social, environmental and governance standards ('responsible mining').
- **Additional actions** beyond the CRMA could include:
  - Ensuring permitting processes are streamlined across the EU to simplify project development across Member States (e.g., ensuring that the sequencing of permitting for mines are similar, from mining concessions to environmental assessment).
  - Ensuring that Member States have the administrative capacity to enforce the CRMA's permitting obligations, for instance by mandating pre-defined staff resources to be allocated to Strategic Projects.
  - Ensuring the streamlining of rules regarding the definition of Strategic Projects.
  - Ensuring Strategic Projects' processing or recycling strategic raw materials can be considered an imperative reason of overriding public interest (IROPI)[10].
  - Adapting environmental legislation to enable a balance between various pressing societal interests that may support a Strategic Project, while ensuring responsible mining practices are properly valued.
- **Use of public procurement and requirements for domestic production targets.** On the demand side, European and national administrations have an important role to play in creating the market through public procurement.

7. **Boost European excellence in research and innovation in alternative materials or processes to substitute critical raw materials in various applications.** This could significantly reduce dependencies by involving different components or metals that are more abundant or less expensive.

   The EU has a strong position in research and innovation in the field of critical minerals, being home to the most innovative start-ups in the world in this area. However, continuous innovation is key for the EU to hold onto this competitive advantage and to address existing technological challenges, from geological exploration to recycling, along the entire value chain.

- **Increase funding and build new partnership for advanced materials.** Build on the initiative to boost EU industrial leadership in advanced materials[xxiv] and ensure that EU funds effectively reinforce and steer investment in technology development and deployment through direct support, by mobilising private capital and by building on the new partnership with industry under Horizon Europe.

10. This possibility is underlined in the CRMA, but it remains up to Member States to decide if they want to qualify a project as an IROPI.

- **Strengthen the uptake of emerging R&I breakthroughs along the critical mineral value chain for promising innovation.** Build the infrastructure to accelerate design, development and testing, de-risk market entry and support the deployment and use of advances in innovation.

- **Upskilling of the workforce and strengthen the R&I ecosystem along the value chain.** Build up a strong know-how base in the EU (which has been partly lost due, for example, to the offshoring of refining activities) by supporting education programmes, expanding expertise in existing facilities, and investing in research programmes.

8. **Circularity: create a true Single Market for waste and recycling in Europe.** The EU could potentially meet more than half to three quarters of its metal requirements for clean technologies in 2050 through local recycling[xxv]. While recycling and the re-use of metals may only become a major factor after 2030 when sufficient end-of-life recycling input is available, secondary raw materials are an asset for the EU and can play a major role.

   A Single Market for circularity enhances the profitability of recycling given its economies of scale. Despite this, important obstacles remain, particularly in the area of waste shipment[11].

- **Steer the secondary market:**

  - Develop an EU-level incentive scheme for recycling, rewarding either recycling itself or the incorporation of recycled raw materials into products.

  - Ensure a level playing field of recyclates between EU and third countries.

  - Provide incentives for private and public finance to build sorting and recycling infrastructure and boost circular innovation. Circular solutions could also be supported with tax incentives.

  - Prohibit market access to imports which are below a pre-defined threshold for some environmental footprint categories[12] and drive the creation of a more sustainable secondary critical raw materials market, relying on the development of ESG standards by the EU.

  - Development of the mid/downstream value chain is also important for the success of the European critical minerals recycling industry[13].

- **Leverage and effectively enforce existing regulation and verify that new provisions are not circumvented.**

  - Address the situation of materials being classified differently by Member States and increase the use of recycled strategic materials[xxvi].

  - Complete the existing European end-of-waste rules to include all strategic raw materials defined by the CRMA, and enable mutual recognition of national criteria, ensuring the recovery of critical minerals which are currently considered waste.

  - Set minimum collection targets for waste streams containing critical raw materials at the EU level and mandatory targets for recycling and the use of recycled materials in sectors like construction. Uphold the rule that national (or EU) recycling targets can only be met when the material is recycled in Europe.

  - Address waste shipment rules which are set at the Member State or regional level and introduce mutual recognition or accelerated procedures for waste shipments within the EU, if certain treatment standards are met.

11. Currently, over half of all waste exports from the EU include ferrous metals.

12. The CRMA currently only empowers the Commission to establish environmental footprint categories for those placing critical raw materials on the EU market.

13. For example, as battery recyclers typically produce refined chemical products such as lithium carbonate, this would require further processing into cathode material before being usable by domestic European battery cell manufacturers. Unless there is a strong domestic mid/downstream, these recycled refined products would be competing with Chinese recyclers for purchase from Chinese cathode material producers, where European recyclers may not possess a cost advantage.

An harmonisation of rules would facilitate waste shipments within the EU, allowing for specialisation and the build-up of scale. Common criteria would reduce compliance costs and administrative burden and provide legal certainty, improving the business case for circularity.

- Enhance the 'green-listing' of non-hazardous waste within the EU to ease notification and safety procedures for waste streams when waste is shipped between Member States. Criteria for 'green-listing' should be revisited against the backdrop of facilitating the establishment of circularity value chains in Europe.

- **Coordinate EU export controls on waste.**
  - Export controls have been an effective tool to address the EU's security challenges if delivered swiftly, uniformly and in coordination with international partners[xxvii]. National export controls should therefore be coordinated at the EU level (including for critical raw materials and rare earths), ensuring a common approach to security and trade policy objectives, and reflecting common standpoints internationally.
  - Take reciprocal measures on limiting the export of critical raw materials waste to third countries if such countries have themselves put in place export restriction measures on critical raw materials.

9. **Accelerate the creation of a sustainable CRM market in the EU,** including the simplification and harmonisation of sustainability rules to establish a common standard for ESG where products are sourced in a resilient and sustainable way.

   The ability for the downstream industry and customers to identify the ESG qualities of critical raw materials may help both reduce environmental and social supply chain impacts, as well as provide incentives for diversification.

- Go beyond the information obligation of the CRMA to display the environmental footprint for CRMs on the EU markets and **prohibit market access to CRM which are below a pre-defined threshold for some environmental footprint categories.**

- Consider **targeted import tariff measures for critical minerals to comply with the same ESG and responsible mining practices as in the EU**, and lower the price premium for EU secondary materials.

- Drive the creation of a **more sustainable CRM market** on the medium-to-long term, relying on the development of ESG standards by the EU.

Moreover while voluntary sustainability standards can support sustainable and responsible supply chain practices, greater transparency, harmonised approaches to credibility and appropriate incentives are needed:

- **Promote collaborative approaches to align voluntary sustainability standards** with international frameworks and credibility criteria.

- **Encourage the adoption and improvement of credible voluntary sustainability standards** that complement legal frameworks and align with relevant international standards, agreements and legislation.

- **Develop centralised public digital platforms** to provide companies and other stakeholders with information on the scope, of alignment and credibility of sustainability systems.

10. **Develop strategic stockpiles for selected critical minerals in the EU.** Contrary to other economies, the EU currently does not have strategic stockpiles of raw materials and metals. It lacks a mechanism to address both short-term and long-term disruptions and price volatility in the supply of critical minerals, for example due to geopolitical tensions or market shocks. To ensure resource security, Japan and Korea's stockpile operate on a rotating basis, where minerals are procured, stored for a certain duration, then released to local industry, allowing for a continuous dialogue on specifications and requirements, and avoiding the technical challenges related to long-duration storage. Stockpiled rare metals are made available in response to the interruption of overseas supply or a shortage in domestic supply.

Stockpiling could be a tool to consider in the EU for minerals where market size is relatively small therefore prone to potential disruptions; the level of supply concentration is high; and pricing schemes are immature and opaque. A stockpiling scheme would be designed to avoid potential market distortion impacts:

- **A framework for stockpiling both of global and recycled resources differentiated by type of rare material** (building on the current strategic stocks for oil and the mandatory storage of gas) **could shield the EU's security of supply concerns and volatility in market prices.** This framework could mainly benefit commodities for which markets are heavily concentrated, suffering from a lack of pricing transparency. **Strategic stockpiles should be developed having clear and transparent rules for stock building and stock releases.**

- **The EU CRM platform could identify critical mineral needs and establish minimum stocks at the EU and national level.** An integrated approach would bring benefits in balancing supply and demand shocks.

- Given the considerable costs associated with stockpiling, criteria for selective **critical minerals stockpiling should be based on liquidity and concentration measures** in assessing potential EU supply and price shocks.

- **Procurement for stockpiling could be linked with projects in geographically diverse regions and with high ESG performance** as an enabler for supply chain diversification. In some cases, procurement and release of the stockpile could provide information about market prices, which could be valuable for markets that are illiquid or opaque.

11. Enhance market transparency for critical mineral wholesale contracts in the EU.

Unlike many other commodities, critical minerals are not widely traded on exchanges. Minerals such as cobalt, lithium and rare earths, are primarily sold through negotiated bilateral contracts between producers and consumers. As these trades are usually not transparent, inefficient price discovery is still an issue in today's critical mineral markets, and may cause undesirable volatility on (regulated) exchanges.

Enhancing market transparency for critical mineral wholesale contracts would improve the interplay between regulated exchanges and the largely unregulated off-exchange markets, improve supervisory judgments and the interaction between physical and financial markets, particularly in regard to price volatility and its impact on economic sustainability.

- **Create oversight for critical mineral wholesale contracts that are now unregulated. Enhance transparency on these markets,** by establishing disclosure requirements (e.g., dependant on the place of delivery) and mandate transparency on information related to critical mineral supply chains. The looming disconnect between short-term financial markets, driven by excessive volatility, and long-term market needs shows the need to enhance transparency on wholesale contracts. The lack of comprehensive and accurate information about raw materials projects may lead to information asymmetry between investors and project developers, resulting in suboptimal investment decisions, and hindering the financing process.

- **Develop EU metal price benchmarks** could generate reliable price signals for investors, rather than being dependent on benchmarks from third countries subject to uncontrollable shocks, and **support market investments in green technologies and materials** incorporating clear definitions of responsible mining practices and harmonised ESG standards.

ENDNOTES

i IEA, Critical Minerals Market Review 2023, 2023, p.5.

ii IEA, Ibid, 2023, p.6.

iii IEA, Ibid, 2023, p.68.

iv European Commission, Directorate-General for Internal Market, Industry, Entrepreneurship and SMEs, Grohol, M., Veeh, C., Study on the critical raw materials for the EU 2023, 2023.

v Boer, L., Pescatori, M.A., Stuermer, M., 'Energy Transition Metals: Bottleneck for Net-Zero Emissions?', Journal of the European Economic Association, Vol. 22, No 1, 2024.

vi IEA, Global Critical Minerals Outlook 2024, 2024.

vii S&P Global, Sadden, E., New Lithium mining, refining projects set to strengthen Europe's battery supply chain, 2023.

viii Carrara, S., Bobba, S., Blagoeva, D., Alves Dias, P., Cavalli, A., Georgitzikis, K., Grohol, M., Itul, A., Kuzov, T., Latunussa, C., Lyons, L., Malano, G., Maury, T., Prior Arce, A., Somers, J., Telsnig, T., Veeh, C., Wittmer, D., Black, C., Pennington, D., Christou, M., Supply chain analysis and material demand forecast in strategic technologies and sectors in the EU – A foresight study, 2023.

ix European Commission, Proposal for a Regulation of the European Parliament and of the Council establishing a framework for ensuring a secure and sustainable supply of critical raw materials and amending Regulations (EU) 168/2013, (EU) 2018/858, 2018/1724 and (EU) 2019/1020 (COM(2023) 160), 2023.

x Reuters, China issues rare earth regulations to further protect domestic supply, 2024.

xi US Department of Commerce, A Federal Strategy to Ensure Secure and Reliable Supplies of Critical Minerals, 2019.

xii IEA, Global Critical Minerals Outlook 2024, 2024.

xiii European Commission, 2022 State of the Union Address by President von der Leyen, 2022.

xiv Eurométaux, Grégoir, L., van Acker, K., Metals for Clean Energy: Pathways to solving Europe's raw materials challenge, 2022.

xv Heijlen, W., Mapping of the European land-based mine development pipeline for lithium, nickel, cobalt, and manganese - Assessment of current and future primary supply potential, Tercienco BV Research Report, 2024.

xvi Heijlen, W., Ibid, 2024.

xvii World Bank, Minerals for Climate Action: The Mineral Intensity of the Clean Energy Transition, 2020.

xviii Cristobal Garcia, J., Caro, D., Foster, G., Pristera, G., Gallo, F., Tonini, D., Techno-economic and environmental assessment of construction and demolition waste management in the European Union, 2024.

xix European Commission, Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions – Critical Raw Materials Resilience: Charting a Path towards greater Security and Sustainability (COM/2020/474), 2020.

xx IEA, The Role of Critical Minerals in Clean Energy Transitions, 2021.

xxi Jones, P. T., 'Made in Europe: from mine to electric vehicle', Storyrunner production in collaboration with SIM^2 KU Leuven, 2023.

xxii IEA, The Role of Critical Minerals in Clean Energy Transitions, 2021.

xxiii EIB, Sweden: EIB finances Northvolt's battery factory with over $1 billion, 2024.

xxiv European Commission, Communication on Advanced Materials for Industrial Leadership, 2024.

xxv Eurométaux, Grégoir, L., van Acker, K., op. cit., 2022.

xxvi National Board of Trade Sweden, Trade rules for a circular economy – The case of used lithium-ion batteries, 2023.

xxvii European Commission, White Paper on Export Controls (COM/2024/25), 2024.

3. Digitalisation and advanced technologies

Introduction

The EU's competitiveness will increasingly depend on the digitalisation of all sectors and on building strengths in advanced technologies, which will drive investment, job and wealth creation. In 2021, the ICT sector represented around 5.5% of the EU's GDP (EUR 718 billion of gross value added) and close to 4.5% of its business economy employment (6.7 million employed)[i], with ICT services contributing more than ICT manufacturing. Beyond the size of the ICT sector itself, digitalisation in the EU plays a key role in all industrial and service sectors in terms of both cost competitiveness (efficiency and productivity gains), and increasingly of innovation and the quality of products and services.

Digitalisation and the deployment of artificial intelligence (AI) are also essential to the ability of public administrations to deliver European public goods, for example in the field of health, justice, education, welfare, mobility and environmental protection. They can, in addition, contribute to reducing the cost of public services and help to maximise support to businesses. However, seizing the benefits of digitalisation and advanced technologies for the EU's competitiveness requires state-of-the-art infrastructure (including ubiquitous, high-speed broadband networks and cloud computing capabilities) and strengthening employees' and citizens' digital skills[ii].

Digitalisation and advanced technologies can also contribute to Europe's open strategic autonomy. Heightened geopolitical competition and third countries' aggressive industrial policies on tech-rich exports are reducing the security of the EU's imports of critical technologies (e.g. semiconductors) and inputs (e.g. critical raw materials). It is essential to restore the security of supply chains for critical technologies by strengthening the EU's capabilities and assets across the entire value chain in terms of end products and service platforms. Moreover, the 'data value loss' (i.e. the amount of EU data transferred to third countries) is today estimated at 90%,[iii] with a long-term risk of loss of industrial know-how. This issue needs to be addressed, especially in light of the crucial role of data in digital developments.

Digitalisation can also contribute to Europe's decarbonisation and transition to net-zero by 2050. Connecting advanced technologies, such as the internet of things (IoT) and remote sensors, additive manufacturing and predictive maintenance has great potential to promote the circular economy and energy savings[iv].

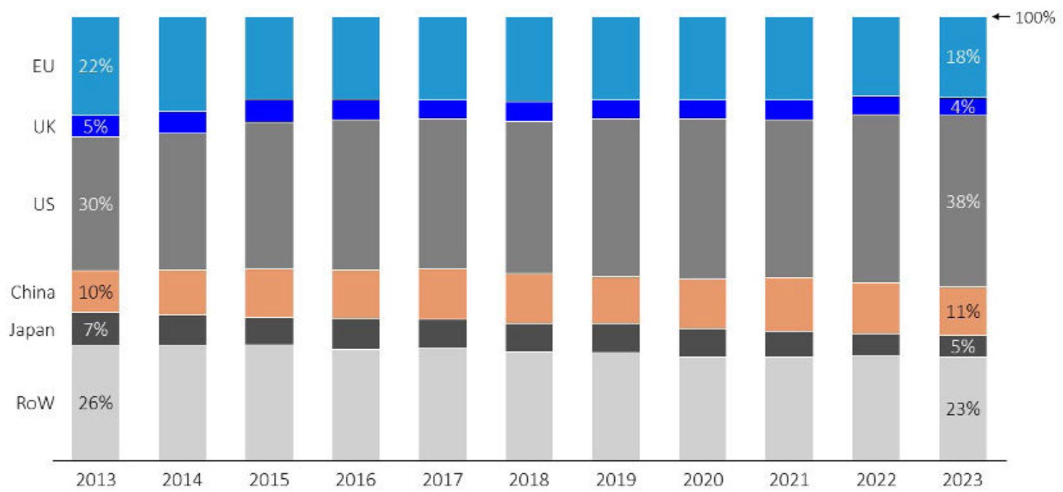
Importantly, digitalisation can help to make Europe's social model more robust and fairer, especially in the key areas of education and public health. In a context of declining hours worked per capita in past decades and population ageing, the digitalisation of public services can mitigate demographic weaknesses and contribute to enhancing socioeconomic resilience and delivery of essential health and education services, preserving living standards. In light of the high risks of automation displacement[v], digital skills are also key to ensuring the preservation of quality jobs as technological progress entails fast changes in the analytical, critical and leadership competencies needed for the future, beyond pure technical education and R&D[vi]. In essence, digitisation of public services can stimulate gains in efficiency, reach and depth in a fair and just way for all EU citizens[01].

The EU's industrial model, so far based on imports of advanced technologies and exports from the automotive, precision mechanics, chemical, materials and fashion industries, does not reflect the current pace of technological change. As 70% of the new value created in the world economy in the next ten years will be digitally

01. For instance, there is potential for generative AI to enhance government operations by automating tasks, improving decision-making, and personalising public services to improve their general productivity. See BCG, 'Generative AI for the Public Sector: From Opportunities to Value', November 2023.

enabled[vii], the risk of value loss for the EU keeps increasing. While the EU relies on third countries for over 80% of its digital products, services, infrastructures and intellectual property (IP)[viii], other blocs like the US and China have been shifting their economic model towards ICT since the first internet revolution of the early 2000s, a trend which accelerated since the 2019 AI revolution. From 2013 to 2023, the EU's share of global revenues in ICT dropped from 22% to 18%, while the US' share increased from 30% to 38%, and China's from 10% to 11% [see Figure 1]. The EU suffers from limited capacity to benefit from 'winner takes most' dynamics, network effects and economies of scale in key technologies – except for next generation materials and clean technologies. Developing leadership in all these key technologies is estimated to be worth between EUR 2 trillion and EUR 4 trillion in corporate added value by 2040[ix].

FIGURE 1
ICT global market share by geographic area
%, 2013-2023



Source: IDC, 2024

Vis-á-vis US and Asian counterparts, EU tech players currently lack the scale to support R&D and deploy investments in telecoms, cloud services, AI and semiconductors. As part of Europe's competitiveness strategy for the coming decade, policies and initiatives on digitalisation and advanced technologies, supported by significant public and private funding, must be prioritised across three areas:

- **3.1. High-speed/capacity broadband networks and related equipment and software** (i.e. fixed, wireless, and satellite/hybrid networks) to enable connectivity and distribute secure, ubiquitous and sustainable digital services essential to EU citizens and businesses.
- **3.2. Computing and AI**, i.e. infrastructure, platforms and advanced technologies needed to autonomously develop and scale up digital services, enabling companies to innovate, boost their productivity and upscale, notably concerning cloud, high-performance computing and quantum, as well as AI and its industrial applications.
- **3.3. Semiconductors**, a key driver and enabler for the electronics value chain, and a strategic element of Europe's security and industrial strength across sectors.

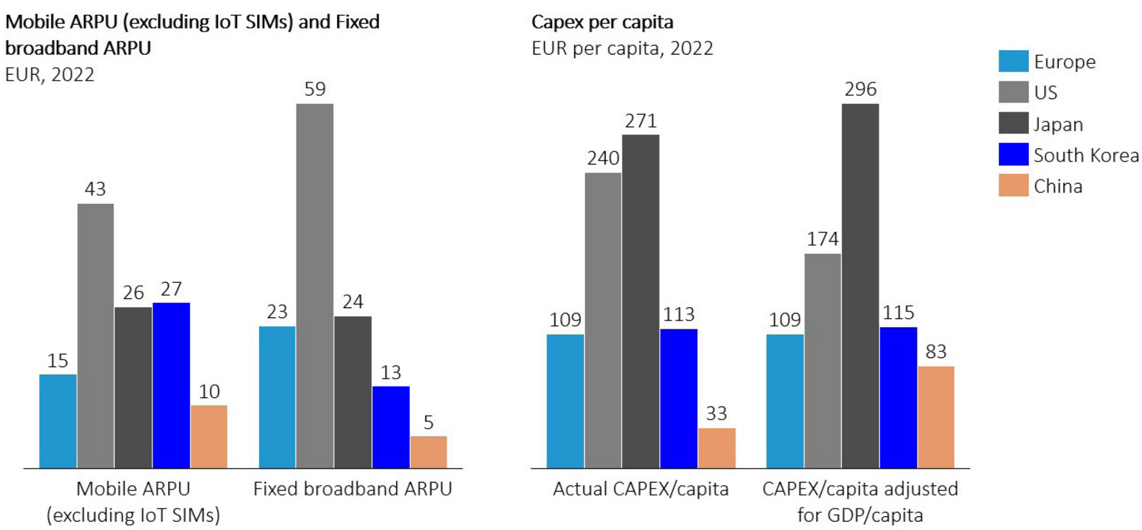
3.1 High-speed/capacity broadband networks

The starting point

Today, the EU has dozens of telecom players serving around 450 million consumers, compared with a handful in the US and China, respectively. EU companies lack the scale required to provide citizens with ubiquitous access to fiber and 5G broadband and to equip businesses with advanced platforms for innovation. The EU has a total of 34 mobile network operators (MNOs) and 351 non-investment-based virtual operators (MVNOs), compared with three MNOs in the US (plus 70 MVNOs) and four MNOs in China (plus 16 MVNOs)[02]. The EU fixed broadband market – where the top three operators hold a joint share of 35% across Europe – is also less concentrated than that of the US (with a joint share of 66%) or China (with a joint share of 95%). Lower prices in Europe have undoubtedly benefitted citizens and businesses but, over time, they have also reduced the industry profitability and, as a consequence, investment levels in Europe, including EU companies' innovation in new technologies beyond basic connectivity.

As a result, in Europe both revenues per subscriber and capital expenditure per capita (also when corrected for GDP/capita to account for differences in purchasing power) are less than half the US' and Japan's levels [see Figure 2]. Investment as a percentage of revenues is at the same level as – or even higher than – other blocs', with the differential due to the lower absolute revenues. Studies suggest that the EU is above the optimal number of operators in the telecom sector, also due to its capital intensity, and that industrial policies have the potential to promote further consolidation without necessarily leading to price increases for consumers[x].

FIGURE 2
Average monthly revenue per unit and CAPEX per capita



Source: ETNO, State of Digital Communications 2023, January 2023.

02. For MNOs in the US and China, see Analysis Mason Data Hub extract as of 25 January 2024; for the MNO in the EU: WIK Consult and Ernst and Young, 'Wettbewerbsverhältnisse im Mobilfunkmarkt', December 2023. For the MVNOs in the US and China, see Telecompaper MVNO List, retrieved as of 25 January 2024. For the MVNOs in the EU, see ANACOM, 'Operadores Móveis Virtuais em Portugal', May 2021.

Regulation and competition policy in the telecom sector have in fact disincentivised consolidation, favouring a multiplicity of smaller players in each market. In the EU, 'ex ante' regulation – e.g. to prevent undesirable price effects – and EU and national competition policies have all favoured a plurality of players and low consumer prices. The industry structure has been progressively affected, leading to the prevention or reversal of the consolidation across Member States in favour of single-country investors or private ventures. In the US, on the other hand, 'ex-post' regulation – e.g. competition enforcement in case of collusion or concerted practices – has allowed consolidation to occur, with the result that both in the US and China a few large operators serve hundreds of millions of citizens each. In particular:

- Spectrum policies have been uncoordinated across Member States and mostly designed to maximise frequencies' pricing and limit frequency bands and their life for existing players. In the US, instead, permanent spectrum ownership and unconstrained auctions allow the possibility for telecom operators to use or freely sell portions of the spectrum.
- New and non-investment-based operators have been supported and remedies imposed upon attempts to consolidate the market into larger players. This has led to the creation of additional smaller players, reducing or eliminating the benefits of consolidation.

The multi-country (rather than pan-EU) set-up of the sector has also led to a costly proliferation of different obligations for EU telecom operators. Examples include cybersecurity standards, so-called 'Lawful Interception' requirements[03], and emergency and public utility services – all essentially set at Member State level. The total number of regulators active in digital networks across all Member States exceeds 270[xi].

To reach the EU's Digital Decade 2030 goals, substantial investment in private infrastructure and commercial initiatives is however needed[04]. Fiber-to-the-premises networks critical to delivering gigabit connectivity only reach 56% of households in Europe. Moreover, 50% of rural households are not served by advanced digital access network infrastructure. Copper networks are still largely in use and retirement dates have not yet been set[xii]. 5G population coverage stands at 81% compared with over 95% in the US and China[xiii] and quality falls short of end-users' expectations and industries' needs, contributing to a persistent urban-rural divide. As a result, 5G adoption in the EU lags economies like the US, South Korea and Japan.

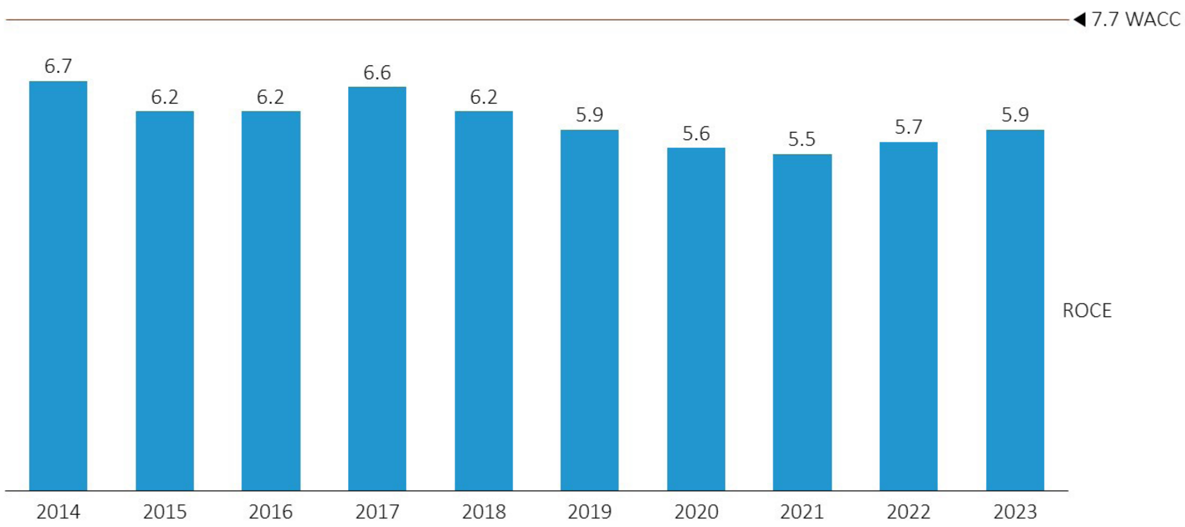
The declining profitability of the telecom sector now may represent a risk for industrial companies in Europe, in a phase when state of the art infrastructure is required to digitise manufacturing, supply and distribution chains. Broadband connectivity (fiber, 4G and 5G) drives the competitiveness of industrial and service companies, supporting manufacturing automation, logistics optimisation, the integration of delivery and customer management systems and enterprise resource planning, as well as product and service innovation. Data streaming for consumers and businesses, data exchanges across companies and institutions, machine-to-machine (M2M) and internet of things (IoT) connections, AI for industrial applications and robotics, will all require faster, lower-latency, more ubiquitous and secure connections across enterprises, SMEs, public offices and homes. The investment levels required to support EU networks are estimated at around EUR 200 billion to ensure full gigabit coverage across the EU and 5G standalone coverage in all populated areas[xiv]. Four main factors negatively affect the EU's telecom industry:

03. Lawful interception (LI) refers to facilities in telecom networks allowing law enforcement agencies with court orders or another form of legal authorisation to selectively wiretap individual subscribers. In the EU, the European Council Resolution of 17 January 1995 on the Lawful Interception of Telecommunications (Official Journal C 329) governs LI requirements.

04. On top of the existing digital investment, the Commission estimated the additional needs to be around €125 billion per year. A separate study by the Commission estimates that investment of around €114 billion will be needed in digital connectivity to achieve the 'one gigabyte target' and a further €33 billion to provide a 'full 5G service' (including new base stations and small cells to provide additional bandwidth and ensure more reliable mobile connectivity). Including the digital investment needed in infrastructure (roads, railways and waterways) of €26 billion increases the total digital connectivity investment gap to at least €173 billion. Funding to meet the digital targets will stem from both public and private-sector sources. See ECB, 'Massive investment needs to meet EU green and digital targets', published as part of 'Financial Integration and Structure in the Euro Area 2024', 2024.

- Fixed and mobile broadband data traffic have been growing enormously in recent years, by around 90% and 138% from 2019 to 2022[xv], respectively – a trend driven by consumer and business applications. In recent years, return on capital has been lower than the weighted average cost of capital, making the financing of future investments problematic[xvi] [see Figure 3].
- Spectrum auctions to assign mobile frequencies have not been harmonised across member states and have been purely designed to command high prices (for 3G, 4G and 5G) over the past 25 years, with limited consideration for investment commitments, service quality or innovation.
- Revenue-generating innovative services (IoT, edge computing, API commercialisation) require relevant upfront investment by Telecom operators, who are today constrained and with limited financial flexibility to commit further capital to innovative platforms.
- As network services are being progressively managed by software, as opposed to by dedicated telecom equipment, offers of standalone communication applications independent from networks are leading to further disintermediation of telecom operators and threatening the business of traditional equipment providers, historically based in Europe.

FIGURE 3
Comparison ROCE/WACC
%, 2013-2023



Source: Barclays Equity Research, Network Operators of the Future, 23 April 2024. Note: the estimation refers to ROCE Adj. EBIT.

To strengthen the EU's competitiveness in advanced industrial manufacturing and defend its data sovereignty, two technological developments are strategic opportunities for telecom providers:

- **Edge computing as an alternative to connecting to the remote cloud.** Global spending on edge computing – the distribution of computational tasks across smaller nodes closer to customers, reducing data transport to smaller distances – is on the rise, with the business case being tested. Data localisation will be key to Europe's industrial digitalisation. As the EU builds highly automated manufacturing plants requiring low latency and significant data volumes steered by AI, edge computing for industrial applications could better enable performance and reduce latency for industrial connected robotics, keeping data transfers more secure. While the Digital Decade sets the goal of deploying at least 10,000 climate-neutral, secure edge nodes by 2030, there are today only three commercially deployed edge computing nodes in the EU[xvii]. Edge cloud computing capabilities could be hosted by EU telecom providers within their networks or by independent national cloud providers.

- **Open network services – the opening of network capabilities to third-party developers and innovators using Application Protocol Interfaces (APIs).** As for roaming in the 90s, the coordination of standards across telecom operators is essential. The high number of players in the EU underscores the need for coordination to ensure a sizeable market can emerge in Europe and that non-EU players align with standards defined in the EU.

Reaping both opportunities will eventually require industry cooperation and alignment on standards to be competitive vis-à-vis non-EU based cloud players. EU telecom operators are now absent in the field of edge hardware, software and services and are not yet commercialising standardised APIs.

The telecommunication equipment and software sector are also key for the EU's cyber-resilience, security of strategic infrastructures, and protection of citizens' and business data. Strong EU champions in these fields are being penalised by the loss of access to the Chinese market, China's fierce competition in developing markets, and lower levels of investment in Europe. Top EU vendors are well positioned in the global supply of telecom equipment. As of 2023, Huawei led the global telecom equipment market with a share of around 30%, followed by Nokia and Ericsson at around 16% each, ZTE at around 10%, followed by Cisco, Ciena and Samsung[xviii]. As network virtualisation progresses, telecom operators are looking for alternative software-based solutions to fully integrated equipment. This includes developing Open-RAN technology (O-RAN)[05], software solutions and systems operating on generic non-proprietary hardware. O-RAN would allow more non-EU software vendors to compete their way into the EU market, challenging the two leading equipment suppliers if they cannot develop virtual and software-based EU technology as well.

Restrictions in technology trade with China have further complicated Europe's position and Europe's reactions have been mixed. Subsidies of production overcapacity and protection of the Chinese equipment market affect market access to China and global markets alike. The EU adopted a 'Toolbox for 5G Security'. Its 2023 Implementation Report found that 14 Member States have no restrictions on high-risk suppliers or other key measures in place. So, while China is a limited export market for the two EU equipment companies, not all Member States have adopted measures to protect European citizens data and EU networks or to shield EU equipment providers from non-market polices and practices adopted outside of the EU.

Satellite connectivity is becoming increasingly critical to the EU's technological sovereignty and essential to meeting citizens', businesses' and governments' communication needs, yet also this domain is set to be dominated by US players. Satellite communications based on low earth orbit (LEO) constellations can enable broadband services with a download speed of up to 100 Mbps to rural and remote areas where no fixed or mobile high-capacity networks are available. However, EU companies have been largely absent from this segment. The technology of incumbent medium earth orbit (MEO) and geostationary equatorial orbit (GEO) private operators (SES, EUTELSAT, and HISPASAT) is unable to deliver speeds competitive to newcomers like the US' Starlink, which is years ahead of EU-based competition in LEO services. The 2022 IRIS2 programme – an optimised multi-orbital constellation of between 100 and 200 EU satellites – will provide the first SatCom system and a secure network for EU governments protected using quantum encryption. While the governmental use case for this type of broadband network is clear, the timing of its deployment for private use in remote areas by vessels and airplanes [see Transport Chapter], as well as for IoT connections across the EU, will be challenged by competition from outside the EU, already several years ahead, and by the need for private funding[06].

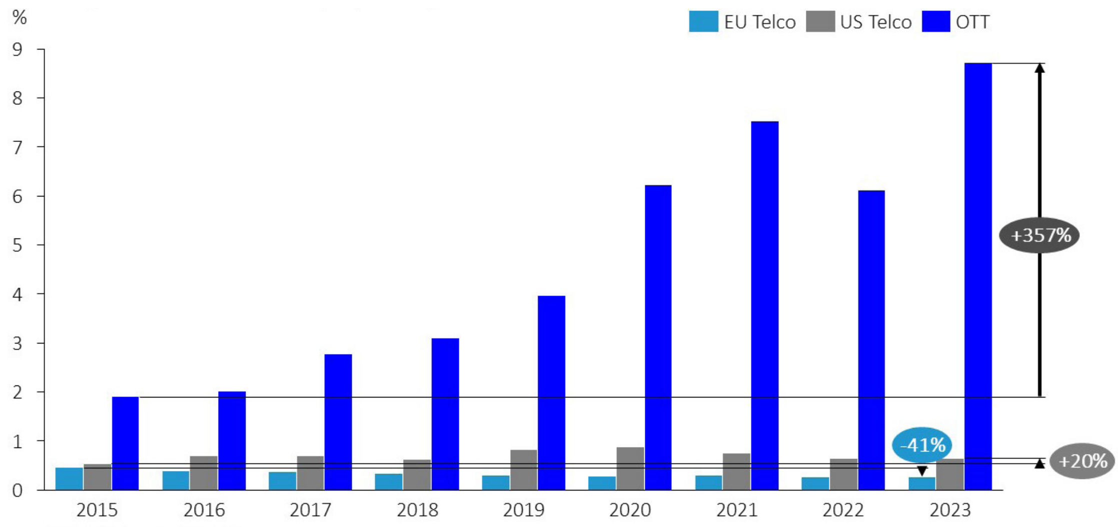
Finally, no EU player has a meaningful share in the sector for communication device software. This is due to the dominance of Google and Apple of mobile operating systems in the EU (with Android holding around 66% and Apple's iOS system approximately 34% market share in 2023)[xix]. Regarding mobile smart terminals, EU manufactures have all but vanished, with the market again being dominated by Apple (33% market share) and Asian providers (notably, Samsung with a 31% market share, and Xiaomi with a 15% market share)[xx].

05. The open radio access network (O-RAN) is a non-proprietary version of the RAN technology, which allows interoperability between cellular network equipment provided by different vendors. In short, it uses software to make hardware manufactured by different companies work together, including cellular radio connections linking individual devices to other parts of a network. O-RAN makes 5G deployment easier, more flexible, and more cost-efficient.

06. Overall public funding is around EUR 6 billion in the current and next MFF, with the aim of attracting around EUR 2.5 billion in upfront private investments.

As a result of all the trends described, the market capitalisation of EU telecom operators and equipment providers has shrunk and become smaller compared to that of competitors. The total market capitalisation of the EU's telecom sector fell by 41% over from 2015 to -2023 to reach around EUR 270 billion, compared to over EUR 650 billion in market capitalisation for US telecom operators. Even more strikingly, the five largest US tech companies (Alphabet, Amazon, Apple, Meta and, Microsoft) capitalise around USD 8.7 trillion [see Figure 4], while only four of the 50 largest tech providers by market capitalisation are EU companies: ASML (USD 391 billion), SAP (USD 222 billion), Siemens (USD 154 billion), and Schneider Electric (USD 127 billion)[07].

FIGURE 4
Comparison of the market capitalisation of the EU and US telecom sectors, and the top-five over-the-tops (OTTs) in the US



Source: S&P Capital IQ. Accessed on 7 May 2024

07. Deutsche Telekom reaches EUR 124 billion, but a large part of it is part of US telecom operators. Based on Companiesmarketcap data, last retrieved on 7 May 2024: https://companiesmarketcap.com/tech/largest-tech-companies-by-market-cap/.

Objectives and proposals

The EU will deliver state-of-the-art communication services to its citizens and businesses provided by strong and successful EU companies, which are not overdependent on critical equipment and software providers from outside the EU. The EU should, therefore, aim to:

- Boost the deployment of competitive high-speed, low-latency, ubiquitous mobile and fixed broadband services, as well as autonomous satellite capacity by 2030. These services should be delivered throughout Europe seamlessly at a standard on par with the best experiences globally.
- Increase private investment in digital networks (5G standalone and fiber), supporting consolidation of players and infrastructures, and underpin leadership in strategic areas (e.g. O-RAN, edge computing, network API standardisation, IoT and other M2M business services).
- Strengthen the security and open strategic autonomy of the EU's digital communication networks by supporting EU-based providers of equipment and software for communications.

FIGURE 5

	SUMMARY TABLE HIGH-SPEED / CAPACITY BROADBAND PROPOSALS: A NEW 'EU TELECOMS ACT'	TIME HORIZON[08]
1	**Reform the EU's regulation and competition stance to complete the Digital Single Market for telecommunications, harmonising rules and favouring cross-border mergers and operations**	**ST/MT**
2	**Harmonise EU-wide spectrum licensing also for satellite connectivity, and design EU-wide auctions with longer duration and fewer restrictions**	**MT/LT**
3	Simplify and harmonise the cybersecurity and Lawful Interception regulation, and improve cooperation among EU cybersecurity agencies	ST/MT
4	Incentivise the deployment of new infrastructure, by defining cut-off dates for older technologies	MT
5	Introduce 'passporting' of B2B services to enable operators in one Member State to offer services EU-wide	ST
6	Strengthen EU-based telecom equipment and software providers to underpin the EU's open strategic autonomy	ST/MT
7	Coordinate technical standards for edge computing, network APIs, and IoT at the EU level	MT/LT

To achieve these objectives, the EU should adopt a new 'EU Telecoms Act' to set a new strategic stance on telecommunication services, with the goal to develop state-of-the-art digital networks for citizens and businesses, financed by private capital, with strong security and autonomy in supply chains. Specifically, it is recommended to:

08. Time horizon is indicative of the required implementation time of the proposal. Short term (ST) refers to approximately 1-3 years, medium term (MT) 3-5 years, long term (LT) beyond 5 years.

1. **Reform the EU's regulation and competition stance to complete the Digital Single Market for telecommunications, harmonising rules and favouring cross-border mergers and operations:**

   Regulation

   - Reduce country-level ex ante regulation, which disincentivises investments and risk-taking, and favour rather ex post competition enforcement in cases of abuse of dominant position or other anticompetitive conducts.
   - Introduce a 'same rules for same services' principle across the EU to remove regulatory arbitrage across providers from adjacent sub-sectors providing similar services.
   - Encourage the definition of commercial contractual agreements for terminating data traffic and infrastructure cost-sharing between internet service providers or telecom operators owning the infrastructure and very large online platforms (VLOPs) using it. The safeguard of mandatory final arbitration offers made by national competition authorities should be foreseen, in case of failed negotiations within a reasonable period.

   Mergers and acquisitions

   - In the EU's rules for clearing mergers, increase the weight of innovation and investment commitments, as well as efficiencies in the form of improved quality vis-à-vis price levels through extended assessment timelines (e.g. to five years) [see Competition Chapter].
   - Define telecom markets at the EU level (as opposed to the Member State level), particularly when this facilitates cross border integration and creation of EU-wide players. Focus remedies on commitments to invest according to detailed time schedules, launch of services or access to data or platforms, rather than partial de-consolidations or the transfer of physical assets.
   - Strengthen the legal means to intervene ex post, i.e. after having cleared a merger, by speeding up regular assessments of price-based competition and, in case of abnormal increases, enable fast enforcement of ex post remedial measures.

2. **Harmonise EU-wide spectrum licensing rules and processes, including for satellite uses, and orchestrate EU-wide auction design features to create scale benefits and incentivise the consolidation of continental digital networks.**

   - Immediately harmonise the release of new frequency bands to allow investment across Member States by EU players, starting with 6G frequencies; progressively harmonise all other frequency bands by 2035; introduce a Commission veto on auctions not following harmonised guidelines. Guarantee the timing of harmonisation, with the objective to boost opportunities to bid across Member States and create scale in investment and alignment of offers.
   - At least double the duration of frequency licences, with the possibility of reselling during their lifespan to encourage investment propensity, incentivise capital allocation to new technologies and mitigate the financial risks of early investment.
   - Ban reservations in spectrum allocation, to create scale benefits for holding larger spectrum bands necessary to improve speed, quality, and ubiquity. Restrict the imposition of caps for spectrum holdings only to cases of dominant position (e.g. more than 50% retail market shares) to preserve competition and choice for citizens and businesses.
   - Include the release of additional WiFi-dedicated bands into the spectrum guidelines, to allocate enough spectrum to 5G and 6G, while preserving the viability of private WiFi in the long term.

3. **Simplify and harmonise across borders the EU's cybersecurity and Legal Intercept architecture and improve cooperation with or among EU cybersecurity agencies, including the introduction of proportionate, consistent and technologically neutral rules on critical national infrastructures.**

4. **Incentivise the deployment of new infrastructures by defining cut-off dates for older technologies to enhance the return profiles of investments in new technologies.**

   - Introduce cut-off dates to phase out copper networks – with adequate social protection measures for the most fragile segments of the population – and the use of 2G frequencies, as recommended in the 2024 Commission's white paper[xxi].

   - Deregulate new investments (fiber, 5G standalone, IoT), subject to preserving competition to enable customers' choice at the retail level.

5. **Introduce 'passporting' of business-to-business services to enable operators in one country to offer services EU-wide, facilitating the creation of EU service providers regardless of the country of establishment. Apply regulation of 'country of origin' as a harmonising factor to facilitate multi-country offerings.**

6. **Support EU-based telecom equipment and software providers to strengthen open strategic autonomy in the EU's technology sourcing.**

   - Favor the use of EU trusted vendors for spectrum assignment in all future tenders and promote EU-based telecom equipment and software providers as strategic in EU trade negotiations and policies vis-à-vis third countries.

   - Enforce compliance with the EU Toolbox for 5G security within a set timeframe and periodically evaluate Member States' network plans to ensure that sensitive elements are from trusted vendors, and preferably from EU providers.

   - Support research initiatives in the 'cloudification' or virtualisation of communication platforms, customer-facing edge cloud solutions, and 6G development – for example, under EU funding programmes and Important Projects of Common European Interest (IPCEIs).

7. **To sustain innovation and cooperation among EU players, coordinate EU-wide technical standards for the deployment of Network APIs, edge computing and IoT, as for roaming in the past, through appropriate EU bodies.**

   - Mandate an EU-level body with public-private participation to develop homogenous standards to enable innovation on competitive platforms seamlessly across Europe.

   - Adopt the agreed standards across regulations throughout the EU to ensure critical mass and consistency in negotiations with non-EU partners.

3.2 Computing and AI

The starting point

The EU is losing ground in R&D and in the creation of innovative tech companies with global reach. The EU has generated fewer new lead innovators in the past decade than the US[xxii], and that the share of EU firms in the top 2,500 global R&D companies has fallen compared to other blocs (as illustrated in the Innovation Chapter). This trend also reflects the EU's weaker specialisation in software and computer services as well as the fact that the EU's industrial innovation model is more diversified, but also more focused on established technologies than in the US or China. For instance, among leading companies in software and internet, EU firms represent only 7% of R&D expenditure, compared with 71% for the US and 15% for China; similarly, the EU only accounts for 12% of R&D expenditure among leading companies producing technology hardware and electronic equipment, compared with 40% for the US, and 19% for China[xxiii].

As a result, the EU has developed few homegrown pan-EU digital platforms and no pan-EU platform is among the most visited in Europe. The Single Market is home today to only four of the fifty largest digital marketplaces worldwide, while the ten largest platforms serving EU citizens are owned by US (six) or Chinese (four) companies[xxiv]. Namely, the largest owners of digital worldwide platforms are Alphabet, Amazon, Meta, Apple, Microsoft, X (all US firms), as well as China's Tencent, Alibaba, Byte Dance and Baidu. Only one EU-based company is designated as a gatekeeper under the Digital Markets Act[xxv] and only four of the twenty Very Large Online Platforms designated by the Digital Services Act are EU companies. Acquisitions by players outside the EU are weakening Europe's position in digital platforms. Of all global online platform acquisitions, 19% are acquisitions of EU companies by non-EU residents and only 6% are companies based outside the EU acquired by EU residents. In summary, European citizens are served mostly by non-EU commercial platforms.

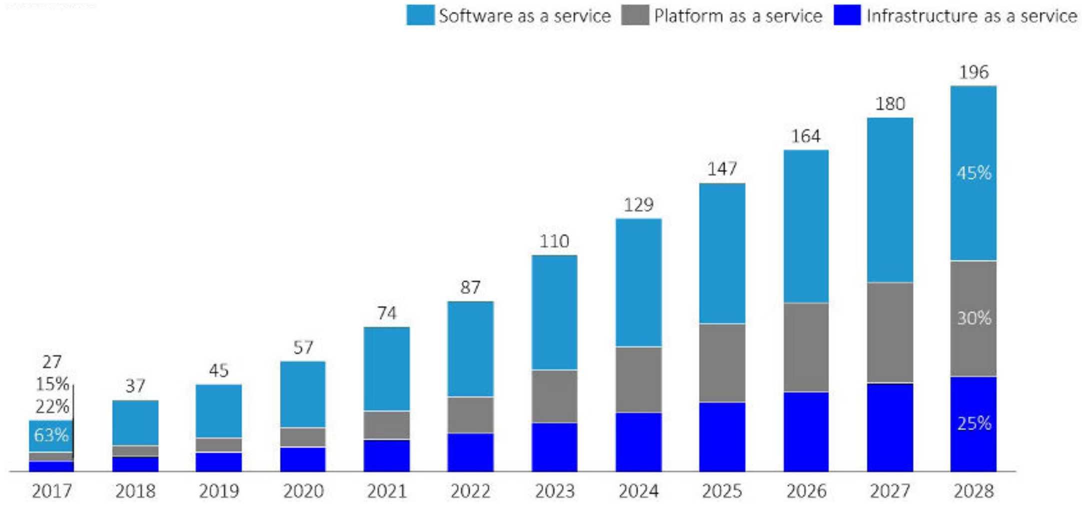
The EU cloud services market is also largely lost to US-based players. Computing needs and data volumes are skyrocketing across all sectors. Europe's cloud computing market was worth around EUR 87 billion in 2022 and is estimated to reach EUR 200 billion by 2028[xxvi] [see Figure 6]. The three US-based cloud 'Hyperscalers' (Amazon Web Services, Microsoft Azure and Google Cloud) account for 65% of this market. EU cloud providers' share decreased to under 16% in 2021, with the largest operator (DT) capturing only 2% of the EU market [see Figure 7]. In addition, most EU providers offer basic services in the form of infrastructure-as-a-service (IaaS) and mostly depend on hosting or re-selling hyperscalers' platform services (PaaS), which are harder to compete with, commercially stickier and more profitable

The EU's competitive disadvantage will likely widen in the cloud market, as it is characterised by continuous and very large investments, economies of scale and the integration of multiple services offered by a single cloud provider. In addition, real estate and energy costs – crucial components of operating costs[09] – are substantially higher in Europe than in the US or the Middle East, which represents a disadvantage for EU-based providers. In the absence of a scale comparable to US hyperscalers, EU companies will hardly be able to enlarge their market share in cloud and invest in full platform services and will most likely continue to depend on hosting or reselling of solutions by US-based providers. Several EU industrial alliances for cloud-based technologies and data exchanges have been created over time with various remits (Andromède, Gaia-X, Catena-X), but results are minimal so far.

More recently, several Member States have promoted 'secure' cloud setups where EU-owned Infrastructure-as-a-Service providers cooperate with hyperscalers' distribution but retain control over sensitive elements of security and encryption ('sovereign cloud' solutions). These set-ups, while not fully 'sovereign' technologically (as deep technology is not fully developed in the EU and is, therefore, still subject to vulnerabilities) are Europe's second-best available option today for data security and territorial sovereignty.

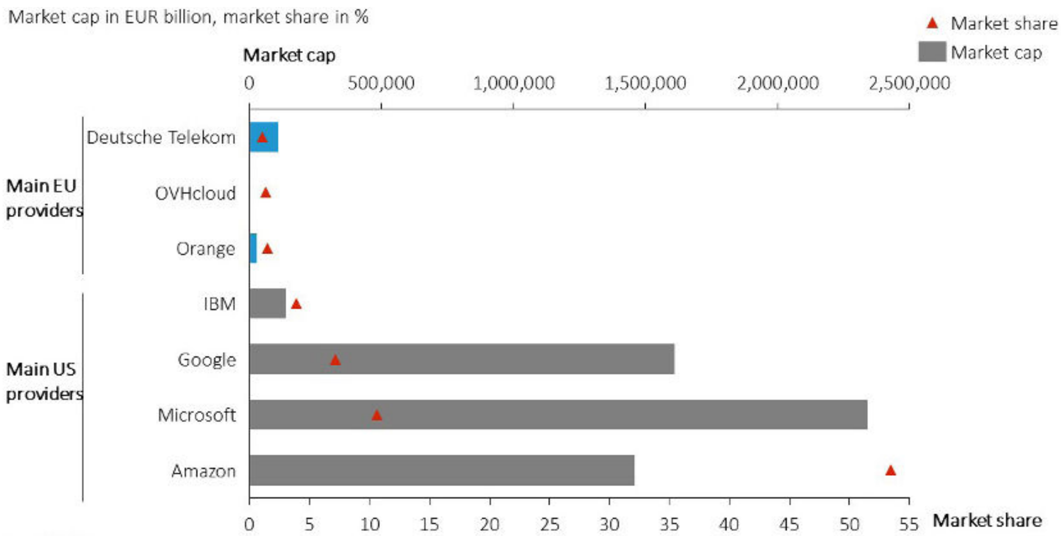
09. The International Energy Agency estimates that data centres (including those dedicated to AI) will consume over 800 TWh globally in 2026, double the amount in 2022. See the Economist, 'Big tech's great AI power grab', 5 May 2024.

FIGURE 6
EU cloud market size
EUR billion



Source: Statista Technology Market Insights, 2024.

FIGURE 7
Market cap and share of main cloud providers
Market cap in EUR billion, market share in %



Source: IDC, 2024.

More positively, the EU has secured a strong international position in high-performance computing (HPC) – a unique advantage to exploit in areas such as AI, and to stimulate private investment. The global HPC market was valued at USD 48.5 billion in 2022 and is estimated to grow at a compound annual growth rate (CAGR) of 7.5% between 2023 and 2030[xxvii]. Following the launch of the Euro-HPC Joint Undertaking in 2018, the EU created a large public infrastructure for computing capacity located across six Member States, which is one-of-a-kind globally. Three EU supercomputers (Lumi in Finland, Leonardo in Italy and Mare Nostrum 5 in Spain) are in the top ten worldwide[xxviii]. Moreover, with the planned launch of 2 exascale computers in the near future, Europe's competitive position remains strong in the medium term and could be further enhanced. So far, the EU's world-class HPC capacity has been mostly applied for scientific purposes. However, with the AI Innovation Package, the Commission is progressively opening it to AI start-ups, SMEs and the broader AI community. Some of the HPC centres are already cooperating with EU based start-ups. In doing so, the EU's HPC ecosystem has now the opportunity to upgrade its computing performance and capacity and extend its remit to support EU based private ventures in AI model training, without distorting the EU market or neglecting their R&D public mission.

AI developments are an opportunity for EU industrial players to boost their competitiveness but also a risk to lose their leadership and profitability if AI is not rapidly integrated in their offerings. Currently, AI is adopted by only 11% of EU companies (vis-à-vis a 2030 target of 75%)[xxix], and 73% of foundational models developed since 2017 are from the US and 15% from China[xxx]. The risk is for Europe is to be totally dependent on AI models designed and developed abroad for both general-purpose AI and, progressively, for vertical uses dedicated to crucial EU sectors, including the automotive, banking, telecoms, health, mobility and retail industries. As AI is very dependent on upfront R&D investment, lower private investments weigh again on the EU's competitive position. The strong position of the US is mostly due to the scale of cloud hyperscalers (internally or through tight partnerships, like the one between Microsoft and OpenAI) and the availability of venture capital. In 2023, an estimated USD 8 billion in venture capital investment was made in AI in the EU, compared to USD 68 billion in the US and USD 15 billion in China[10]. The few companies building generative AI models in Europe, including Aleph Alpha and Mistral, need large investment to become competitive alternatives to US players. This need is currently not met by the EU's capital markets, pushing EU companies to seek overseas funding. Taking the top global AI start-ups worldwide, 61% of global funding goes to US companies, 17% to Chinese companies, and only 6% to those in the EU.[xxxi] Moreover, the EU has a low total number of new data scientists vis-à-vis the US and China. In particular, the talent pool needed to develop AI in the EU is smaller and highly skilled professionals are often 'poached' by high salaries offered overseas.

The EU's weak position in developing AI means that, in the future, it may not fully leverage its competitive advantage across several industrial sectors, with the risk of EU companies' market and value share potentially eroded by non-EU-players. Remarkably, this includes reaping in full the benefits of the digitalisation of industrial processes in the automotive industry (as detailed in the Automotive Chapter) and in robotics for advanced manufacturing. The EU's robotics industry has registered strong growth in the past decade, with 82,000 industrial robots installed in 2021, making Europe the second largest market after China and a major supplier worldwide – today almost half of the over 1000 service robots suppliers worldwide are European[xxxii], although 73% of all newly deployed robots are installed in Asia and only 15% in Europe[xxxiii]. Thanks to the introduction of AI-controlled capabilities, the EU's service robot market is set to further expand by a CAGR of 14% by 2026, continuing to play a key role across sectors. Overall, a weak AI ecosystem would represent an obstacle to EU companies' digitalisation and productivity gains and represent a threat to Europe's current leadership in advanced robotics.

Finally, while the ambitions of the EU's GDPR and AI Act are commendable, their complexity and risk of overlaps and inconsistencies can undermine developments in the field of AI by EU industry actors. The differences among Member States in the implementation and enforcement of the GDPR (as detailed in the Governance Chapter), as well as overlaps and areas of potential inconsistency with the provisions of the AI Act create the risk of European companies being excluded from early AI innovations because of uncertainty of regulatory frameworks as well as higher burdens for EU researchers and innovators to develop homegrown AI. As in global AI competition 'winner takes most' dynamics are already prevailing, the EU faces now an unavoidable trade-off between stronger ex ante regulatory safeguards for fundamental rights and product safety, and more regulatory light-handed rules to promote EU investment and innovation, e.g. through sandboxing, without lowering consumer standards. This calls for developing simplified rules and enforcing harmonised implementation of the GDPR in the Member States, while removing regulatory overlaps with the AI Act [as detailed in the Governance Chapter]. This would ensure that EU companies are not penalised in the development and adoption of frontier AI. With the DMA and DSA, the EU has also adopted pioneering legislation to ensure that digital competition and fair online market practices are enforced. This aims to protect smaller innovators and players from the dominance of Very Large Online Platforms, and to safeguard citizens, creators and IP holders from lack of accountability by the responsible platforms. While it is early to fully gauge the impact of these landmarks regulations, their implementation must avoid producing administrative and compliance burdens and legal uncertainties as the GDPR's and must be enforced within shorter timeframes and more stringent processes for compliance provisions.

10. For cutting-edge generative AI models, it is estimated by the OECD that the EU invested EUR 0.2 billion, compared to USD 21.5 billion by the US. See: Oecd.ai.

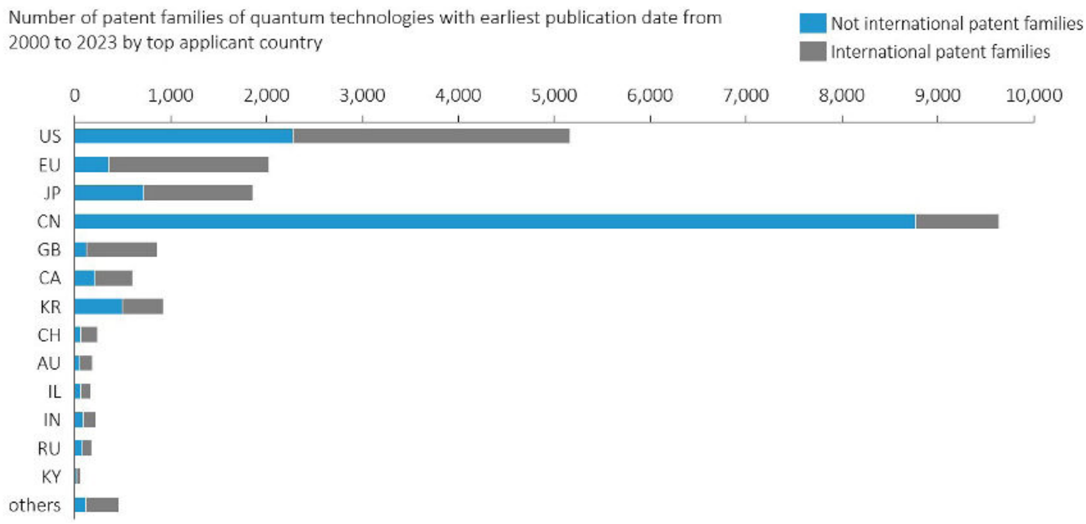
Quantum computing, the next trailblazing innovation in the computing field, could open new opportunities for the EU's industrial competitiveness and technological sovereignty. Quantum computing will have a foundational role in next-generation digital ecosystems, with large economic and security implications. It could contribute up to EUR 850 billion to the EU economy in the next 15-30 years[xxxiv]. By 2030, quantum computing could most importantly revolutionise digital encryption systems (defensive and offensive) underpinning today's security and defence communication, and business transactions. This has led to a global race to be first movers in quantum cryptography[xxxv].

In the quantum race, the EU can rely on key strengths such as large public investment, excellent skills and research capabilities. With EUR 7 billion allocated so far, the EU ranks second only to China worldwide for public investment in quantum[11]. Moreover, the EU has the highest absolute number (over 100 000) and largest concentration of quantum-ready experts (231 experts per million inhabitants) worldwide, excellent research in quantum scientific publications, with multiple Nobel prizes, as well as strong academic and research infrastructure focussed on quantum technologies. Finally, between 2000 and 2023, the EU ranked second worldwide (at around 16%) in quantum patenting – based on international patent families – behind the US (32%) but ahead of Japan (13%) and China (10%)[12] [see Figure 7]. The EU has developed a comprehensive plan to further support the development of quantum companies, including the Quantum Flagship program for R&D&I support, EuroQCI to develop and deploy a pan-European quantum communication infrastructure, and the deployment plan of a pan-European quantum computing infrastructure under the Euro-HPC Joint Undertaking.

FIGURE 8

Share of patents in quantum computing by segment and country

Number of patent families of quantum technologies with earliest publication date from 2000 to 2023 by top applicant country



Source: European Patent Office Data Desk, July 2024

However, Europe suffers from very limited private investments in quantum technologies vis-à-vis other geo-blocs. Five of the top ten tech companies globally ranked in terms of investment in quantum technologies are based in the US and four in China, while none are based in the EU. The US remains the world-leader in most quantum technologies, with deployment driven by private 'big tech' operators and demonstrated technical capabilities in quantum computing and sensing, but less so in quantum communications. China's quantum technology capabili-

11. However, data on China's public investment are scarce and vary widely. A more recent report estimates public investment in the EU (including from Member States) at around 10.9 bn EUR over 2021-2027, behind China's at 15.3 bn EUR. See COM(2023) 570 final, Brussels, 29 September 2023 and McKinsey & Company, 'Quantum Technology Monitor', 2024.

12. The presented figure from the European Patent Office groups patent applications in quantum technologies (based on three sub-areas of quantum technologies: quantum computing, quantum communication, and quantum simulation) into patent families, which makes it possible to count all patent applications related to the same invention as a single observation; moreover, focusing on international patent families (including patent applications in at least two jurisdictions for the same invention) makes it possible to neutralise national biases and enable sound international comparisons.

ties are rapidly improving, with R&D being concentrated in government-funded laboratories. Given the relative low degree of technological maturity, EU R&D investments in quantum computing require large private sector involvement and expansion beyond basic science into industrialisation and early commercialisation. However, private funding of EU quantum champions lags significantly behind that received by US players: EU firms attract only 5% of global private funding compared with 50% attracted by US firms[xxxvi]. China and the US, moreover, hold technological leadership in most critical components or materials for quantum computing platforms[13].

The EU seems far from its stated goals of having the first computer with quantum acceleration by 2025 and three quantum supercomputers by 2030. Its vibrant ecosystem of research organisations and start-ups could be better leveraged as quantum computing is still nascent enough for the EU to be able to develop an internationally competitive ecosystem. Prerequisites for that will be the involvement of private with public players and coordination as a priority at the EU level. The fact that the EU's Chips Act gives support to the creation of pilot lines for testing and experimenting with quantum chips is key, as quantum development is more capital-intensive than other advanced technologies.

For quantum, cloud and AI (albeit to different degrees) the virtuous circle driving innovation is weaker in the EU than in the US or China on three fronts, all to be urgently addressed: capital and financing; skills and human capital; and ease of access to a large Single Market.

- The financing model for technological innovation – based on a flywheel of public and private research funding, angel investing, public development investment, private venture and growth capital, debt funding and long-term institutional and pension investors – is not developed enough in the EU. Specifically, the absence (or limited size) of pension funds exacerbates the challenge of operating without a fully-fledged Capital Markets Union, while the EU's prudential regulation – not replicated elsewhere – limits the EU capital available to finance innovation.
- Available human capital with STEM skills applicable to development and deployment of innovative technologies is of high quality but limited quantity compared to other blocs. Talent is in fact more limited with the EU, with only 203 ICT graduates per million habitants, compared to 335 per million in the US. Similarly, the EU has only 845 STEM graduates per million inhabitants per year compared to 1,106 in the US. Most importantly, the EU's talent pool is depleted by brain drain overseas due to more and better employment opportunities elsewhere.
- The fragmentation of jurisdictions and diverging regulations across Member States is the third barrier to EU innovative tech companies' growth and ability to scale up.

Therefore, the EU should as a priority adopt a new 'Tech Skills Acquisition Programme' [as recommended in the Closing the Skills Gap Chapter] which is urgent to enhance the EU's competitiveness in advanced technologies.

13. Namely, the US and China are found to lead respectively in eight and seven out of ten overall steps or elements of the computer stack, vis-à-vis four for the EU and three for Japan. See Riekeles, G., 'Quantum technologies and value chains: Why and how Europe must act now', March 2023.

Objectives and proposals

The EU must have the ambition to be a leader in developing AI for its sectors of strength, regain and retain control over data and sensitive cloud services, and develop a robust financial and talent flywheel to support innovation in computing and AI. To achieve this, the EU should aim to:

- Secure a strong position during the next five years in AI embedded in key industrial sectors, such as advanced manufacturing and industrial robotics, chemicals, telecoms and biotech based on a set of EU-developed sectoral Large Language Models and Vertical Models.
- Expand the EU's computing capability and capacity of the Euro-HPC network across Europe to serve both science and research, as well as to business ventures.
- Retain control of security, data encryption and residency capabilities within EU companies and institutions and facilitate the consolidation of EU cloud providers.
- Develop research excellence in quantum computing and couple EU HPC installations with quantum testing labs.

	SUMMARY TABLE HPC / AI / QUANTUM / CLOUD PROPOSALS: A NEW 'EU CLOUD AND AI DEVELOPMENT ACT'	TIME HORIZON[14]
1	**Increase the computational capacity dedicated to the training and fine-tuning of AI models and create an EU-wide framework for providing 'computing capital' to innovative SMEs in the EU**	**ST/MT**
2	Identify priority AI vertical applications for the EU, encouraging EU companies to participate in their development and deployment in key industrial sectors	MT
3	Leverage the EU-wide coordination and harmonisation of national AI sandbox regimes, and ensure harmonised and simplified implementation of the GDPR	ST
4	**Define a single EU-wide policy and residency requirements for public administrations' cloud services, as well as EU-wide sensitive data security policies for collaboration between private cloud providers and hyperscalers**	**ST/MT**
5	Adopt a Single Market 'passporting' regime for all EU-provided cloud services	ST/MT
6	Support data brokers as preapproved data intermediaries with regulatory clearance ensured by a Data Ombudsman	MT/LT
7	Step up cooperation between the EU and the US to ensure access to cloud and data markets	MT

To achieve these objectives, the EU should adopt a new 'EU Cloud and AI Development Act', aimed at enhancing European HPC, AI and quantum capabilities and infrastructure, harmonising cloud architecture requirements and procurement processes, as well as coordinating priority initiatives to scale-up private involvement and financing. Specifically, it is recommended to:

HPC / AI / QUANTUM

1. **Develop and fund a strategy to rapidly enhance the EU's computing infrastructure and AI capabilities, connect private and public computing nodes, and reinvest returns of this public 'computing capital' in new capacity. This requires a Euro-HPC upgrade program to:**

14. Time horizon is indicative of the required implementation time of the proposal. Short term (ST) refers to approximately 1-3 years, medium term (MT) 3-5 years, long term (LT) beyond 5 years.

- Regularly increase computational capacity dedicated to the training and algorithmic development of AI models in existing EU HPC centres, and for the development of tomorrow's exascale and post-exascale computing.
- Finance the expansion of Euro-HPC to additional cloud and storage capabilities to support AI training and extend their activity to AI fine-tuning and inference.
- Validate hosting in 'regulatory compliant' infrastructures as a key EU advantage for start-ups. Additional cloud and storage capabilities should be physically distributed throughout Europe, also to favour multi-location AI training (see below).
- Open up Euro-HPC to a 'federated AI model' favouring cooperation of public-private infrastructure to provide AI training power, leveraging the joint capacity of public computing and private resources and increasing the EU's competitive scale.
- Create an EU-wide framework (a legal, financial and operational model, including revised state aid rules) allowing the 'computing capital' of public institutions to be provided to innovative SMEs in the EU in exchange for financial returns. Under this model, public HPC facilities or research centres could competitively offer free computing capacity to innovative entities developing AI models, in exchange for equity options, royalties or dividends to be reinvested in capacity and maintenance.
- Develop quantum labs or nodes attached to all EU HPC centres and launch public-private partnerships – involving large EU tech leaders as a priority – to co-invest in the whole frontier tech stack, including neuromorphic and quantum chips.

2. **Launch an 'EU Vertical AI Priorities Plan'. Within these priorities, the plan would fund key vertical AI models across industrial sectors, built on EU data sharing, safeguarded from anti-trust enforcement.** This would encourage EU companies to participate in and accelerate European AI developments, across the following ten strategic industries where European know-how and value capture should be safeguarded:

   - Automotive industry and mobility platforms for autonomous driving [see the box];
   - Advanced manufacturing and robotics;
   - Energy, for both grid optimisation, as well as the production and integration of sources [see the box]
   - Telecom networks, including edge computing and IoT;
   - Agriculture, including space-generated Earth observation data;
   - Aerospace;
   - Defence;
   - Environmental forecasting;
   - Pharmaceutical, with a focus on drug discovery, personalised and more efficient treatments of rare diseases, more precise immunotherapy, radical shortening of clinical trial processes;
   - Healthcare, including early disease detection, autonomous robotics to integrate healthcare professionals work, and data management to define public prevention policies [see the box].

   This effort would be fed with data freely contributed by EU companies and supported within open-source frameworks in data-intensive industries, duly safeguarded from EU anti-trust enforcement, to encourage systematic cooperation between leading EU companies for generative AI and EU-wide industrial champions in key sectors.

Depending on each sector and the solutions being targeted, the specific initiatives could be tendered as 'challenges' to support disruptive R&D in AI – guided by granular technological foresight [see the box] – or financed as 'quasi-pilot lines' for defined 'industry fist-of-its-kind cases'. The implementation of the 'EU Vertical AI Priorities Plan' will require a clear separation of the governance – necessarily independent of individual businesses and research centres – from the actual development of solutions – decentralised and involving EU private and academic institutions of excellence.

3. **Harmonise national 'AI Sandbox regimes' across all Member States to enable experimentation and the development of innovative AI applications in the selected industrial sectors and ensure harmonised and simplified implementation of the GDPR.** Regular assessments should be carried out of potential regulatory hindrances deriving from EU or national legislation, with feedback from research centres to regulators and the EU. On this basis, it is recommended to introduce regular and fast review process of the main AI-related regulations (e.g. every three years), as technological developments can make regulations rapidly obsolete in this sector. In this context, develop simplified rules, particularly for SMEs, and enforce harmonised implementation of the GDPR in the Member States, while removing regulatory overlaps with the AI Act [as detailed in the Governance Chapter].

CLOUD

4. **Develop homogeneous and mandatory EU rules for sensitive areas of cloud services.** In particular, the EU and Member States should adopt:

    - A single EU-wide policy for public administrations' procurement of cloud service and data residency requirements, requiring as a minimum EU sovereign control of key elements for security and encryption. Public procurement should be aligned across Member States, standardising tenders and facilitating/promoting collaboration between EU companies to scale up commercially and support consolidation in the EU, with exceptions allowed only in nationally sensitive areas (e.g. defence, home affairs and justice).

    - EU-wide sensitive data security policies for collaboration between private EU cloud providers with US hyperscalers – given the valuable role of the latter to support adoption by European companies and due to their current scale and market presence – allowing access to hyperscalers' latest cloud technologies, while preserving encryption, security and ring-fenced services to trusted EU providers.

5. **Guarantee a Single Market passporting regime for all EU-provided cloud services,** eliminating the possibility for Member States to 'gold-plate' protection requirements beyond the requirements of the GDPR and the AI Act.

6. **Support data brokers (ex Data Governance Act) as 'pre-approved' data intermediaries,** certifying ex ante compliance with the EU acquis and guaranteeing regulatory clearance for instance via an 'EU Data Ombudsman' mechanism. This would help to favour industry-specific solutions promoted by EU companies.

7. **Step up the cooperation between the EU and the US to ensure access to cloud and data markets.** As part of a low-barrier 'digital transatlantic marketplace', it is crucial to foster common standards for procurement and cooperation between US and EU, to guarantee supply chain security and favour industrial and trade opportunities for EU and US technological companies on fair and equal conditions –for both the US equipment and software needed by the EU's cloud industry as well as for trusted equipment and software originated in the EU.

BOX 1

A design for the development of EU-wide vertical AI use cases

To thrive in an increasingly heated global technology race, the EU must leverage the development and application of 'AI verticals', i.e. innovative use cases for AI technologies across key industrial sectors – e.g. manufacturing, pharmaceuticals, automotive industry or robotics. In fact, in addition to the potential of AI in enhancing government operations by automating tasks, improving decision-making and personalising public services, AI can greatly enhance productivity in most EU industries, with estimates pointing to gains of around four hours per work week[xxxvii]. To seize the full potential of AI verticals for EU competitiveness, a strong and integrated EU strategy is needed, complementing the 'AI factories' and 'GenAI4EU' initiative foreseen by the Commission's AI Innovation Package[xxxviii]. This strategy should include the following elements:

- Coordination of key AI verticals at the EU level via a dedicated 'CERN-like AI incubator'. In the absence of EU hyperscale companies, developing AI verticals requires strong coordination between multiple actors, including AI developers, Research and Technology Organisations (RTOs), and industrial players. For instance, discovering whether an innovative product can be developed by a factory using its AI-powered digital twin requires the replication of the factory, its robots, processes and the overlay of an AI algorithm. In the absence of clear coordination at an early stage, the product would not be developed, leading to a market failure. EU-wide collaboration and coordination among Member States on AI verticals would enable EU players to reach the required scale in terms of data, investment and market share, potentially enabling them to compete with US hyperscalers.
- Launch EU-level calls to finance 'quasi-pilot lines' within sectoral AI labs to promote EU-wide industrial research for lower technology readiness levels (TRLs 3-5). The calls would involve public and private actors in each sector to develop standards for AI verticals and software for industrial applications. The AI labs would gather selected RTOs, sectoral champions and AI companies to develop foundation (vertical/small) models tailored to that sector. In addition to the availability of public infrastructure, this would incentivise private companies to contribute with data in a safe (sandboxed) environment. Each sectoral AI lab would be assessed against KPIs linked to concrete 'super-questions' framing future high added value applications in that sector.
- Orchestrate 'EU grand challenges' to develop industrial applications, once the key problems have been framed, spinning out of the quasi-pilot lines. Implementing these challenges (including EU-wide aggregation of data along the model of Euro-HPC) would require a range of research teams and early-stage start-ups active in disruptive or incremental R&D, focussed on solving specific technical, industrial or commercial problems and applications for mid-TRLs (5-7). The inducement prize model could enable rapid translation of scientific findings and new concepts into breakthrough innovation moving towards commercialisation (proof of concept), thanks to:
  - Early financial support for mid-TRL ventures, where research funding is not appropriate for further development and technological risk is often too high for private investors to chip in.
  - Demonstration of new use cases under faster, more flexible public-private funding mechanisms designed as 'pre-commercial procurements' open to any teams across the EU (universities, research institutes, start-ups and large companies) and designed to eliminate teams at each stage to progressively concentrate higher funding on fewer, most promising teams.
  - Sustained competition between different teams and approaches fostering the development of multiple technologies in parallel with a strong bridge to commercialisation, as well as including talent from across institutions, Member States and disciplines.

In the EU, the European Innovation Council (EIC) and the European Space Agency (ESA) already run calls for challenges. Yet, the model is more widely used in the US, where around 70% of public investment in R&I is done by the Department of Defence via challenges for technology procurement. For instance, DARPA currently has an open challenge for AI cybersecurity for critical infrastructure[xxxix]. China ran a global AI challenge for electrical and mechanical services, ended in September 2022[xl], and the United Arab Emirates launched challenges in the form of hackathons in 2023[xli].

3.3 Semiconductors

The starting point

The EU has key strengths and leads in selected segments of the chips market, but its position is impacted – as in most other areas – by strong dependence on non-EU players and scarce presence in high-value innovative segments. The global chip market was valued at USD 520 billion in 2023 and is expected to grow by 13.1% in 2024[xlii]. The EU market is valued at USD 57 billion, representing around 10% of the global supply across the value chain, down from 20% in the nineties. Its current value is half of the 20% target for 2030 [see Figure 10]. The EU's share of the global capacity of wafers production has also decreased to 7%. In 2023, the EU market grew by 5.9%, while the Americas, Asia Pacific and Japan experienced a downturn.

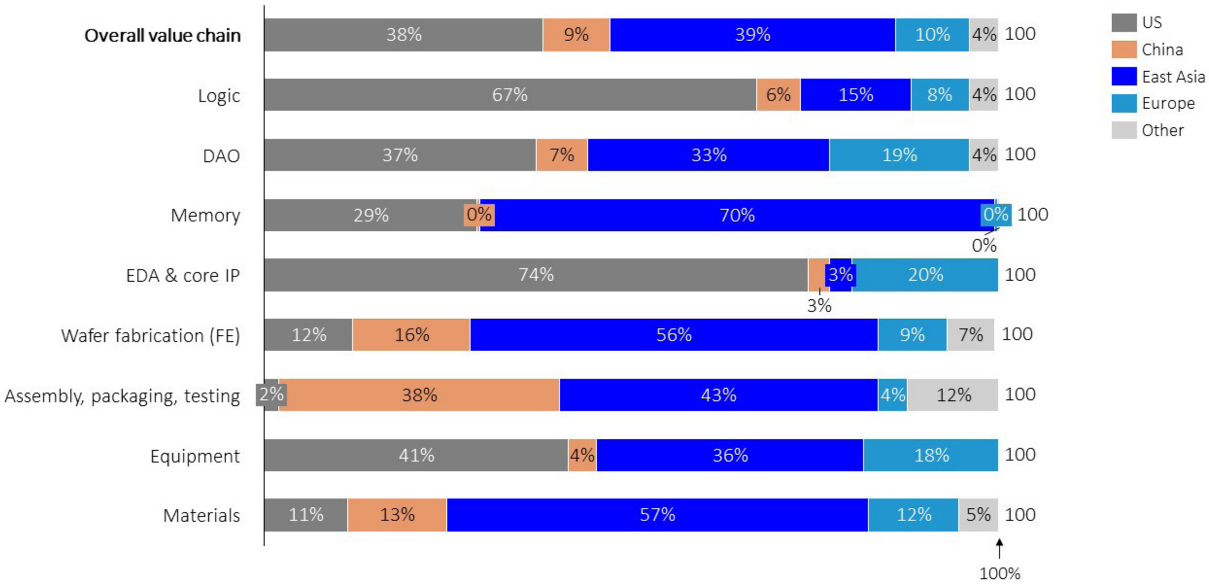
The global nature of semiconductors buyers, together with growing demand for most chip types, entails the need for massive scale to develop and manufacture chips. Most companies run 'fabless' business models, whereby manufacturing is outsourced to foundries. This results in a market structure dominated by a small number of large players, plus smaller operators controlling niches with oligopolistic nature. In this context, the US has specialised in chips design, Korea, Taiwan and China in chips manufacturing, and Japan and some Member States (e.g. the Netherlands) in key materials and equipment – optics, chemistry and machinery.

The EU has developed strong presence and capabilities in specific chip segments including sensors, power controls and mature chips for car microcontrollers and peripherals. However, in these segments value added could be eroded by industrial users insourcing design and by low-cost manufacturing competition, for instance from China. Areas where the EU has developed clear leadership are equipment and materials, in particular lithography machines (ASML – without which no advanced chip below 7 nm in the world can be efficiently produced), deposition (ASM and others), substrates and gases, as well as testing (IMEC). However, this primacy could be challenged by export controls in the backdrop of rising geopolitical tensions worldwide.

On the other hand, the EU lacks capabilities in memories and advanced processors for HPC and graphics processing units (GPUs). This renders Europe's AI industry dependent on hardware produced largely by the US-based company Nvidia, a key supplier of GPUs. Europe currently has no foundry producing below 22 nm nodes, with Samsung and Taiwan's TSMC holding market dominance. As such, the EU and US are dependent on Asia for 75% to 90% of chips production[15]. Finally, Europe has strong dependences on third countries like China for the supply of germanium and gallium, as well as for design, packaging and assembly, traditionally outsourced to East Asia.

15. Namely, East Asia and China concentrate over 75% of the global wafer fabrication capacity, with peaks for advanced logic capacity <10nm, currently located in Taiwan and South Korea. See: BGC, 'Strengthening the Global Semiconductor Supply Chain in an Uncertain Era', 2021

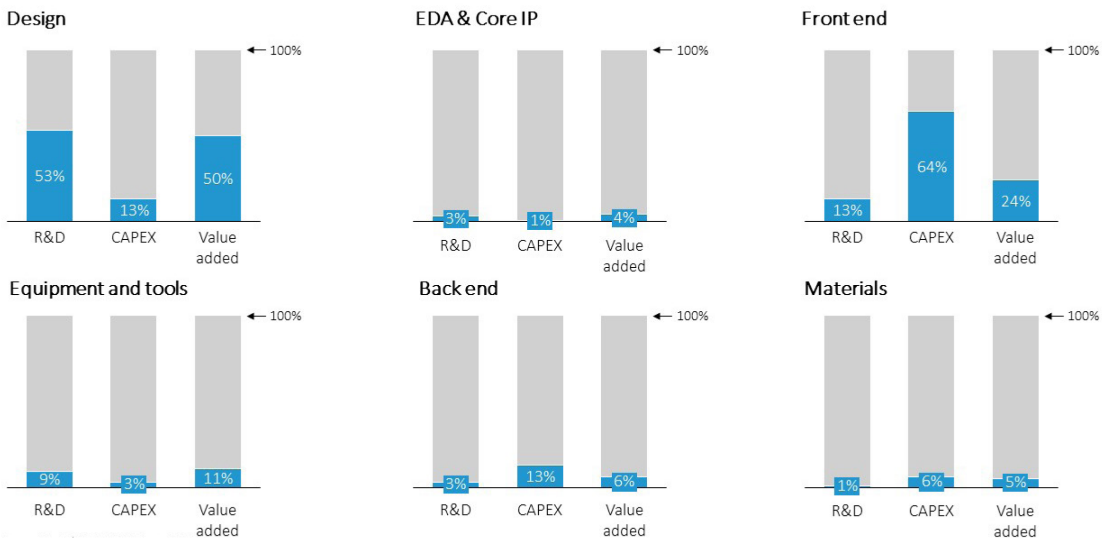
FIGURE 10
Share in semiconductor value chain by country
% of worldwide total, 2019.



Source: SIA, 2021.

Around three-quarters of the semiconductor industry's total value added is today accrued to chip designers and foundries, but some shifts towards advanced packaging are expected. The global semiconductor value chain includes seven differentiated activities – design, electronic design automation (EDA) and core intellectual property (core IP), front-end (wafer fabrication), back-end (assembly, packaging and testing), equipment and tools, and materials. In this context, chip design accounts for 50% of the total value-added in the industry, while front-end wafer fabrication accounts for 24% of value added. This is followed by equipment and tools with 11%, and all other stages representing each around 5% of value added [see Figure 11]. This will likely remain the case in the coming years, although some shifts will occur, with higher CAPEX needs expected to materialise in advanced packaging facilities, while currently the highest CAPEX needs are in wafer fabs.

FIGURE 11
Share in R&D, CAPEX and value added by step of the semiconductor value chain
%, 2019



Source: Capital IQ, 2020. Gartner, 2020.

In the coming decade, value added in the global chips sector will thus continue to be captured by players with strong architectural and design capabilities, or with research and innovation scale in manufacturing for most advanced product lines. Supply overcapacity and shortage cycles will likely persist in the long term as investment requirements remain high, and public support (now 50% of total requirements) needed. Concentration in large-scale specialised geographical areas and massive scale installations will be unavoidable. On the demand side, volumes for most advanced products will continue to depend on the production of smartphones, electrification, computing and the automotive industry, whose market developments and innovation requirements are difficult to predict. Demand for less innovative chips will be sustained, but their supply will be more subject to price and cost competition, as well as non-market policies and practices.

Demand imbalances and fluctuations will be structural, with expensive supply to test and deliver hardly being synchronised and often resulting misaligned. Further miniaturisation will take place. The industry is now edging sub 2 nm, but the capabilities required to domestically innovate this technology are virtually non-existent in the EU. New manufacturing, products, and innovative chips (neuromorphic and quantum) will also be required over time. Technological advancements will extend to back-end packaging, vertical developments of substrates and new materials for wafers. Advanced skills and expert labour will be increasingly needed. Availability of specialised engineering skills for R&D and manufacturing will determine or undermine the EU's competitive advantage.

Some of these issues are being addressed by the EU Chips Act. The Act tackles these challenges to the extent required to maintain the EU's leadership in mainstream product segments and at the innovation frontier (e.g. quantum and chiplets), to enhance open strategy autonomy and act as a strategic counterweight, in particular on logic processors for computing. The EU Chips Act aims to give Europe leverage over key segments of the semiconductor value chain. It seeks to bolster innovation 'from lab to fab', attract investment and enhance domestic production capacities, and put in place monitoring and response mechanisms in case of supply disruptions. Rightly so, a central tenet of the EU Chips Act is the goal of operating the most advanced fabs capable of producing 2 nm chips in the EU by 2030.

Yet, despite the Chips Act, overall investment and public support for semiconductor production in the EU remains below that in the US. The EU's semiconductor industry is investing below the scale needed to sustain expected demand and the governance of Chips investments in the EU is characterised by lengthy processes and conflicting, uncoordinated postures of Member States. Around EUR 100 billion of total investments in industrial deployment have been announced in the EU since the proposal for a European Chips Act[xliii], but the majority is supported by Member States under State aid control, with only a minimal portion of EUR 3.3 billion coming from the EU budget. By contrast, the US CHIPS Act allocated EUR 52 billion in federal subsidies alone to research and manufacturing, not including state-level subsidies as well as tax credits and loans. Specifically on R&D, the EU has allocated approximately EUR 5 billion to strengthen its chips ecosystem, compared to the USD 11 billion allocated by the US. Given the technological complexity of the semiconductor industry, the size of investments required and the long lead times to deliver industrially, the Chips Act has been a good first step but is already confronted by decisive moves by other geopolitical blocs and needs to be stepped up to underpin the EU's future competitiveness, including the delivery of essential electronics cores for many strategic industries.

The absence of large EU players in electronics and end-user sectors, which results in demand requirements being weakly coordinated, represents a significant additional policy challenge. EU companies have not reached sufficient scale in vertical electronics sectors, rendering it challenging to invest in more innovative and state-of-the-art semiconductor segments without visibility on demand. The battle to attract non-EU firms to Europe could easily result in intra-EU competition in subsidies, benefitting the new establishment of existing players from outside the EU, rather than enhancing the autonomy of EU firms.

A new, more articulated and concerted approach is, therefore, needed to boost the EU's future competitiveness in this sector. Coordination of research challenges and demand requirements, funding of innovative pilots lines and manufacturing implementations and allocation of subsidies to specific product and process stages will determine the EU's ability to increase sovereignty and lead in selected industrial segments.

Objectives and proposals

The EU must de-risk its strategic dependencies and improve its capabilities in semiconductors, focusing on supply chain segments where it has or can develop a competitive advantage. The EU should aim to:

- Boost R&D in selected mainstream and innovative product segments, like larger nodes (sensors, power controls, etc.), where the EU is already present.
- Develop a sovereign position in design and manufacturing processes, incentivising technology transfer only for newer manufacturing technologies.
- Strengthen EU companies of demonstrated excellence in selected semiconductor equipment and materials, defending their export ambitions and expanding their addressable markets.

FIGURE 12

	SUMMARY TABLE SEMICONDUCTOR PROPOSALS: A REVISED EU CHIPS ACT	TIME HORIZON[16]
1	**Enable the development of a new EU Semiconductor Strategy, by establishing an EU semiconductor budget, coordinating demand requirements, introducing EU preferences in procurement and a new 'fast-track' IPCEI**	**ST/MT**
2	**Launch the new EU Semiconductor Strategy, including: i) funding for innovation and the establishment of testing labs near existing centres of excellence; ii) grants or R&D tax incentives for fabless companies active in chips design and foundries in selected strategic segments; iii) support for the innovation potential of mainstream chips; and iv) coordinated EU efforts in back-end 3D advanced packaging, advanced materials and finishing processes**	**MT**
3	Support consolidation and leadership in manufacturing equipment in response to competitors' export restrictions	ST/MT
4	Foster a friendly EU-wide permitting regime for chips	ST
5	Launch a long-term EU Quantum Chips plan	LT
6	Foresee a chip sub-component of the 'Tech Skills Acquisition Programme' to attract, develop and retain world-class competencies in advanced electronics and semiconductors	ST/MT

To achieve these objectives, the EU Chips Act should be reviewed and expanded towards increasing funding, coordination and speed of public-private cooperation at continental level, as well as maximising joint efforts to strengthen innovation in semiconductors and presence in most advanced chips segments. Specifically, it is recommended to:

1. **Create an EU semiconductor budgetary allocation complementary to Member States' allocations, as well as ensure all other pre-conditions to develop a long-term EU Semiconductor Strategy aimed to boost Europe's open strategic autonomy, by:**
    - Ensuring a centralised EU budgetary allocation dedicated to semiconductors, allowing Member States' co-investment on priority initiatives and industrial projects of high EU added value.
    - Facilitating voluntary R&D and demand requirements to increase the critical mass necessary to support the EU chips industry strategic investments in innovative chips – e.g. shared industry pilot lines in the automotive industry, industrial robotics, aerospace, telecoms equipment and medical devices – safeguarding them from EU anti-trust enforcement.

16. Time horizon is indicative of the required implementation time of the proposal. Short term (ST) refers to approximately 1-3 years, medium term (MT) 3-5 years, long term (LT) beyond 5 years.

- Defining chips procurement preferences for EU products and a new 'EU Chips' certification for public and private procurement tenders, to support the growth of EU-based companies.
- Introducing a new 'fast-track' IPCEI, with co-financing from the EU budget and shorter approval times for semiconductor projects, consistent with the EU Semiconductor Strategy [see below].

2. **Launch a new EU Semiconductor Strategy based on five pillars:**
    - Funding for innovation and testing labs located near existing EU centres of excellence (e.g. CEA LETI, Fraunhofer and IMEC) to accelerate the development of frontier technologies including chips for neuromorphic and quantum computing, memristors/capacitors, and sub-7 nm chiplets.
    - Incentives for innovative design capabilities and fabless companies. As EU ownership of large foundries is unrealistic at this stage due to unsustainable CAPEX levels and labour costs in the Union, provide grants or R&D tax incentives to fabless companies active in chips design.
    - Subsidies for foundries focussed on selected strategic segments, where the EU is stronger and demand is more robust (e.g. automotive, manufacturing and network equipment), trends are favourable (electrification and renewables), or innovation is faster (chiplet architectures, AI chips).
    - Support for the innovation potential of mainstream chips in larger nodes (more than 28 nm) as well as of chiplets, to leverage EU strengths in established industries and innovative deployments (e.g. the automotive industry, sensors for IoT, power controls, photonics, etc.)
    - Subsidisation of more innovative production stages. While manufacturing capabilities of front-end processes are expensive and might reach extreme technical and financial challenges below 2 nm, a concerted EU effort should focus on back-end 3D advanced packaging, advanced materials and finishing processes.
3. **Support European consolidation and leadership in semiconductor manufacturing equipment (lithography, depositions, etc.) as a pillar of the EU long term strategy in semiconductors as well as a geopolitical negotiation strategy for partnerships with third countries to boost the EU's value chain autonomy.** Increasingly manage export controls at the EU level and defend EU interests in equipment and materials from third-countries' export restrictions.
4. **Foster a friendly EU-wide permitting regime for chips across Member States.** Given the complexity of permitting and the amount of direct and indirect resources needed (water, electricity, roads, transportations, etc.), adopt a simplified EU-wide permitting procedure (e.g. under the overriding public interest framework) for chips in all Member States.
5. **Launch a long-term EU Quantum Chips plan coordinating funding and architectural choices and avoiding the duplication of investment to concentrate funding efficiently.**
6. **Foresee a chip sub-component of the 'Tech Skills Acquisition Programme' [as detailed in the Closing the Skills Gap Chapter] to attract, develop and retain world-class competencies in advanced electronics and semiconductors. This should include:**
    - A special entry visa for graduates and researchers in advanced electronics to immediately increase the availability of competencies and experience in Europe.
    - New EU-wide scholarships for master's and PhD students in universities with excellence in relevant fields to increase the availability of semiconductor talent.
    - Early-work internships and temporary contracts with public and private research centres to ensure early and immediate employment opportunities in the strategic areas identified by the EU strategy and stimulate synergies between academia and industry.

ENDNOTES

i Eurostat, 'ICT Sector - value added, employment and R&D', 2024.

ii EIB, EIB Investment Report 2022/2023, Resilience and renewal in Europe, 28 February 2023.

iii COM(2021) 118 final, Brussels, 9 March 2021. UNCTAD, Digital Economy Report 2019, 4 September 2019.

iv COM(2022) 289 final, Brussels, 29 June 2022.

v McKinsey, The economic potential of generative AI: The next productivity frontier, 2023.

vi Renda, A., Balland, P. A. and L., Bosoer, The Technology/Jobs Puzzle: A European Perspective, 2023.

vii WEF, 'Why we need to ramp up tech diplomacy to harness opportunities of the digital economy', 28 December 2023.

viii COM(2023) 570 final, Brussels, 29 September 2023.

ix Mc Kinsey, 'Securing Europe's competitiveness: Addressing its technology gap', 22 September 2022.

x COM(2024) 81 final, Brussels, 21 February 2024, p. 14.

xi Cullen International, 'Mapping EU Regulators', forthcoming.

xii See reference viii.

xiii For the EU, see reference vii. For the US, see BCG, 'Accelerating the 5G Economy in the US', 2023. For China, see Ericsson Mobility Report data and forecasts, '5G network coverage outlook 2023', 2023.

xiv See reference viii.

xv ITU, 'Facts and Figures 2023, Internet Traffic', 2023.

xvi Deloitte, 'Decision time for Europe's telcos', 2023.

xvii See reference viii.

xviii Dell'Oro Group, 'Total Telcom Equipment Market Grows 2 Percent in 1H23', 2023.

xix Statcounter Global Stats, 2023: https://gs.statcounter.com/os-market-share/mobile/europe/.

xx Statcounter Global Stats, 'Mobile Vendor Market Share in Europe', April 2024. For market shares by shipment volumes see https://www.statista.com/statistics/632599/smartphone-market-share-by-vendor-in-europe/.

xxi COM(2024) 81 final, Brussels, 21 February 2024.

xxii See reference viii.

xxiii See reference ii.

xxiv Similarweb ranking: https://www.similarweb.com/top-websites/e-commerce-and-shopping/marketplace/.

xxv https://ec.europa.eu/commission/presscorner/detail/en/ip_24_2561.

xxvi https://www.statista.com/forecasts/1235161/europe-cloud-computing-market-size-by-segment.

xxvii Grand View Research, 'High Performance Computing Market and Segment Forecast to 2030', February 2023.

xxviii Euro-HPC, Press release, 13 November 2023.

xxix See reference viii.

xxx LEAM:AI, 'Large AI Models for Germany – Feasibility Study 2023', 2023. Moreover, in 2023 only, around two thirds of all notable machine learning models were released in the US: see Stanford University, 'Artificial Intelligence Index Report 2024', 2024.

xxxi Renda, A. and P. A., Balland, 'Forge Ahead or Fall Behind - Why we need a United Europe of Artificial Intelligence', CEPS Explainer, 2023.

xxxii International Federation of Robotics, 'World Robotics 2022', 2022. Both professional and consumer applications.

xxxiii International Federation of Robotics, 'World Robotics 2023', 2023.

xxxiv BCG, 2022: https://www.bcg.com/press/25august2022-quantum-tech-race-europe-cant-afford-to-lose.

xxxv US Department of Home Security, 2021: https://www.dhs.gov/sites/default/files/publications/post-quantum_cryptography_infographic_october_2021_508.pdf. Candelon, F., Bobier, J. F., Courtaux, M. and G., Nahas, 'Can Europe Catch up with the US (and China) in Quantum Computing', August 2022.

xxxvi McKinsey & Company, 'Quantum Technology Monitor', 2022. McKinsey & Company, 'Quantum Technology Monitor', 2023.

xxxvii BCG, 'Eliminating the Ugliest 4 Hours of Your Work Week with GenAI', April 2024.

xxxviii European Commission, Press Release IP/24/383, 24 January 2024.

xxxix https://www.darpa.mil/news-events/2023-08-09.

xl https://globalaichallenge.com/en/home.

xli https://fastcompanyme.com/news/dubai-launches-a-global-ai-competition-with-a-prize-pool-of-over-200000/.

xlii World Semiconductor Trade Statistics, '2023 Report', 2023.

xliii European Commission, Press Release IP/23/2045, 18 April 2023.

4. Energy-intensive industries

The starting point

Energy-intensive industries (EIIs) are a vital part of the European economy and play a critical role in reducing the EU's strategic dependencies. EIIs contribute directly and indirectly, through downstream activities, to a large share of the EU's economy, employment and innovation. They comprise industries such as chemicals, basic metals, non-metallic minerals (ceramics, glass and cement), plastics, paper products, wood and wood products, and food. Evidence in this chapter will focus on the four most energy-intensive industries in the EU (at NACE two-digit classification level): chemicals; basic metals; non-metallic minerals; pulp, paper and printing.

Part of the EIIs include hard-to-abate (HtA) activities. These are activities such as cement, glass, steel, chemicals and plastics production, which use fossil resources (coal, gas and oil) as fuel or feedstock. In these segements, greenhouse gas (GHG) emissions are comparatively difficult to reduce using current technologies.

Developments in energy costs and decarbonisation needs have had a strong impact on the EEI industries' competitiveness. EIIs, and particularly HtA sectors, in Europe have been at the forefront of global quality and innovation for decades. Nevertheless, they are now facing increasing competitive pressure, primarily due to increased energy costs and stronger decarbonisation efforts required in Europe compared to its international competitors. Deindustrialisation in the EU in some of these sectors has already started, and may accelerate without dedicated policies.

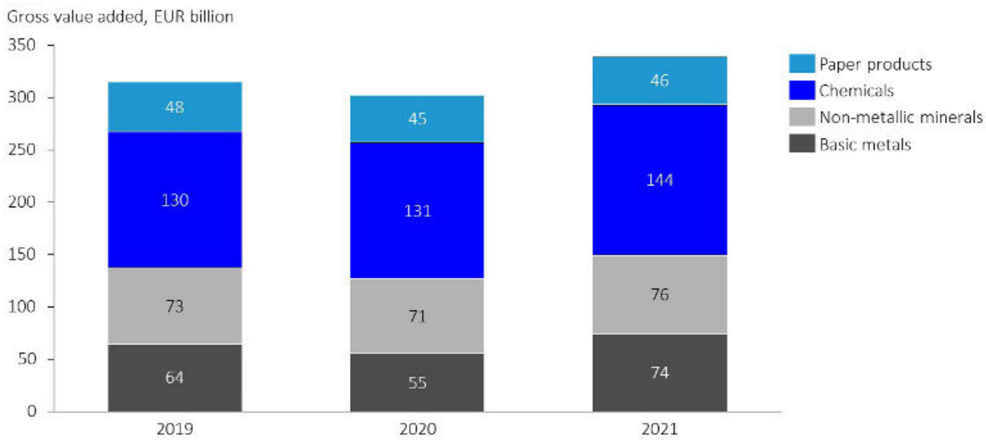
TABLE OF ABBREVIATIONS

BF-BOF	Blast furnace-basic oxygen furnace
CAPEX	Capital expenditure
CBAM	Carbon Border Adjustment Mechanism
CCfD	Carbon contract for difference
CCS	Carbon capture and storage
CCSU	Carbon capture, utilisation and storage
CEEAG	Climate, Energy and Environmental Aid Guidelines
CfD	Contract for difference
CO_2	Carbon dioxide
DRI	Direct reduced iron
EAF	Electric arc furnaces
EHB	European Hydrogen Bank
EII	Energy-intensive industry
ESPR	Eco-design for Sustainable Products Regulation
ETS	Emissions Trading System
EV	Electric vehicle
G7	Group of Seven
GHG	Greenhouse gas
GSA	Global Arrangement on Sustainable Steel and Aluminium
GVA	Gross value added
HtA	Hard-to-abate
ICE	Internal combustion engine
IRA	Inflation Reduction Act
MEAT	Most economically advantageous tender
NACE	Statistical classification of economic activities in the European Community
NZIA	Net-Zero Industry Act
OECD	Organisation for Economic Co-operation and Development
OPEX	Operating expenditure
PCF	Product Carbon Footprint
PPA	Power purchasing agreement
RRF	Recovery and Resilience Facility
SME	Small and medium-sized enterprises
TSI	Technical Support Instrument

EII'S CONTRIBUTION TO THE EU ECONOMY

EIIs account for a relevant share of the EU's industrial economy in terms of production and employment. The four most energy-intensive industries together – chemicals, metals, non-metallic minerals, and pulp and paper products – represented a relatively stable 16% share of total manufacturing gross value added (GVA), or about 2% of the EU GDP until 2021 [see Figure 1]. These four industries accounted for 13% of jobs in manufacturing, equal to 3% of employment in the entire EU market sector, in 2021[i] (on plastics, see the box).

FIGURE 1
Gross value added of the chemicals, minerals, metals and paper industries in the EU



Source: European Commission, 2024. Based on Eurostat, 2024.

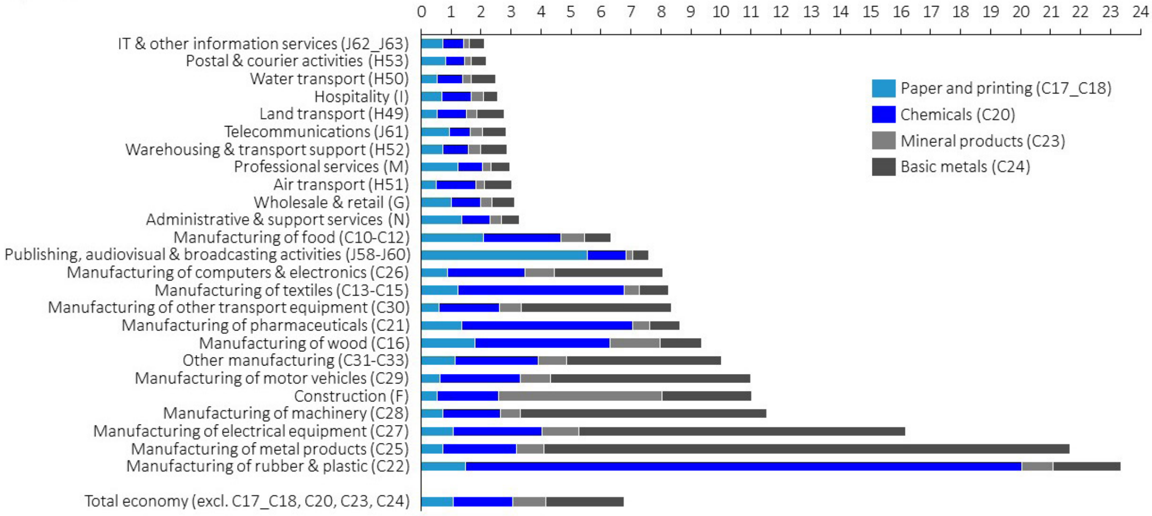
EII production creates value for downstream activities. For the market economy (i.e. excluding government), EUR 100 of downstream production contains on average EUR 5 of inputs from chemicals, minerals and basic metals [see Figure 2][01]. Multiple knock-on effects link upstream EIIs in Europe with the competitiveness of local downstream activities. These include supply chain and transport efficiency and resilience, the potential for circularity (re-cycling, using by-products of other industries), knowledge sharing and innovation systems (clusters), and regulatory alignment (producing in the same jurisdiction should ensure compatibility).

01. This excludes intra-industry transactions from the market economy aggregate.

FIGURE 2

Reliance on heavy industry inputs in industry production

% 2018



Note: The graph displays each industry's use (direct and indirect) of paper and printing (C17_18), chemicals (C20), non-metal minerals (C23), and basic metals (C24) as inputs relative to total production in the respective industries. C17, C18, C20, C23, and C24 are omitted from the figure as intra-industry exposure is generally strong.

Source: European Commission, 2024. Based on OECD, 2021.

EIIs are crucial to avoid strategic dependencies in critical industries in Europe. They are, for example, important for ensuring food security (fertilisers and pesticides), strategic autonomy in the defence sector, for the clean energy transition, and for the resilience of overall EU downstream activities in the current geopolitical context[02].

EIIs are an important emitter of greenhouse gases (GHG), but are also important for decarbonisation to be achieved. Several EIIs, in particular the HtA industries, use carbon as an an integral part of their processes. Together, they were responsible for 19% of overall GHG emissions in the EU business sector and 68% of GHG emissions in EU manufacturing in 2021, equalling approximately 543 million tonnes of CO_2 equivalents (97% of which were actual CO_2 emissions, the remaining 3% other GHGs)[03]. Their emissions are more difficult and costlier to avoid (heat and pressure requirements that are hard to electrify, chemical processes and feedstock needs) than in other sectors. At the same time, EIIs will play a central role in the EU's green transition, including the achievement of the climate neutrality targets. The demand for EII outputs will grow together with increasing demand for greener investment goods, infrastructure and construction[04]. Policy needs to account for the industry-specific decarbonisation paths of EIIs. In the chemical and metal industries, for instance, hydrogen and CCS/CCU are possible pathways to reduce net emissions, while meeting temperature and heat requirements, carbon feedstock needs in chemicals, and the use of coal or hydrogen as reducing agents in steelmaking (with electricity or gas prices critically affecting the cost of hydrogen). Electrification is a solution for low - and medium - temperature heat (already standard in aluminium), whereas CCS/CCU are the main emission abatement options for CO_2 process emissions at current technologies for example in the cement sector. The supply of sustainable biomass as fuel or feedstock is insufficent to replace fossil fuels on a permanent basis[ii].

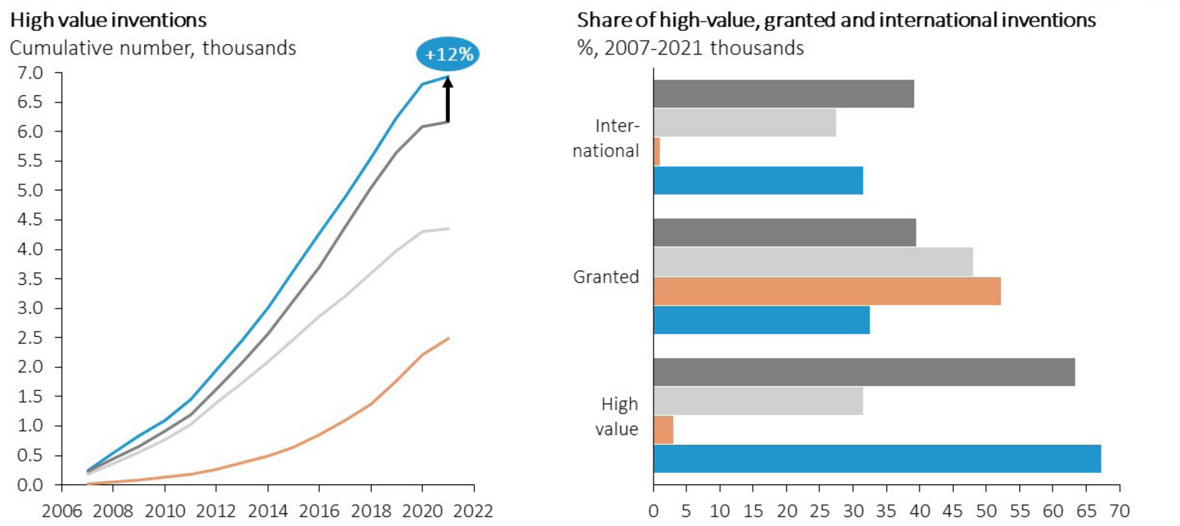
02. According to the European Commission's methodology, out of 204 products with strategic dependencies 43% belong to chemical industries, 12% to basic metals, and 11% to mineral products. Strategic dependencies are input dependencies in critical industries or ecosystems, namely security and safety, health, and the green and digital transitions. See: Arjona, R., Connell, W., Herghelegiu, C., 'An enhanced methodology to monitor the EU's strategic dependencies and vulnerabilities', Single Market Economic Papers, No. 14, 2023. Vandermeeren, F., 'Understanding EU-China economic exposure', Single Market Economics Briefs, No. 4, 2024.

03. Values for EIIs refer to the NACE 2-digit sectors paper and printing (C17, C18), chemicals (C20), mineral products (C23), and basic metals (C24). EII GHG emissions have fallen from 543 million tonnes of CO_2 equivalents in 2021 to 492 million tonnes in 2022, due to the contraction in EII activity in 2022. EII CO_2 emissions also fell during the COVID-19 pandemic but have rebounded subsequently. Data source: Eurostat, Air emissions accounts by NACE Rev. 2 activity.

04. Examples include: (i) steel and metals as input for metal products, electrical equipment, machinery, automotives, and (ii) metals, and minerals (including cement) as input for green infrastructure (renewable electricity generation, transport) and construction (energy efficiency).

Traditionally, the EU's EII industry has been a frontrunner in quality, innovation and green technologies, and their deployment. High levels of research and innovation in the EU have allowed companies to increase product differentiation. For example, European companies have traditionally been strong in high-quality steel grades and speciality chemicals. Strength in research and innovation, as well as the quality of infrastructure in the EU, have attenuated cost disadvantages in the EIIs to some extent, especially through improved energy efficiency and raw material recycling[iii]. Finally, the EU's EII industries have been leading in green technologies for EIIs [see Figure 3][05]. Innovation relates, for instance, to energy savings, recycling, and carbon capture, storage and use. European companies have incurred significant upfront costs in leading the development and deployment of innovative abatement solutions.

FIGURE 3
Patenting of climate change mitigation technologies for energy-intensive industries



Note: Technologies related to metal processing, chemical industries, oil refining and petrochemicals and the processing of minerals. The number of inventions is measured by patent families, which include all documents relevant to a distinct invention, including patent applications to multiple jurisdictions. An invention is considered of high value when it contains patent applications to more than one office, as this entails longer processes and higher costs, indicating stronger expected prospects in international markets. Patent applications protected in a country different to the residence of the applicant are considered international (excluding other European countries and EPO). Granted patents represent the share of granted applications in a patent family.

Source: European Commission, JRC, 2024.

Production in EIIs tends to be concentrated in larger firms. The average firms in paper production, chemicals, and basic metals have around 40-60 employees, in non-metallic minerals and total manufacturing around ten. Production is concentrated in larger companies, however. Firms with over 250 employees account for 70-80% of the gross value added in paper production, chemicals, and basic metals, compared to almost 60% in non-metallic minerals, and 2/3 value-added share of large firms in total manufacturing[iv].

THE EU'S ERODING COMPETITIVENESS

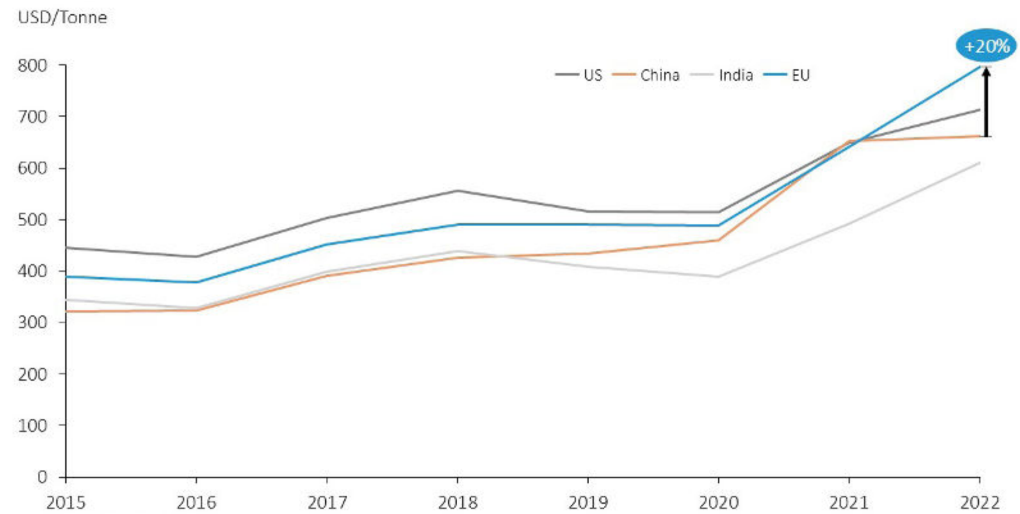
Declining competitiveness has been reflected in output losses and an increased reliance on imports. During the past years, and in particular since the energy crisis of 2022, the competitiveness of the EU's EIIs has deteriorated sharply. Cost gaps with other world regions have widened [see the example of steel in Figure 4]. As a result, domestic production has contracted sharply [see Figure 5], while total manufacturing remained robust by comparison. In parallel, trade intensity (imports and exports) has trended upwards and reliance on domestic supply (in particular, for

05. For example, Scandinavian countries are world leaders in terms of patent density (patents per capita) in the field of GHG abatement.

chemicals and metals) has declined, implying more reliance on imports to serve domestic demand [see Figure 6][06]. A loss of competitiveness is also visible in data on export performance, where the higher energy intensity of an industry is associated with lower or negative export growth during from 2022 to 2023 compared to other EU industries[v].

Adjusting EII production capacity is costly. Shutting down EII production facilities for an extended period of time in response to cost presure leads to a loss of competencies (labour force, supplier networks, etc.) that will make it difficult to restart, in addition to the technology-related costs (including equipement losses) of interrupting production processes temporarily.

FIGURE 4
Example steel: hot rolled coil production costs



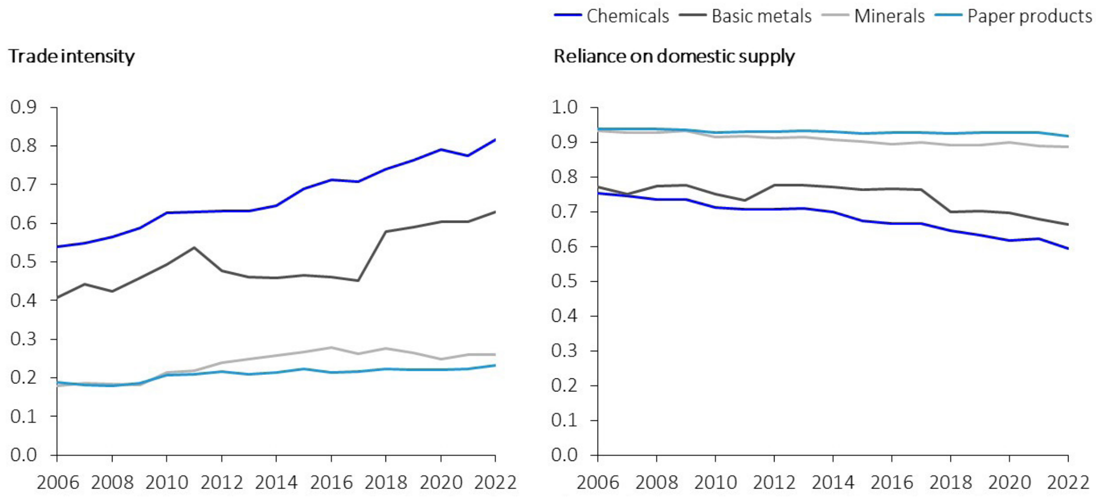
Source: European Commission, JRC, 2024.

FIGURE 5
EU production in energy-intensive industries

Source: European Commission, 2024. Based on Eurostat, 2024.

06. Reliance on imports does not imply a negative trade balance. It rather reflects, with the wider industry grouping applied here, patterns of specialisation within the industry across differentiated products, meaning that exports and imports cannot easily be substituted.

FIGURE 6
Trade intensity and reliance on domestic supply for energy-intensive industries



Note: Trade intensity is defined as exports plus imports over domestic production (all in value terms). Reliance on domestic supply is domestic production net of exports over domestic production net of exports but plus imports. Reliance on domestic supply, hence, displays the ratio of domestically produced output for domestic use relative to total domestic absorption (demand) at the industry level. The ratio is bounded between 0 and 1 (0 = full import dependence, i.e. zero domestic production for the domestic market, 1 = full autarky, i.e. no imports in domestic absorption). Trade here refers exclusively to extra-EU trade.

Source: European Commission 2024. Based on Eurostat, 2024.

THE ROOT CAUSES OF THE EU'S COMPETITIVENESS GAP

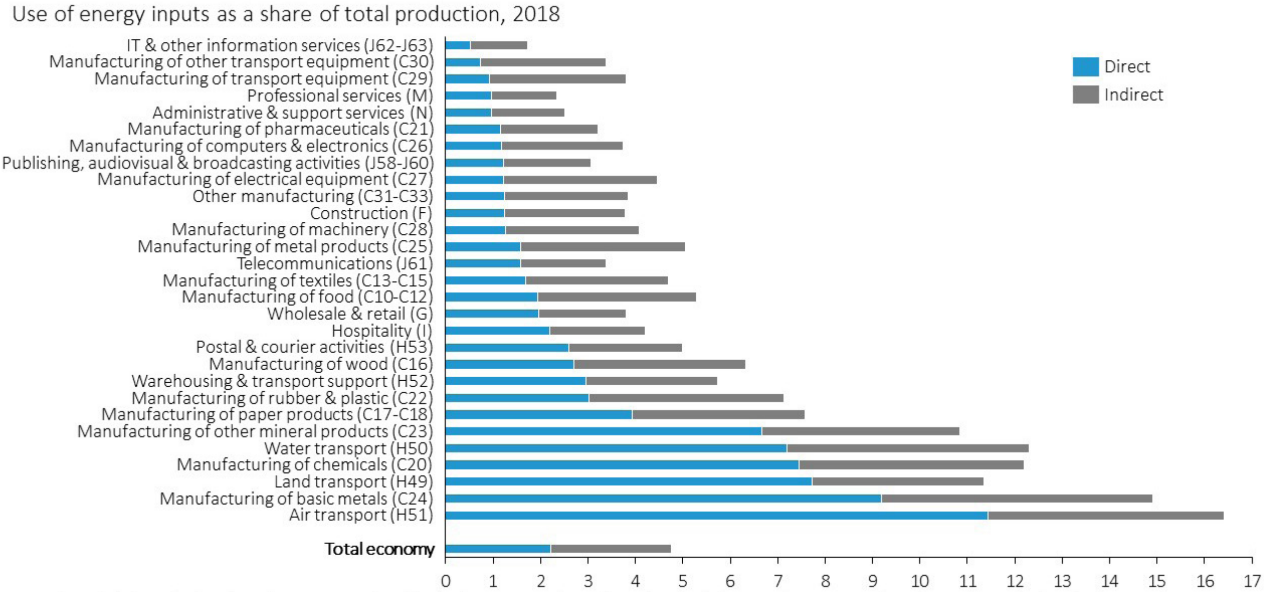
Energy costs and decarbonisation are the primary determinants of the EIIs' competitiveness in Europe. The competitiveness of EIIs in the EU is primarily challenged by higher energy prices and emissions costs compared to global competitors, substantial investment needs required for decarbonisation, as well as red tape and an unlevel playing field for the industry, including limited markets for greener products.

1. High energy prices.

Energy inputs represent a substantial share of the EIIs' value chain. Electricity and fossil fuels account for 7%-9% of the industries' production value directly, and 12%-15% including the energy contained in intermediate inputs [see Figure 7].

FIGURE 7

Reliance on primary energy inputs in industry production



Note: The graph displays each industry's use of energy inputs as share of total production. Direct reliance refers to the industry's direct use of energy inputs; indirect reliance refers to the industry's indirect use of energy through non-energy intermediate inputs.

Source: European Commission, 2024. Based on OECD, 2021 (data from 2018).

The EU faces structurally higher energy and raw material costs. As analysed in the chapter on energy, the EU faces significantly higher energy costs than its main global competitors[07]. During the 2022 energy crisis, production costs for the chemical, mineral, basic metal, and paper industries rose by 20%-25%, and as much as 40%-50% for individual products[vi]. The EIIs have been more affected by the energy crisis than other industrial sectors. . A clear correlation can be observed between energy intensity and reduced production in the EU's manufacturing sectors [as discussed in chapter 3 of Part A][08]. Energy costs are the decisive factor having systematic effects on investment location decisions and determining the continuation of EII activities in the EU. Large and persistent cost shocks should have a stronger impact than small and transitory ones, as the former affect long-term prospects and associated investment incentives[vii]. For chemicals, high oil and gas prices also mean high costs of feedstock for production, i.e. a gap in raw material costs adding to the gap in energy prices.

2. High emissions costs.

Carbon pricing increases relative production costs in EIIs. As the EU is the only region globally with a significant CO_2 price and most EIIs fall under the scope of the EU's ETS[09], the significant carbon intensity[10] of EIIs affects their production costs. GHG emissions relative to value added are around five times higher for EIIs, such as metals and minerals, than for total manufacturing, and around ten times higher than for total economic activity [see Figure 8].

07. Global energy prices do not affect EIIs equally across Member States, as those with an accelerated uptake of renewables and low-carbon flexibility may benefit in terms of competitiveness. Electricity prices have diverged inside the EU after the 2021-2022 energy shock, with the Nordics and the Iberian Peninsula, for example, having significantly lower prices compared to the EU average. See: Gasparella, A., Koolen, D., Zucker, A., The Merit Order and Price-Setting Dynamics in European Electricity Markets, European Commission, 2023.

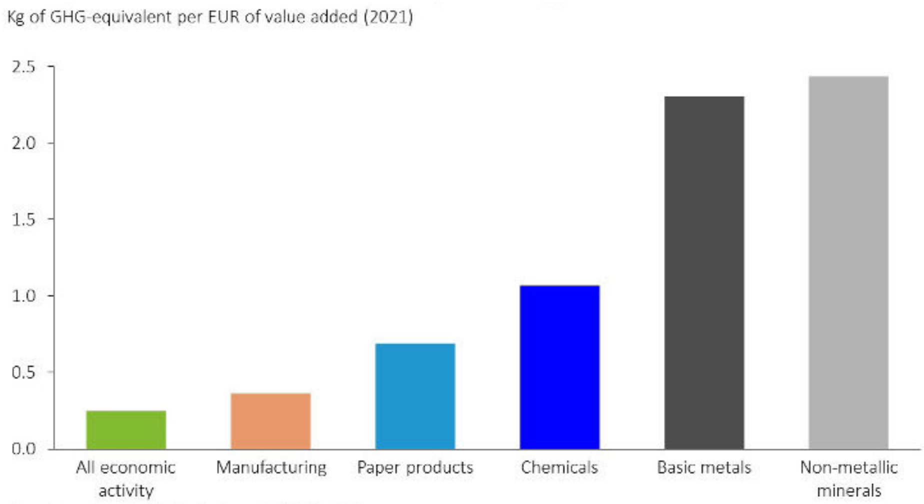
08. For an illustration of the link between industry energy intensity and output growth in the EU during the energy crisis, see also: Sgaravatti, G., Tagliapietra, S. and Zachmann, G., 'Adjusting to the energy shock: The right policies for European industry', Bruegel Policy Brief, 17 May 2023.

09. Including oil refineries, steel works, and the production of iron, aluminium, metals, cement, lime, glass, ceramics, pulp, paper, cardboard, acids, and bulk organic chemicals.

10. EII processes structurally lead to GHG emissions through energy consumption or emissions in carbon feedstock processing.

Free allowances for the EIIs have so far limited the ETS' impact. Carbon pricing has been of limited importance as a cost factor for heavy industry, because, in light of competitiveness and carbon leakage risk, until now heavy industry production has been covered largely by free allowances under the ETS. For EU-27 steel production, for example, CO_2 costs represented (only) 2% of total production costs in 2019.[viii] This will change with the phasing out of free ETS allowances towards 2035.

FIGURE 8
Comparison of the emission intensity of energy-intensive industries



Source: European Commission, 2024. Based on Eurostat, 2024 (data from 2021).

3. Relevant investment needs to decarbonise.

Decarbonising the HtA industries requires the far-reaching transformation of assets and processes, which calls for substantial investment. Emission-abatement technologies, including electric arc furnaces (EAF), clean hydrogen, carbon capture and storage (CCS), carbon capture and use (CCU), and raw material recycling, require massive investment. The 2040 Climate Target Plan estimates the investment needs to transform the steel sector at around EUR 100 billion between 2031 and 2040, and at around EUR 340 billion for the four largest EIIs together during the same period, and EUR 500 billion investment over the period 2025-40.

Large parts of this investment currently lack a clear business case. The industries are also 'hard to abate' from an economic perspective. On top of large upfront capital costs (CAPEX), the operational costs (OPEX) of producing with greener technologies are uncertain when technologies are not mature ('first-mover disadvantage')[11] and often higher than those of traditional technologies as long as electricity and low-carbon fuel (e.g. clean hydrogen) prices remain high in Europe. Estimates suggest that green steel (H2-DRI-EAF based) production would be approximately EUR 100/tonne (17%) more expensive in Europe compared to the US or Saudi Arabia in 2030 – a gap even larger than there is today for grey BF-BOF steel[ix]. Markets today do generally not provide a premium to green products, including for secondary (recycled) materials, that would compensate for higher costs[x].

Long investment cycles for the EIIs increase the importance of stability. EIIs are capital-intensive, and their capital stock tends to have long lifetimes (typically 30-40 years). This means that technologies are locked in for a long time, unless the installations can be adapted or retrofitted at aceptable costs, whereas retiring productive assets early implies large write-offs. The long invetment cycle in EIIs underlines the importance of policy predictability to reduce regulatory and financing risks for investment in CO_2 abatement.

11. 'First-mover disadvantage' more generally refers to higher costs and uncertainties for early adopters, due, e.g. to technology and performance risks, higher technology costs, smaller production scale, less developed infrastructure (electricity supply, hydrogen, CCS), evolving methodologies (including definitions of low-carbon production and low-carbon products), and unrewarded knowledge externalities (learning) that benefit later adaptors.

ETS revenues currently contribute little to EII decarbonisation. The stream of revenue from the auctioning of ETS allowances (around 0.3% of the EU's GDP in 2022) could be an appropriate source for CAPEX and OPEX support. Currently, around one quarter of ETS revenues remain at the EU level (of which approximately one third is directed to the Innovation Fund and two thirds to the Modernisation Fund), whereas three quarters are allocated to EU Member States[xi]. However, the funds are not earmarked to bolster the path towards decarbonisation and the competitiveness of these industries. There is a risk that rather than leading to the decarbonisation of production processes, the inclusion of EIIs under the ETS may contribute to the delocalisation of processes to outside of the EU.

The funding currently available is clearly insufficient. The EU's Innovation Fund strategically reinvests a portion of EU ETS revenues to support the decarbonisation of the EIIs, among others. By monetising around 530 million ETS allowances[12], the fund dedicates financial support[13] to pioneering projects that promise substantial CO_2 reductions, aligning economic growth with climate objectives. However, with less than 10% of ETS revenues redirected to the Innovation Fund in 2022, the distribution of ETS revenues is a strong limitation in the context of the vast funding needs for the green transition. Applications meeting the funding criteria tend to exceed the number of projects actually funded by a considerable margin, highlighting a scarcity of funds. The Modernisation Fund does not directly support EIIs. It is designed to support the modernisation of energy systems and the improvement of energy efficiency in 13 lower-income EU Member States[14]. Its investment is channelled to priority areas, such as renewable energy production, energy networks and interconnectors, energy efficiency, and the just transition.

Only a residual share of all ETS auctioning revenues goes towards decarbonisation investment in industry and the EIIs[15]. Member States should spend ETS revenue they receive on climate action and have reported that 76% of total ETS revenue from 2013 to 2022 was spent on climate, renewable energy, and enhancing energy efficiency[16]. Nevertheless, in many Member States a concentration (more than 55%) on electricity cost subsidies for households and companies, and measures to improve the energy and emissions efficiency of buildings, can be observed. Other large expenditure categories include support for renewable energy generation or for railway infrastructure. Some ETS revenues are used for innovative support mechanisms for decarbonisation investment (CAPEX and OPEX), such as Carbon Contracts for Difference, but still only a very limited amount[xii].

4. **An unlevel playing field and complex regulation.** With high trade volumes, some EIIs are particularly affected by global partners and competitors with diverging decarbonisation objectives, trade measures, and subsidies.

Many other world regions do currently not have decarbonisation targets which are as ambitious as in the EU. EIIs elsewhere, therefore, do not require decarbonisation investment of similar magnitudes. For products with higher market entry barriers, such as high transportation costs and limited substitutability (e.g. cement), cost increases for domestic EIIs tend to result in increasing prices for EU consumers. For other EIIs, such as basic metals and the chemicals industry, higher costs would rather imply decreasing exports and increasing imports, resulting in carbon leakage, or eventually, in shutting down domestic capacity to relocate production to outside of the EU.

Trade barriers have increased in recent years. Tariff reduction between WTO members has slowed down or even flattened during the past 10-15 years. Instead, an increasing number of non-tariff restrictions has been activated, in particular in the context of the Covid-19 pandemic and increasing geopolitical tensions, covering an increasing share of trade. Many of the recent trade restrictions rely on temporary instruments, but the medium- and long-term perspective remains uncertain[xiii]. At present, Chinese import tariffs and non-tariff measures sum up to the equiva-

12. The overall size of the EU's Innovation Fund has been increased from 450 million ETS allowances to approximately 530 million ETS allowances. The Innovation Fund's total funding depends on the carbon price, and it may amount to about EUR 40 billion from 2020 to 2030, calculated by using a carbon price of EUR 75/tCO_2.

13. Support can cover a maximum of 60% of project costs for direct grants (additionality to incentivise the efficient use of funds) and up to 100% for competitive bidding (where payment only arrives when projects operate, creating less incentive and verification problems).

14. Bulgaria, the Czech Republic, Estonia, Greece, Croatia, Latvia, Lithuania, Hungary, Poland, Portugal, Romania, Slovenia and Slovakia.

15. The breakdown for Germany, for example, foresees concentration (more than 55%) on electricity cost subsidies for households and companies, and measures to improve the energy and emissions efficiency of buildings. A similar focus on the modernisation of buildings and infrastructure applies in other large revenue recipients (France, Poland, Italy, Spain). Some ETS revenue in Germany is used for innovative support mechanisms for decarbonisation investment (CAPEX and OPEX), such as Carbon Contracts for Difference, but still a very limited amount.

16. As money is fungible, ETS revenues may of course crowd out other funding to some extent, instead of constituting entirely additional spending.

lent of around 12% for iron, steel and other metals. US tariffs and non-tariff measures amount to a tariff equivalent of around 4% for iron and steel, and 7% for other metals.

Levels and the ease of access to financial support are uneven compared to the EU's global competitors. For instance the US Inflation Reduction Act (IRA) offers USD 5.8 billion in grants to support the installation of advanced technologies in EIIs to curtail emissions. The IRA also offers tax credits for investment in manufacturing facilities for the production of clean energy equipment, as well as projects which re-equip manufacturing facilities to reduce GHG emissions by at least 20%. By design, tax credit systems offer a more streamlined and accessible route to funding compared to grant-based allocations. The Chinese government provides, e.g., more than 90% of the global USD 70 billion in subsidies in the aluminium sector[xiv].

High levels of subsidies in other parts of the world have contributed to building overcapacity in multiple sectors globally. For instance, global excess steel capacity is estimated at more than 611 million tonnes (2023), implying global capacity utilisation of 76%. Overcapacity is expected to increase further, with around 124 million tonnes of new capacity underway or planned in the 2024-2026 period. Most of this additional capacity is expected in Asia (notably, India) and based there mostly on carbon-intensive BOF routes. Capacity extension in the rest of the world, by contrast, largely concerns EAFs (Electric Arc Furnaces). However, 72% of existing furnaces globally are still BOFs[xv]. When domestic utilisation rates are low, for example due to import penetration stemming from excess capacity abroad, steel producers face high unit costs for production because of the significant fixed costs of operating their plants.

Funding for the green transition in the EU is complex to access, fragmented, and CAPEX-focused. Multiple funds are available at the EU level (e.g. the RRF, InvestEU, the Innovation Fund, Horizon Europe and Euratom, the Modernisation Fund, the LIFE programme, and the Social Climate Fund), as well as at the Member State level. Available funding has different requirements and application rules, sometimes incentivising only innovative segments of the chain. Operational cost funding is often excluded, and support is subject to a lengthy case-by-case analysis of investment projects and costs.

Moreover, regulation in the EU is complex compared to other regions:

- Red tape and permitting rules in the EU impact the EIIs' competitiveness by raising compliance costs, delaying investment and projects, as well as increasing administrative burden. The increased attractiveness of the US for industries following the introduction of the IRA has also been attributed to the specific focus of reducing bureacratic hurdles and red tape. Permitting as a bottleneck can also concern investment in decarbonisation (new facilities and the extension of existing ones).

- Most permitting takes place at the local or regional levels, and is a Member State competency. It often takes three to five years to receive a permit, including for the extension of existing plants. The Net-Zero Industry Act (NZIA) introduces a single contact point for green technology investment and shorter timelines (of up to 18 months).

- Uneven implementation of legislation (directives) across Member States adds to uncertainty and compliance costs, and weakens the level playing field within the EU.

- Risk assessment of EU regulation may not always be based on actual exposure, imposing additional constraints on products and processes. The PFAS regulation for example, bans 10,000 substances, but is at the same time difficult to enforce for imported products, including for a lack of laboratory capacity (distorting the level playing field).

5. Untapped potential from circularity.

Raw material circularity has the potential to lower energy demand, carbon emissions and fossil feedstock needs. The business case varies across materials, however. It is strong for a number of metals, where recycling generates large energy cost and emissions savings compared to virgin material production (e.g. aluminium, iron and steel), reducing production costs very substantively. It also dampens the demand for primary raw material (e.g.

bauxite, or iron ore) and (energy-intensive) mining activity, reducing import dependence[17] [see the chapter on critical raw materials]. Recycling of most other waste streams, including chemicals and plastics (see the box), to the contrary, does not have a viable business case at present. In the latter case, recycled materials can replace fossil feedstock, but the recycling comes with costs in collection, sorting and processing that make it more expensive (less competitive) than virgin material (despite the lower carbon footprint), and the recyclates tend to be of limted quality, making it difficult to justify a green premium. In addition, recycling of many waste streams is currently not viable economically also because costs for incineration and landfilling tend to be lower than the additional costs of recycling[18].

BOX 1

Rubber and plastics

Rubber and plastics (NACE C22) accounts for circa 1% of EU27 business-sector gross value added (GVA) and circa 5% of manufacturing, and it is the fifth NACE 2-digit sector in terms of energy intensity of production. Illustrating its energy dependence, rubber and plastics production in the EU also contracted in response to the 2022 energy price shock[xvi].

As rubber and plastics are carbon-based products, the industry's green transition objective is not to 'decarbonise', but to reduce the reliance on fossil fuels as carbon feedstock. In 2022, 80% of European plastics production was still fossil-based, compared to 20% bio-based or from recycled materials[xvii]. By contrast, rubber and plastics production generates much less direct GHG emissions than the four NACE 2-digit EIIs that have been the focus of the chapter, both in absolute terms and relative to the sector's value added[xviii].

Given these characteristics of the industry, especially its energy intensity and carbon feedstock needs, challenges and recommendations presented in the chapter carry over to rubber and plastics in large parts: (i) Higher energy and fossil fuel prices affect rubber and plastics similarly to other EIIs, and the sector's international competitiveness in the green transition also depends on the stable and competitive supply of renewable energy, necessary carbon feedstock, and the support of R&D. (ii) The impact on rubber and plastics of the ETS and CBAM is more indirect ('downstream industry'), however, via the cost of energy and inputs from the chemical industry[19]. (iii) While circularity reduces fossil feedstock needs, plastics recycling has no strong business case at present[20]. In particular, virgin material continues to be cheaper at current costs (including carbon prices), costs of landfill and waste incineration are still low, and it is difficult to earn a green premium for recycled plastics to compensate for higher costs, due also to the often limited quality of the secondary material.

17. In steelmaking, e.g., electric arc furnaces (EAFs) work well with secondary materials that have lower heat requirements in processing compared to virgin material production.

18. The revised EU ETS Directive requires the European Commission to look, by mid-2026, into a possible extension of the EU ETS to waste incineration.

19. Rubber and plastics (C22) has close linkages with chemicals (C23). Inputs from the latter account for almost 19% of the former's production value (2018), and around one fifth of chemical industry output goes into rubber and plastics production (2022).
See, for example: CEFIC, 2023 facts and figures, 2023.

20. There are two basic recycling technologies, i.e. mechanical recycling (which is the dominant form, reusing plastics molecules), and chemical recycling (splitting the molecules into basic chemical components for further use).
See, for example: Elser, B., Ulbrich, M., Taking the European chemical industry into the circular economy, Accenture, 2017.
CEFIC, Chemical recycling: Greenhouse gas emission reduction potential of an emerging waste management route, 2020.
Garcia-Gutierrez, P., Amadei, A., Klenert, D., Nessi, S., Tonini, D., Tosches, D., Ardente, F., Saveyn, H., Environmental and economic assessment of plastic waste recycling: A comparison of mechanical, physical, chemical recycling and energy recovery of plastic waste, European Commission, 2023.

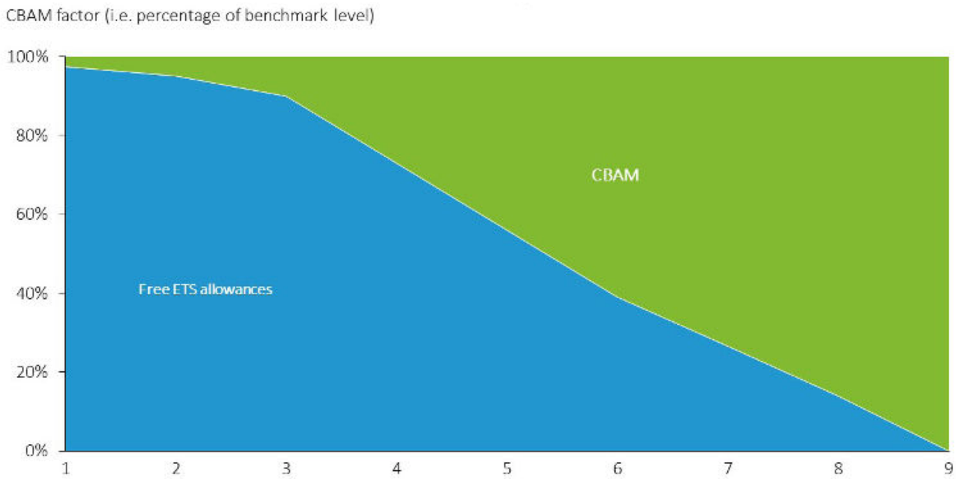
The perspective moving forward

Reaching emissions reduction targets will maintain high adjustment pressure on EIIs. The EU's ambitious decarbonisation targets lead to higher emission costs and require investment in greener production technologies in the EU, combined with a massive increase in the demand for electricity and clean fuels (such as hydrogen). The European Green Deal includes financial support (e.g. through NextGenerationEU) and market defence measures (e.g. CBAM) to support this transition. It is likely that current measures will not be sufficient to transform and ensure the competitiveness of the EU's EIIs, however.

Reaching the EU's emission targets requires, in the first place, a large-scale and stable supply of decarbonised energy [see the chapter on energy]**, and a tightening of climate policy built into the EU's carbon pricing**. In particular, free allocations of ETS certificates to heavy industry are set to be phased out. This pushes European companies to substantially decarbonise by 2030, as the carbon price is expected by multiple analysts to reach approximately EUR 100/tonne or more by 2030. This increases costs for industry, and potentially weighs negatively on their competitiveness[21].

To remain competitive with international players facing no price on carbon or a lower imposition, the success of regulatory measures, including CBAM, is key. CBAM imposes fees on CO_2 emissions associated with imported products within its scope. After a transition phase from October 2023 to 2025, it will come into force progressively as of 1 January 2026 (Figure 9).

FIGURE 9
EU ETS free allowances phase-out and CBAM phase-in



Source: European Commission, 2024.

The introduction of CBAM intends to prevent carbon leakage. CBAM provides a level playing field for the decarbonisation of EIIs and incentivises trading partners to introduce similar carbon pricing mechanisms ('leading by example'). Nevertheless, the success of CBAM is uncertain, because its design is complex, its implementation in the hands of Member States is fragmented, and it relies on robust international cooperation.

Key risks associated with CBAM include:

- **The challenge of ensuring consistent, uniform implementation.** CBAM will have to cover CO_2 emissions for tens of thousands of products across all production facilities exporting to the EU. While the ETS is installation-based, CBAM will be product-based requiring the translation of emissions per installation into emissions per product. Complexity would increase with the extension of CBAM to a larger set of products (for the purpose

21. Over the 2025-2030 period, current market expectations put the average EU ETS price at around EUR 100 with front-year futures recently dropping, but analysts remaining bullish for the rest of the decade.

of avoiding downstream carbon leakage) that would require the tracing of emissions along the value chain with direct and indirect emissions. Very limited data is available today, and calculations may be very difficult for complex products.

- **CBAM is potentially easy to circumvent.** As an example, as it is structured, exporters to the EU will not be taxed if they serve the European market from their low-emission plant segments and sell CO_2-intensive steel on domestic or other third-country markets instead. Similarly, the zero-emissions assumption for recycled material, including industry scrap, could provide incentives for deliberate scrap generation to export the secondary material (exempt from CBAM) instead of the primary one (within CBAM) to Europe (relevant, notably, for aluminium where recycling costs are low). Moreover, monitoring and verification may be very difficult without strong cooperation.
- **There is a risk of downstream carbon leakage.** With EIIs covered by CBAM and downstream industries exempted, imports may shift to downstream products to circumvent or avoid the border tax. Downstream leakage risk is amplified by the fact that the ETS integration of industry segments to be covered by CBAM will likely increase production costs also for domestic downstream industries outside of CBAM (e.g. plastics, using basic chemicals as input). This would translate into larger cost differentials compared to foreign competitors in downstream industries. Available research finds some evidence that the inclusion of EIIs in the ETS would increase carbon leakage and production costs for downstream industries sourcing domestically. Multinational companies are more likely to relocate activity in response, while (exclusively) domestic companies lose cost competitiveness. Future increases in cost gaps (notably, starting in 2030 with the ramping up of the CBAM levy) may strenghten the incentive to relocate downstream activities[xix].
- **CBAM does not level the playing field for exporters.** CBAM levels the playing field on the import side, but exporters will face a cost disadvantage as ETS certificates are not reimbursed (supporting emission-intensive exports would go against the objective of incentivising greener production elsewhere). This may feed back to the domestic market in segments where products are differentiated (i.e. the European market of limited size) and scale is important for efficient production[22].

Instruments to foster decarboniation investment of EIIs have been put in place, but need to be scaled up. EEIs decarbonisation also became part of the Net-Zero Industry Act (NZIA), allowing for an harmonised regulatory framework to streamline permit-granting processes, and the possibility to be granted strategic project status. Moreover, dedicated tools to support the green transition of the EIIs have been launched and are gaining traction at the EU and Member State level. These include Carbon Contracts for Difference and the European Hydrogen Bank, as well as policies to increase the circularity of raw materials. However, a relevant scaling up of these tools is needed to accelerate the decarbonisation of EIIs.

Finally, decarbonisation has the potential to reshape the geography of comparative advantage and industrial specialisation in Europe. EIIs, in the past, have been installed where energy and raw materials were abundant and cheap. Regions and countries with an abundant and stable supply of cheap low-emissions energy (renewables) are likely to attract EIIs in the future. In these regions, decarbonisation and reindustrialisation may go hand in hand, implying potential heterogeneity across countries and regions with respect to the future of EIIs[xx].

22. 12% of EU-27 iron and steel production and 19% of aluminium production were exported in 2022. Source: Eurostat.

Objectives and proposals

Two objectives are to be pursued in parallel:

- Enable EIIs in their path to decarbonisation, which is very granular and industry specific.
- Level the playing field with international competition.

Guidelines for proposals: i) ensure a competitive and predictable supply of energy input; ii) support the transition to decarbonised solutions (by ensuring investment and markets for low-emissions products); iii) avoid production relocation driven by asymmetric subsidies, weaker decarbonisation regulation, or regulatory burden.

Specific proposals for the sector include:

FIGURE 10

	SUMMARY TABLE – ENERGY-INTENSIVE INDUSTRIES (EII) PROPOSALS	TIME HORIZON[23]
1	Increase the level of coordination across the multiple policies impacting the EU's (e.g. energy, climate, enviroment, trade, circularity, and growth).	ST
2	**Ensure access to a competitive supply of natural gas during the transition, and sufficient and competitive decarbonised electricity and clean hydrogen resources** [as detailed in the chapter on energy].	ST/MT
3	Simplify and accelerate permitting, and reduce compliance costs, red tape and regulatory burden.	ST
4	Further develop financial solutions (such as financial guarantees) for the EU's EIIs to improve market financing conditions.	ST
5	Reinforce relevant funding to support the decarbonisation of EIIs, starting by earmarking ETS revenues.	ST/MT
6	**Simplify, accelerate and harmonise subsidy allocation mechanisms. Adopt common instruments across Member States, such as the European Hydrogen Bank and Carbon Contracts for Difference.**	ST/MT
7	**Closely monitor and improve the design of CBAM during the transition phase. Evaluate whether to postpone the reduction of free ETS allowances if CBAM's implementation is ineffective.**	ST/MT
8	Stimulate demand for green products by promoting transparency and by introducing standardised low-carbon criteria for public procurement.	ST
9	Improve the circularity of raw materials (recycling rates, Single Market for circularity, stimulate demand where needed).	ST
10	Ensure the effective design of global trade arrangements and the ability to react, where justified.	ST/MT
11	Coordinate the establishment of green regional industrial clusters around the EU's EIIs.	ST/MT

23. Time horizon is indicative of the required implementation time of the proposal. Short term (ST) refers to approximately 1-3 years, medium term (MT) 3-5 years, long term (LT) beyond 5 years.

1. **Increase the level of coordination across the multiple policies impacting the EU's EIIs.** A coordinated strategy to enhance competitiveness, strengthen economic efficiency and accelerate the decarbonisation of EIIs should foresee: timely planning, with appropriate impact assessment and stakeholder engagement and the execution and monitoring of multiple actions across several domains, including the environment, climate, energy, critical raw materials, trade, and employment [see also the chapter on governance]. Given the long investment cycles in EIIs, a reliable long-term perspective is particularly relevant for these industries. A coordinated approach would allow the EU to:

- Ensure that the different tools to support EIIs (e.g. grants and credits, taxation, and free allowances) are well coordinated and deployed in a comprehensive way without distorting the Single Market.

- Attract key industrial players to produce in the EU and access its market. At the same time, it would offer a competitive environment to pioneer new solutions by accurately incorporating the cost of externalities, promoting innovation, and aligning research and innovation incentives, as well as investment.

- Ensure a true Single Market in which the EU's EIIs are located in places where they can be most competitive. This will depend importantly on the stable availability of competitive renewable energy. The reorganisation of value chains inside the Single Market would also mitigate the need to massively expand energy infrastructure (energy transport costs are higher for electricity and hydrogen than, for example, pipeline gas).

2. **Ensure access to a competitive supply of natural gas during the transition, and sufficient and competitive decarbonised electricity.** Use decarbonised gases, such as clean hydrogen, in an affordable way for activities that cannot abate emissions otherwise.

   Sufficient provision of competitive energy should include a stable supply and appropriate infrastructure. As detailed in the chapter on energy, measures include: the development of an EU-level gas strategy, moving away from spot-linked sourcing and increasing the EU's bargaining power, the simplification and acceleration of permitting for renewables development, stable and interconnected grids and storage, decoupling inframarginal generation from natural gas prices through long-term power purchasing agreements (PPAs), futures contracts or Contracts for Difference (CfD), and compensation mechanisms for offering flexibility. Moreover, specific measures for EIIs could seek to:

- **Develop guidelines for the removal of barriers for industrial power purchasing agreements (PPAs) and foster industrial consumers to pool demand** for renewable power through corporate PPAs [see also the chapter on energy], under the supervision of a public body acting as a single buyer and seller for participating companies. Pooling demand could allow improving the (short-term) correlation between the (aggregated) industrial demand profile and the variable renewable generation profiles, thereby reducing price and profile hedging risks and lowering the PPA price. PPAs specific to EIIs may have the potential to secure competitive prices, long-term price stability and lower direct EII emissions. As industrial offtakers increase the share of electricity consumption covered by renewable PPAs, new investment in energy efficiency, more flexible production processes, fuel switching, and possibly industrial relocation will also be needed to address capacity constraints constituting a risk for energy users. Financial guarantees may, therefore, be necessary to further de-risk this market.

- **Encourage aggregation of low-volume demand.** EIIs could benefit from aggregators that act as brokers of industrial access to electricity, also enabling SMEs to structure electricity demand through new PPAs for groups of companies. EIIs can benefit from aggregation by avoiding individual negotiations and their costs, lower costs associated with risk management, and through price advantages that come with a large bulk purchase. The creation of mechanisms to aggregate demand, e.g. a platform with governement support, or specific regulation, setting incentives for their establishment, should be envisaged.

- **Establish clear and harmonized rules considering temporary electricity price relief** for EIIs (e.g. under State aid guidelines). Support could be in the form of ensuring price security, or reducing network charges, on an equally temporary basis.

Avoid over-complexity in the definition, implementation and monitoring of low-carbon and green hydrogen and focus on bringing the market to scale in a pragmatic way with a focus on lowering emissions. To provide certainty to the industry regarding the definition of low-carbon hydrogen, the European Commission will present a Delegated Act before mid-2025. The delegated act should set out the methodology to calculate the greenhouse gas emissions associated with low-carbon hydrogen.

3. **Simplify and accelerate permitting, and reduce compliance costs, red tape and regulatory burden.** While relevant for the entire economy [see the chapter on governance], specific measures for EIIs could seek to:

- **Replace current permitting procedures with those outlined in the NZIA** facilitating permitting for decarbonisation investment. This is already part of the NZIA for decarbonisation investment by qualified EIIs and facilities (project investing in decarbonisation while, at the same time, being a priori part of the cleantech value chain), but it could be broadened to abatement investment more generally, especially when relating to the conversion of an existing facility. A precondition for meeting shorter permitting time limits will be sufficient digitisation of the permitting process and the relevant administration.

- **Ensure 'one-stop-shop' permitting for decarbonisation assets**, ensuring that the required technical support is provided to local authorities by the Commission or Member States [see the chapter on governance]. The NZIA introduces a Single Contact Point (in each Member State, one existing administration becomes the single contact for permit applications) and extends it to qualified investment projects in EIIs. The approach could be extended to decarbonisation investment in EIIs in general. A lack of administrative capacity (e.g. digital systems and qualified staff) for permitting can be addressed using the EU's Technical Support Instrument (TSI) to build administrative capacity to effectively lower the administrative burden for applicants.

- **Extend the possibility of approval for clusters of projects**, instead of assessing them on a company-by-company basis. Integrated permitting processes could be introduced for whole industry and infrastructure ecosystems, as much of the relevant investment is complementary. Ensure the coherence of practices used across processes and industries (e.g. important for integrating circularity value chains across industries).

- **Extend 'positive silence'** (or the escalation of decision power) to increase the predictability of the process.

- **Introduce structured pre-application consultation** between authorities and operators, which can help to fast-track the permitting process.

- **Establish a public registry for the average time** that authorities take to process permits, or penalties for excessively long decision times. Develop KPIs to measure the performance of permitting authorities and regulators.

- **Prefer EU regulations to directives in areas where the level playing field is important**, as heterogeneity in the transposition of directives between Member States risks causing an unlevel playing field.

4. **Further develop financial solutions for the EU's EIIs to improve market financing conditions.**

Develop financial guarantees by the EIB and/or National Promotional Banks. Offer financial guarantees to creditors as an instrument to lower capital costs and reduce uncertainty concerning the business case for decarbonisation investment. Guarantees are also relevant to lower counterparty risk in long-term contracts on energy purchases (PPAs). The EIB or National Promotional Banks could provide the guarantees to allow borrowing in the absence of proper credit ratings.

Simplify the EU Taxonomy for Sustainable Finance, which may also contribute to improving access to finance, notably for SMEs (not yet covered), to the extent that creditors or investors value sustainability with a green finance premium. The EU Taxonomy is a tool to improve the transparency of corporate activity with respect to environmental standards and goals. Reporting is mandatory for large companies, and – based on the scoring – investors looking for investment in sustainability may select high-performing companies. SMEs have so far been excluded, which spares them the administrative burden of sustainability reporting. However, it also excludes them from benefits in terms of sustainable investment (green premium). Extension to SMEs should be accompanied by the provision of tools (notably, software solutions) that would allow efficient and uniform calculation of sustainability scores [see similar arguments concerning CBAM in proposal seven]. Simplifying the approach should also address the risk of the lack of comparability in sustainability reporting across and within industries due to discretion or judgement elements in reporting.

5. Reinforce relevant funding support for the decarbonisation of EIIs, starting by earmarking ETS revenues.

More of the continuous stream of ETS and possibly CBAM revenues could be invested in EIIs. This should occur as CAPEX and OPEX support for decarbonisation, both at the EU and Member State levels, contrary to the current focus on construction and infrastructure. The earmarking of ETS revenues for affected industries could cover additional costs linked to their decarbonisation (e.g. CCfDs for CCS/CCU, plant upgrades, hydrogen, etc.). In particular, increased R&D and deployment funding is needed for HtA -related technologies, such as carbon capture and storage, carbon capture and use (CCS/CCU), and carbon capture technologies, to provide solutions where (full) electrification is not feasible (e.g. cement), as analysed in the chapter on clean technologies.

6. Simplify, accelerate and harmonise subsidy allocation mechanisms. Adopt common instruments across Member States, such as the European Hydrogen Bank and Carbon Contracts for Difference.

Competitive bidding has increasingly gained traction in climate policy and transition financing. It is a market-based mechanism to allocate State aid, where support is auctioned. The auction price tends to contain a subsidy component for decarbonisation, as well as a hedging element against carbon price fluctuations. Bidders reveal their true financing gap (CAPEX and OPEX) in the auction (as long as the auction is competitive), as the lowest bids win. The pay-out only takes place in the future when the investment projects are implemented and operational, which reduces verification costs compared to front-loaded grants.

There are strong arguments in favour of a more prominent EU-level component in decarbonisation funding. Competition in bidding processes requires a sufficient number of participants in the auction. EU-wide auctions with stronger competition would improve allocative efficiency and allow the allocation of larger volumes in a competitive environment in light of the required scale. Auctions at the national level tend to come with the requirement that investment be made in the respective country. This does not ensure efficiency in the distribution of activities across the EU in line with comparative advantage, for example investment in regions with abundant access to renewable energy, or suitable geological conditions for carbon capture and storage (CCS).

An early project at the EU level is the European Hydrogen Bank (EHB). The EHB supports investment in clean hydrogen, with a focus on the most cost-efficient projects [see the Box below]. The EHB started with a pilot auction by the EU's Innovation Fund. The experience with the EHB should be reviewed in light of its possible extension to further areas.

BOX 2

The European Hydrogen Bank (EHB)

While not representing a solution for competitiveness challenges in the short and medium term, the development of clean hydrogen can contribute to decarbonising EII and HtA activities [see the chapter on energy]. However, investment in clean hydrogen production requires stability concerning future hydrogen prices to establish a business case.

The EHB is an auction platform for hydrogen contracts based on renewable energy ("green hydrogen"), intended to provide stability of the business case and a green premium. Interested projects can participate and submit a fixed-premium bid (EUR/kg) to receive support for their renewable hydrogen production, for up to ten years. Bids are ranked from low to high, and support is awarded in this order until the auction's budget has been exhausted. The budget per auction is limited to create sufficient competition among bidders (over-subscribe the auction) and award only the most cost-efficient projects.

The EHB does not cover project risks. The guaranteed price is paid only for renewable hydrogen produced, in other words, only when the project is up and running. The EHB is (as other auctions) comparatively light in terms of administrative burden. It imposes no constraints on how companies use the future revenue (CAPEX and OPEX). The certain future cash-flow makes projects viable on the demand side (risk may still materialise on the cost side), and it can also be used as a guarantee to obtain private financing for the project at moderate interest premia.

The first EU-wide auction of the EHB awarded nearly EUR 720 million to seven renewable hydrogen projects across Europe (all in the Iberian Peninsula and in Scandinavia) under the Innovation Fund, out of a total of 132 bids. Together, the winning bidders plan to produce 1.58 million tonnes of renewable hydrogen over ten years. Germany became the first EU Member State to participate in the 'auction-as-a-service' scheme, making EUR 350 million available from its national budget for the highest ranked projects in Germany meeting the eligibility criteria, but which did not qualify for EU-level support[24].

Carbon Contracts for Difference (CCfD) are another form of auction which could be implemented at the EU and/or Member State level. Bidders would typically bid on a price in EUR/tonne of CO_2 abated. Bidders with the lowest abatement costs win, and are paid the difference between the price they ask at the auction and the variable market carbon price. CCfD has a hedging (carbon price certainty) and a subsidy component (the asking price typically sits above the average market price of carbon), both of which facilitate access to bank and capital market funding for abatement investment [see the Box below][25].

CCfDs only pay to successful bidders once companies have made the investment effectively reducing carbon emissions. The auctions can be calibrated to industries to ensure a long-term commitment from investors (e.g. by setting maximum target prices that will ensure contracts are profitable only over a long-term horizon, when renewable energy prices are expected to be lower than today). Not disbursing funds until the companies deliver on decarbonisation significantly reduces verification costs compared to direct grants, which pay most support before observing project performance.

To stabilise expectations and facilitate the access to the mechanism, information about successive rounds of auctions should be made available sufficiently far in advance to facilitate forward planning by companies and the complexity of application should be reduced. Within the EU, CCfDs fostering clean investment already exist in the Netherlands, and Germany just launched its first programme targeting emissions-intensive industries. The Netherlands, for example, organises auctions annually. Experience gained from these schemes and feedbacks from participants should be evaluated to for a possible extension to other EU Member States and for the development of an EU-level component.

24. See: European Commission, European Hydrogen Bank, for more information

25. The hedging component (i.e. removing carbon price uncertainty) could also be fulfilled by sufficient prior purchases of ETS allowances, as the latter are 'bankable'. In other words, unused allowances can be saved for later use. Front-loading purchases of ETS allowances would, however, require up-front financing and may hit companies' financing constraints.

BOX 3

Carbon Contracts for Difference (CCfD)

EU GHG abatement targets are formulated in terms of volume. The supply of and demand for ETS certificates determine the ETS carbon price endogenously. Hence, the carbon price fluctuates over time in response to certificate supply and demand.

In a CCfD auction, bidders bid on a carbon price in EUR/tonne of CO_2 abated, where they are served starting from the lowest bid (i.e. the lowest abatement costs). Bidders are paid the difference between the price set in the auction (with some dynamic adjustment over time) and the market carbon price. The idea is that with CO_2 abated, the company can sell at the fixed price the unused ETS certificates bought on the carbon market, guaranteeing a stable income from abatement.

CCfDs combine two effects in economic terms (hedging and investment subsidy):

- The CCfD hedges industrial producers against volatile carbon prices, by guaranteeing a certain price for ETS certificates (carbon price) to abating companies selling them. Hence, it insures against changes in the carbon price and the profitability of carbon abatement. The hedging (price insurance) effect of CCfDs can help to obtain funding for abatement investment and reduce related financing costs. CCfDs, in this regard, substitute for deep and liquid secondary carbon markets[26].
- Abatement costs for HtA industries tend to be higher than the ETS carbon price. The bid price for HtA industries is, therefore, likely to exceed the average market price of CO_2, implying a subsidy for investing. The implicit investment subsidy can be interpreted as reflecting, at least in part, a risk premium given the long investment cycles in HtA industries and the problem of political commitment (future governments may change course). Higher guaranteed carbon prices act as a commitment device.

CCfDs are a market-based hedging and subsidy scheme, with support limited to the financing gap revealed by bidders. The distribution of CCfDs by competitive auctions implies that bidders have an incentive to reveal their true financing gap. Exaggerating funding needs in the bid increases the probability of not obtaining a contract. The market-based allocation of CCfDs facilitates implementation at the EU level, given that competitive bidding is considered to be proportionate support under the Guidelines on State aid for climate, environmental protection, and energy (CEEAG)[xxi].

7. **Closely monitor and improve the design of CBAM during the transition phase. Evaluate whether to postpone the reduction of free ETS allowances if CBAM's implementation is ineffective.** Given the lack of prior experience, there is a need to closely monitor the implementation in practical terms and in terms of intended and unintended effects, with adjustment where needed. The Commission will untertake a deep effectiveness review in 2025 before introducing the actual border levies and possibly expand CBAM in scope (expansion must strike a balance between administrative feasibility and the risk of downstream carbon leakage). The review will involve European industry (industry associations) to ensure a differentiated assessment of the impact across industries.

   Simplifying reporting is crucial given the complexity of the system and low reporting compliance in the first trial[27]. CBAM implies a heavy administrative burden in terms of reporting and calculating carbon footprints

26. The hedging component (i.e. removing carbon price uncertainty) could also be fulfilled by sufficient ex ante purchases of ETS allowances as the later are 'bankable' (i.e. unused allowances can be saved for later use). Frontloading purchases of ETS allowances would, however, require up-front financing and may hit the financing constraints of companies.

27. See: Financial Times, World-first carbon border tax shows teething problems, 1 March 2024. Using country-specific average values of carbon intensity would provide incentives for a re-routing of exports to the EU via third countries with a lower benchmark carbon intensity value.

at the product level[28]. The following measures can help to reduce administrative burden, improve effectiveness and attenuate the trade-off between product coverage (downstream leakage) and administrative feasibility (data needs):

- **Develop common standards and improve international cooperation**: i) develop an effective, uniform EU-wide methodology to determine embedded carbon emissions; ii) lead efforts to develop in international fora (e.g. the OECD) common standards for carbon emissions measurement, monitoring and reporting.

- **Provide appropriate IT solutions for reporting**. Improve digital infrastructure and support the development of integrated and secure software solutions to determine the carbon footprint of goods along the value chain according to the agreed methodology. Ensure conditions are met to allow companies to securely upload the respective information.

- **Simplify the monitoring, reporting and verification process** for importers and third-country producers through greater use of tech-based solutions. This could help to avoid the duplication of efforts by linking reporting tools to existing supply chain and entreprise management systems.

- **Using exporter-specific national averages** for product carbon footprints to simplify data needs would invite the re-routing of trade and favour larger (multinational) producers that may be better able to evade higher levies. It may also be prone to legal challenges given the variation of emissions across production facilities.

- **Address remaining loopholes** in carbon footprint accounting, such as the exclusion (zero-emissions presumption) from CBAM of recycled materials.

- **Revisit the treatment of exports in CBAM**. While an effective CBAM provides a level playing field in the domestic market, there is no compensation for higher ETS costs on the export side. Compensating exporting industries for increasing ETS costs, in particular for exports to countries with higher product carbon footprints, would have to be assessed against the rules of the international trading system, including the possibility that importers may react by imposing an offsetting tariff. The issue of exports and exporter compensation will be reassessed as part of the CBAM review in 2025.

8. **Stimulate demand for green products by promoting transparency (e.g. by defining EU standards, such as labelling, for measuring and communicating Product Carbon Footprints (PCFs)). Introduce standardised low-carbon and environmental sustainability criteria for public procurement[29]:**

Appropriate 'lead markets' to raise demand for low-carbon EII production are generally downstream industries in which the EII input share in total production value is relatively small (diluting the required price premium), but output volumes high enough to allow for a scaling up of low-carbon production (e.g. steel and aluminium in automotives).

Measures to **increase transparency for consumers:**

- **The definition of a carbon footprint or 'greenness' should be harmonised for the Single Market.** This should exploit synergies with other methodologies already in place (under the EU Taxonomy, and CBAM) to avoid a proliferation of standards and corporate reporting obligations. The development of a common methodology can be based on internationally recognised standards. A choice is to be made as to whether PCF assessment is limited to the production stage or product lifecycle performance (which would, for instance, affect the ranking of ICE cars compared to EVs in the automotive industry), and if it should be voluntary (hoping for a green premium in consumer markets) or mandatory in the long term. Clarify the relation between existing

28. The administrative burden is arguably most difficult to shoulder for smaller producers from developing countries, in addition to being subject to carbon pricing without associated technology transfer or financial support for decarbonisation.
See, for example: Sen, P., EU's Carbon Border Adjustment Mechanism and the Global South: How to Make it Work, IEP@BU.

29. Spending on public procurement in the EU accounts for around 14% of EU GDP per year.
See: European Court of Auditors, Public procurement in the EU, 2023.

and recognised eco-labels and certifications, on which PCF labelling could build, but with which it may also compete in consumer decisions. The Eco-design for Sustainable Products Regulation (ESPR) and related delegated acts on particular products provide a framework for such harmonisation.

- **Support digitally-available PCFs (Digital Product Passport)**, which can facilitate the collection of data along the supply chain, and be more accurate and timely in the event of changes in products and production processes. Information requirements would need to be harmonised to facilitate implementation at the EU level as there is a risk of creating barriers to trade inside the Single Market. Otherwise, administrative burden could be created (including the question of whether country-of-origin or country-of-destination rules should apply in terms of labelling requirements). The Digital Product Passport brings numerous benefits and has cost-saving potential. It facilitates data management and the optimisation of material flows, provides information about the environmental and social impact of materials, facilitates regulatory compliance and auditing, and provides verifiable proof of sustainable practices.

Introduce building codes to strengthen green demand in the construction sector, with harmonisation across the EU to enable the development of common standards in construction and upstream industries (complementing the supply-side incentives for circularity in construction in the EU Taxonomy).

Introduce low-carbon criteria and minimum environmental sustainability requirements for public procurement when applying the principle of most economic advantageous tender (MEAT) in EU public procurement directives[30]. This can be launched by the EU for procurement values above the threshold at which EU rules apply, and later become pan-European legislation for Member States. Green public procurement can be implemented by, for example, applying adjustment factors based on lifecycle emissions to the economic evaluation of bids, or through the establishment of shadow prices for the emissions associated with each proposal. More focus in public procurement on what to buy should, however, avoid a large administrative burden (the current framework has lead to 52 legislative acts for product groups, of which 43 have been already published or, at least, adopted). Digitising public procurement processes would promote more sustainable sourcing, eliminate inefficiencies, standardise contractual processes, and ensure that supplier emissions data is tracked and reported.

9. **Improve the circularity of raw materials.** Conditions for circularity vary across industries and materials, with few recycling stream being economically viable at present, pointing to different policy levers to strenghten recycling:

   - **Improve the recycling of end-of-life materials** in qualitative and quantitative terms: Recovery rates for end-of-life materials leave room for improvement even for materials with a strong business case for recycling (various metals). The quality of secondary materials is often limited by contamination with other materials, impeding separate collection which is a precondition for high-quality recycling. Recent EU-level policy initiatives, such as the Ecodesign for Sustainable Products Regulation, the proposed End-of-Life Vehicle Regulation, and the announced review of the Waste Electrical and Electronic Equipment Directive, have the potential to improve recycling rates and the quality of waste streams by requiring more circular product design, more effective separate collection and improved waste treatment, and extended producer responsibility. The Commission should closely monitor the success of these initiatives in improving material circularity.

   - **Broaden the Single Market for circularity:** As proposed in the chapter on critical raw materials, a true Single Market for the circularity of secondary raw materials should be established. There are EU-wide end-of-waste criteria for aluminium, iron and steel, and copper scrap, and these materials are "green-listed", facilitating shipment in the EU and the exploitation of economies of scale in recycling. To promote circularity, the extension **of EU-wide end-of-waste criteria to other waste streams, the development of EU-wide by-product criteria, and the "green-listing" of other non-hazardous waste streams should be evaluated**, in the latter case carefully balancing savings in terms of resources, fossil feedstock demand, and environmental pollution against possible environmental and health risks.

30. The most economically advantageous tender (MEAT) criterion enables the contracting authority to consider criteria that reflect qualitative, technical and sustainability aspects of tender submissions in addition to the price when reaching an award decision.

- **Monitor the evolution of scrap metal exports:** Recycling of metal scrap is consistent with more ambitious decarbonisation policies and saves unit production costs in areas where decarbonised virgin material production tends to be more expensive than production with traditional technologies. Therefore, demand for metal scrap is likely to increase substantially as more ambitious climate policies are implemented worldwide. Improved separate collection of (high-quality) scrap metals and further incentives to develop and deploy sorting and recycling technologies can improve scrap supply. On the demand side, scrap exports need to be monitored to ensure sufficient supply of scrap for use within the EU. The Waste Shipment Regulation and the proposed End-of-Life Vehicles Regulation provide a framework to better manage scrap exports and improve the quality and availability of scrap for recycling. It will be important that their provisions are implemented in a timely and effective manner, ensuring robust enforcement at national level.

- **Strengthen demand for secondary materials:** In addition to ensuring the availability of quantitatively and qualitatively sufficient secondary materials, establishing a circular economy also requires policies that enable green premia for categories of recycled material that do not have a business case at present otherwise. Two areas of action are private demand stimulus and public procurement [see proposal eight for the uptake of greener products in general] – as measures supporting business models for circularity in industrial manufacturing. Transparency (Digital Product Passport) as well as minimum content requirements for recycled materials in new products have the potential to support the private uptake of recycled materials. Both measures are part of the Ecodesign for Sustainable Products Regulation and related sectoral legislation. The Commission shall closely monitor their effectiveness and adapt them accordingly.

- **Pricing of externalities:** Cost advantages for virgin material production in areas where recycling is an important emission and fossil feedstock saver point to an incomplete pricing of emission externalities. The full integration of EIIs in the EU ETS (phasing out free allowances) – potentially coupled with the extension of the EU ETS to cover incineration and landfilling operations – can be expected to increase the attractiveness of recycling relative to primary production from a cost perspective. Coupling the carbon price with minimum recycled content requirements could prevent a crowding out of domestic secondary material production by imports of cheaper virgin material where the latter will not be covered by CBAM. Incineration or landfill taxes could be an appropriate instrument to reduce the cost advantage of landfill operations and waste incineration, but taxation issues remain in the competence of Member States (or requiring unanimity in the European Council).

10. Ensure the effective design of global trade arrangements and the ability to react quickly, where justified to reduce emissions and preserve EU strategic autonomy. Tackle overcapacity and unfair practices at the international level.

The EU should contribute to enhancing the global competitiveness of its energy-intensive industries with supporting trade measures, in line with the key principles for trade policy discussed in Part A. Moreover, specific actions with reference to the sector include:

Promote international alliances. Agree on a common commitment to decarbonise and/or tackle non-market excess capacity, accompanied by the mutual removal of customs and environmental tariffication measures on countries investing in decarbonisation efforts. This would reduce the complexity of introducing measures such as CBAM, while strengthening its outcomes (tackling circumvention, avoiding resource shuffling, improved monitoring, etc.). The initiatives would aim to create large enough common markets and to facilitate the coordination of market behaviour in line with geopolitical and economic security. It might be launched by a limited number of countries, such as the G7 Climate Club, and/or specific sectors, as intended by the attempt to secure an EU-US Global Arrangement on Sustainable Steel and Aluminium (GSA).

Promote global climate standards, starting with global carbon reporting [as discussed in the context of proposal seven].

Strategically, but rapidly, apply trade defence instruments and anti-subsidy measures when justified, including the use of ex-officio investigations. A unlevel playing field in EIIs can have repercussions for many downstream industries, which is important especially from a perspective of open strategic autonomy. As reaction to a strong rise in imports, linked to global capacity expansion and restrictive trade policy in third countries, the EU has introduced safeguards for the steel industry, recently extended until 2026, at which point the maximum period of eight years will be reached. In line with the example, the EU should maintain its capability to react quickly to market distortions. Given the persistent increase in global steel overcapacity, it should assess the situation in the steel industry before safeguards expire and be prepared to react to a changing environment with structural solutions.

11. **Encourage the establishment of green regional industrial clusters around the EU's EIIs.** Industrial decarbonisation requires green supply chains, the integration of a low-carbon energy supply, and adequate infrastructure. While EIIs are already clustered in many instances in the EU today, their decarbonisation could be accelerated by promoting industrial symbiosis (sharing of by-products or services that would have been underused or disposed of otherwise, such as CCU) and providing access to infrastructure for clean energy carriers and for capturing CO_2. Furthermore, there are opportunities for establishing new green regional EII clusters[xxii], in line with and in the spirit of the Net Zero Acceleration Valleys under the NZIA, that could benefit from accelerated procedures and funding accordingly.

    Some of the potential advantages are:

    - Energy sharing will allow improved investment cases for local low-carbon energy generation, making energy consumption greener and more cost-competitive compared to short-term contracts, where they are exposed to volatile markets.
    - The exchange of new raw materials, technology, waste, and energy flows can improve resource efficiency, environmental quality, and contribute to the development of the circular economy (including CCU).
    - Geographical proximity allows the development of shared infrastructure, such as the accelerated build-out of regional electricity and heating networks.

    Regional industrial projects of common interest could benefit from accelerated procedures and funding, in line with NZIA measures.

ENDNOTES

i Based on: European Commission, Eurostat, Structural Business Statistics.

ii On industry-specific decarbonisation options, see, for example: De Bruyn, Jongsma, C., Kampmann, B., Goerlach, B., Thie, J., Energy-intensive industries: Challenges and opportunities in energy transition, 2020.
European Commission, Transition pathway for the chemical industry, 2023.
Gross, S., The challenge of decarbonizing heavy industry, 2021.
IEA, Achieving net zero heavy industry sectors in G7 members, 2022.
Material Economics, Industrial Transformation 2050: Pathways to Net-Zero Emissions from EU Heavy Industry, 2019.
Material Economics, Scaling Up Europe: Bringing Low-CO2 Materials from Demonstration to Industrial Scale, 2022.
Zore, L., Decarbonisation Options for the Aluminium Industry, 2024.

iii For the case of steel, see: Medarac, H., Moya Rivera, J., Somers, J., Production costs from iron and steel industry in the EU and third countries, European Commission, 2020.

iv Eurostat, Structural Business Statistics.

v European Commission, '2024 Euro Area Report', European Economy Institutional Paper 259, 2023, p. 27. Similarly, also: ECB, ECB Economic Bulletin 3/2023, 2023.

vi Archanskaia, E., Nikolov, P., Simons, W., Turrini, A., Vogel, L., 'Corporate vulnerability and the energy crisis', Quarterly Report on the Euro Area, Vol. 22, No. 2, 2023, pp. 35-47.

vii Zachmann, G., McWilliams, B., 'A European carbon border tax: much pain, little gain', Bruegel Policy Contribution 5/2020, 2020.

viii See Medarac et al., op. cit., 2020.

ix European Round Table for Industry, Competitiveness of European Energy-Intensive Industries, 2024.

x European Commission, Masterplan for a competitive transformation of EU energy-intensive industries enabling a climate-neutral, circular economy by 2050: Report of the High Level Group on Energy-intensive Industries, 2019.

xi European Commission, Commission Staff Working Document Technical information Accompanying the document Report from the Commission to the European Parliament and the Council on the functioning of the European carbon market in 2022 pursuant to Articles 10(5) and 21(2) of Directive 2003/87/EC (SWD/2023/346 final), 2023.

xii European Environment Agency, Use of auctioning revenues generated under the EU Emissions Trading System, 2023.

xiii See, for example: Gunnella, V., Quaglietti, L., 'The economic implications of rising protectionism: a euro area and global perspective', ECB Economic Bulletin, No. 3, 2019.
WTO, Report on G20 trade measures, 2023.
Gopinath, G., Gourinchas, P., Presbitero, A., Topalova, P., 'Changing Global Linkages: A New Cold War?', IMF Working Paper, No. 24/76, 2024.

xiv For a comparison, highlighting the large amount of government support for companies in China compared to the OECD average, see: OECD, 'Government support in industrial sectors: A synthesis report', OECD Trade Policy Paper, No. 270, 2023.

xv OECD, Latest Developments in Steelmaking Capacity, 2024.

xvi Eurostat.

xvii Ibid.

xviii Eurostat.

xix See Böning, J., Di Nino, V., Folger, T., 'Benefits and costs of the ETS in the EU, a lesson learned for the CBAM design', ECB Working Paper, No. 2764, 2023.

xx See, for example: Gil Tertre, M., Renewables: Spanish industry's competitive advantage, 2024.

xxi See: European Commission, European Hydrogen Bank pilot auction results for more information about fixed-premium contracts (EHB), Contracts for Difference (CfDs), and Carbon Contracts for Difference (CCfDs).

xxii For the identification of possible EII clusters, see for example: Strane Innovation, D6.1—EPOS Tool Market Study,2016.
Cervo, H., Ogé, S., Maqbool, A., Mendez Alva, F., Lessard, L., Bredimas, A., Ferrasse, J.-H., Van Eetvelde, G., 'Case Study of Industrial Symbiosis in the Humber Region Using the EPOS Methodology', Sustainability, Vol. 11, No. 24, 2019, 11, 6940.

5. Clean technologies

The starting point

A FAST-GROWING GLOBAL MARKET

Clean technologies are indispensable to reach climate neutrality targets, in the EU and worldwide. They include a wide range of technologies[01] that produce or store renewable energy or absorb emissions. As enablers of the path towards decarbonisation, clean technologies are becoming 'the new oil'. The widespread deployment of clean technologies maintains the possibility of limiting global warming to 1.5°C above pre-industrial levels[i]. By 2030, solar PV and wind, electrification, bioenergy, hydrogen, CCUS and fuel shifts are set to together contribute to 65% of emission reductions [see Figure 1].

01. This analysis makes reference to the most critical and promising technologies where the EU has a comparatively large market share and deployment potential – solar PV, wind, batteries, heat pumps, CCUS, and electrolysers. Sustainable renewable and low-carbon fuels for the decarbonisation of transport are addressed in the chapter on transport. These clean technologies have been identified by the European Commission as strategic to reaching the 2030 target of reducing greenhouse gas emissions by at least 55% relative to 1990 levels. It is to be noted that for CCUS, many of the general considerations for other technologies do not apply. CCUS are not mass-manufactured technologies (although some of their components are). They are mostly large-scale, site-tailored technologies individually designed and manufactured to fit specific processes and local conditions.

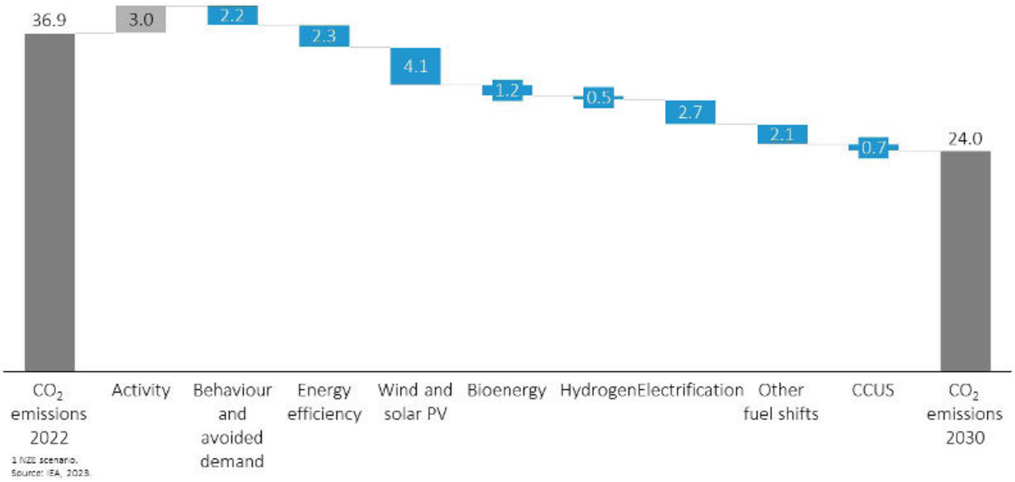
TABLE OF ABBREVIATIONS

ARPA	Advanced Research Projects Agency
CAPEX	Capital expenditure
CCUS	Carbon capture, utilisation and storage
CfD	Contract for Difference
CO2	Carbon dioxide
ECHA	European Chemicals Agency
EIC	European Innovation Council
ESG	Environmental, Social and Governance
ETS	Emissions Trading System
FDI	Foreign direct investment
IEA	International Energy Agency
IPCEI	Important Project of Common European Interest
IPR	Intellectual property rights
IRA	Inflation Reduction Act
JRC	Joint Research Centre
MFF	Multiannual Financial Framework
MSA	Market surveillance authorities
NPB	National Promotional Bank
NZIA	Net-Zero Industry Act
OPEX	Operating expenditure
PFAS	Per- and polyfluoroalkyl substances
PLI	Production Linked Incentive
PV	Photovoltaics
R&D	Research and development
REACH	Registration, Evaluation, Authorisation and Restriction of Chemicals
RRF	Recovery and Resilience Facility
TCTF	Temporary Crisis and Transition Framework
VC	Venture capital

FIGURE 1

CO_2 emissions reduction by mitigation measure

Contribution to CO_2 emissions reduction on the path to climate neutrality by 2050[02] (by 2030, in Gt).



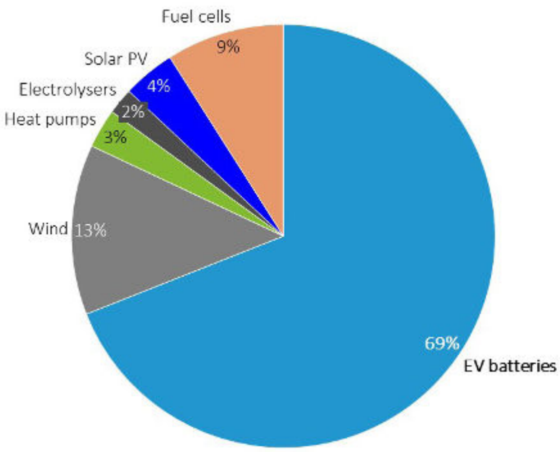
Source: IEA, 2023.

Clean technologies are projected to continue expanding in size, investment and their contribution to employment. The relevant market has already experienced very fast growth. In 2022, the combined global market for solar PV, wind, batteries, electrolysers and heat pumps surged to just under USD 300 billion, nearly triple the 2010 value. Investment in clean technologies has surpassed investment in conventional technologies – both in volume and their growth rate. Worldwide, twice as much investment is set to be directed to clean energy in 2024 compared to fossil fuels[ii]. The global market for clean technologies is forecast to expand to reach USD 650 billion by 2030[iii].

The manufacturing of clean technologies provides an important contribution to these investment opportunities. In 2023, clean technology manufacturing accounted for around 4% of global GDP growth and nearly 10% of global investment growth. Furthermore, in 2023 global investment in the manufacturing of five clean energy technologies reached USD 200 billion, increasing by more than 70% compared to 2022[iv]. USD 640 billion in investment will be needed from 2022 to 2030[v] to expand global manufacturing of a set of key clean technologies needed to reach climate neutrality by 2050. Around two-thirds of this sum will need to be dedicated to scaling up the manufacturing of EV batteries.

FIGURE 2

Shares of required global investment between 2022 and 2030 in manufacturing of selected clean technologies



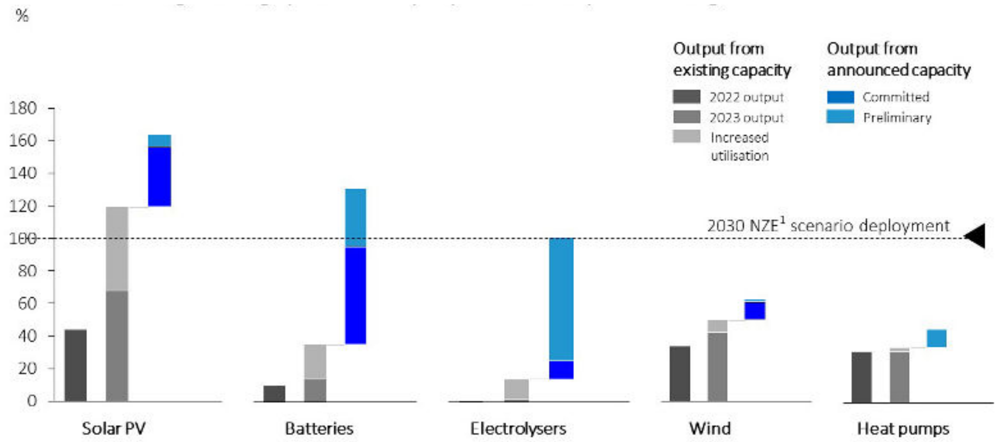
02. NZE scenario

Source: IEA, 2023.

The expanded production of clean technologies will trigger job creation. By 2030, around five million new jobs are estimated to be created alone for the assembly of electric vehicles and the manufacturing of their batteries[vi].

Despite overall steady growth, supply undercapacity is projected for some technologies. By 2030, manufacturing gaps are projected for wind power-generation equipment and heat pumps. Depending on whether preliminary projects are committed, electrolysers are also expected to experience manufacturing gaps [see Figure 3]. For these technologies, investment will need to be rapidly strengthened to enable the transition.

FIGURE 3
Manufacturing throughput and deployment of clean technologies
1 Path to climate neutrality in 2050



Source: IEA, 2024.

Moreover, the current supply of clean technologies is highly concentrated. For some components for solar PV (wafers) and batteries (anodes and cathodes) sitting upstream in the supply chain, around 90% of manufacturing capacity is located in the Asia-Pacific region. This situation is not projected to change during this decade[vii].

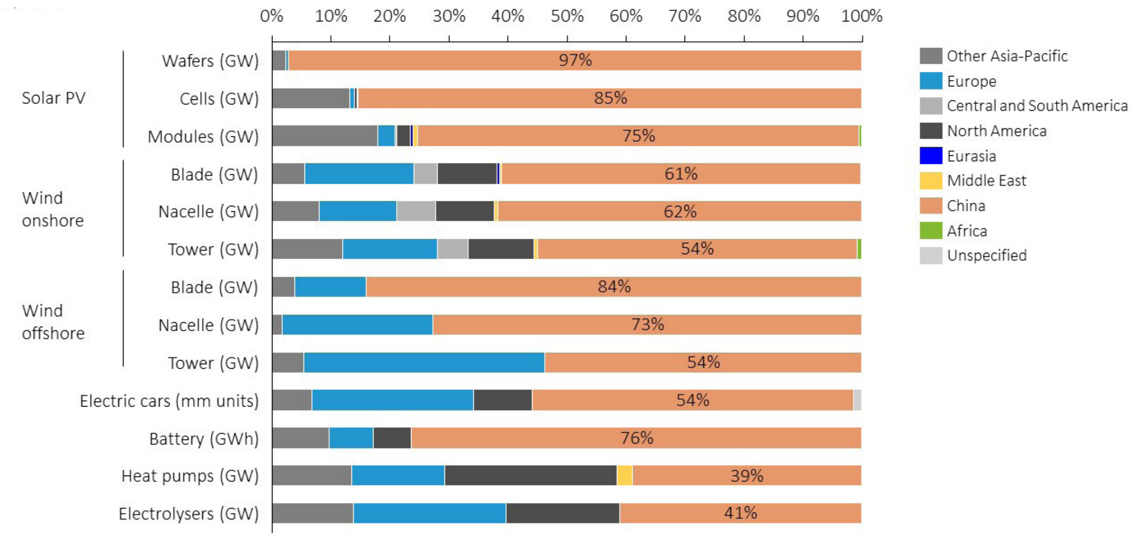
China, in particular, dominates manufacturing capacity. In 2023, clean technologies were the largest driver of China's economic expansion, accounting for 40% of its growth in GDP[03]. In October 2023, China's announced investment in clean technologies exceeded USD 280 billion[viii]. China's increase in its share of global manufacturing capacity has been stunning, in particular for some solar PV segments, such as polysilicon and cells. In 2021, China comprised only 36% of global demand, but was responsible for over three-quarters of world production. Its massive production capacity also means that China has developed technological know-how pertaining to these mass-manufactured products.

03. This allowed China to reach its objective of 5% GDP growth (without clean technologies, China's GDP would have risen by only 3.0% instead of 5.2%). Myllyvirta L., Qin Q, Analysis: Clean energy was top driver of China's economic growth in 2023, 2024.

FIGURE 4

Clean technology manufacturing capacity by region

(% 2021)



Source: European Commission, 2024. Based on IEA, Bruegel, 2024.

China has built overcapacity in several clean technologies. Some exceptions remain (e.g. towers for wind turbines). During the next years, and by 2030 at the latest, China's annual manufacturing capacity for solar PV is expected to be double the level of global demand. Moreover, its manufacturing capacity for battery cells is expected to at least cover the level of global demand (or even reach double the level of global demand, according to some estimates)[ix].

STRONG INNOVATION POTENTIAL, INABILITY TO SCALE UP IN THE EU

The EU is one of the world's largest markets for clean technologies, with China and the US as its main competitors. Thanks to ambitious decarbonisation targets and policies promoting this objective, the EU has already developed a large market for clean technologies. Today, the EU is the second largest market in the world for solar PV, wind and EV sales (with between 17% and 25% of global market shares for these technologies). The EU's solar PV and wind sectors expanded their output by some 489 GW between 2010 and 2023, with record additions in the last year[x].

The EU's market for clean technologies will continue to grow in light of its ambitious climate and renewable energy targets. Additional investment needs for the green transition are estimated at EUR 450 billion a year between 2025 and 2030.

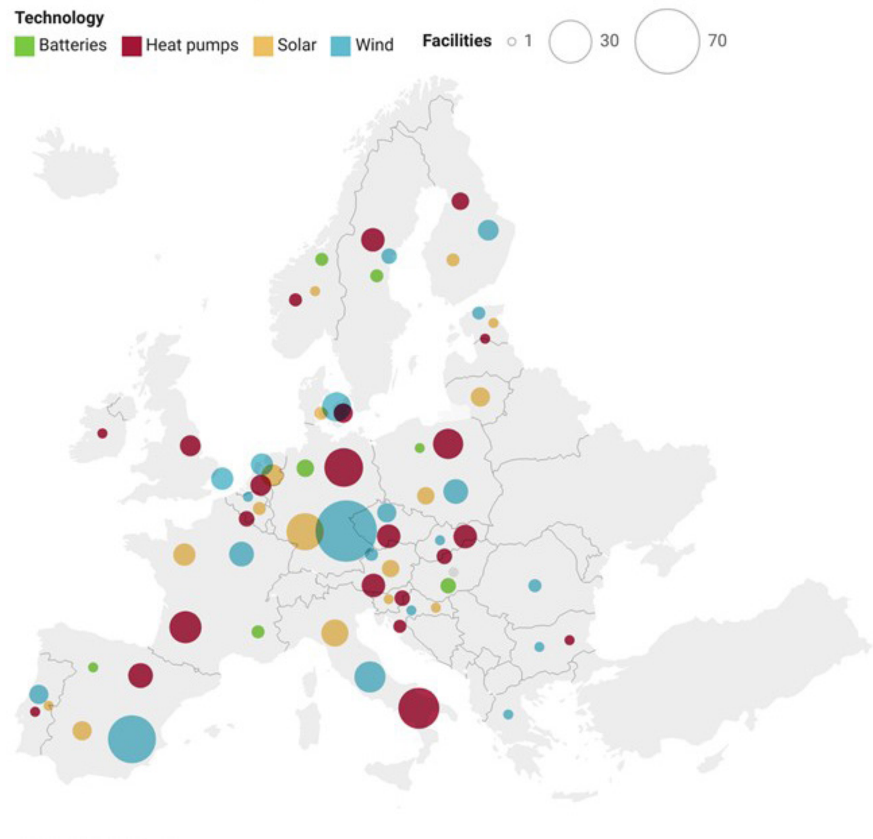
By 2030, investment in the manufacturing of the clean technologies covered by this analysis may reach at least EUR 52 billion (if EU industries' current share is maintained in meeting domestic demand). If the EU steps up manufacturing capacity as envisaged under the NZIA Regulation[xi], this sum could reach EUR 92 billion. If the EU would domestically supply 100% of its own demand, investment needs would reach EUR 119 billion[xii]. Subsequent investment of an estimated EUR 23 billion will be required between 2031 and 2040[xiii] to further enhance the EU's manufacturing capacity.

The EU has opportunities at hand to lead the innovation of clean technologies. For example, EV batteries for electric vehicles can rely on a strong automotive industry for positive spillovers, and the offshore wind sector on the EU's oil and gas industry. Furthermore, the solar PV and heat pumps sectors can learn and exploit synergies with the building industry. The production of upstream or mid-stream components in clean technologies also finds strong players in the EU's chemicals industry. The EU is already a global leader for high-value inventions concerning all the clean technologies covered in this analysis. Around 40% of global innovative companies in wind and heat pump technologies – 30% for electrolysers and 20% for solar PV, batteries and CCUS – are European. Furthermore, thanks to public EU financing support for R&I, the EU is a leader in electrolysers and carbon capture technology solutions.

The EU also leads sustainability along the full lifecycle of clean technology solutions. For example, the new Battery Regulation is the world's most far-reaching environmental blueprint addressing the battery lifecycle, and the EU has had rules in place for several years covering the eco-design of energy products.

The EU has been 'early mover' in developing a manufacturing base for several clean technologies, retaining leadership in some sectors and Member States. In the mid-2000s, benefitting from leadership in technology development, the EU represented an important share of global production in solar PV. By 2010, for at least one component (polysilicon), Germany competed directly with the US and China. Germany remains the EU leader in the production of inverters and polysilicon[xiv]. Concerning the manufacturing of wind turbines, the EU (led by Denmark, and Spain) secured early technological leadership, holding a 90% share of the global market in 2000. Denmark hosted the world's first wind farm and currently accounts for half of the EU's production[xv]. Moreover, it is an EU-based Original Equipment Manufacturer (OEM) that ranks first worldwide in terms of market share for offshore wind turbine production (36% in 2023) and holds primacy, almost on a par with a Chinese OEM, in onshore wind turbine production. Portugal hosted the world's first wind floating farm, and the first offshore solar farm was created in the Dutch North Sea. EU companies continue setting world records for wind turbine power output and are testing offshore solar projects at Giga scale. While hubs exist concentrating production, the manufacturing of clean technologies is currently somewhat fairly distributed across the EU.

FIGURE 5
Map of European clean technology manufacturing



Source: Bruegel, 2024.

Despite this, to a different degree by segment, the EU's clean technology manufacturing industry faces barriers to scale up and compete. The picture is nuanced and very much varies depending on technologies and components with legacy strengths and encouraging signals:

- **Solar PV.** The EU has lost considerable market shares in solar PV production over the years and has a now negligible presence in solar PV production manufacturing.
- **Wind turbines.** While retaining primacy in turbine assembly (serving 85% of domestic demand and acting as a net exporter), the EU has lost significant market shares to China in just a few years (declining from 58% in 2017, to just 30% in 2022). While the EU claims the second largest global market share for various wind turbine components, a massive gap has emerged with China (e.g. the EU produces 10% of the world's gearboxes and power converters, while China produces 66% and 77% respectively).
- **Heat pumps**. While the EU's industry delivers 60%-70% of domestic demand for heat pumps, it has become a net importer in the past three years. Today, a very large share of compressors is imported, as is a significant amount of air-to-air heat pumps (which comprised 40% of all sales in the EU in 2021).
- **Batteries.** Despite legacy strength in lead-acid battery production, the EU has achieved only marginal manufacturing capacity for lithium-ion batteries (a 6.5% share of the global production of battery cells), and components – including processing capacity. With investment more than tripling in 2023, committed projects suggest the potential for the EU to achieve in the coming years self-reliance for the production of battery cells. There would, however, be strong competition from Chinese producers, while the undersupply of components would continue to be a challenge.
- **Electrolysers**. The EU holds technological leadership in this segment, but, contrary to China, does not yet produce at Giga scale.
- **CO2 capture technologies.** The EU is a global frontrunner in carbon capture technologies (over half of global investment in 2023). Yet, it is confronted by barriers hindering the actual expansion of this segment. This is due, at least in part, to the need to secure CO_2 storage sites and transport infrastructure.
- **Sustainable renewable and low-carbon fuels**. As detailed in the chapter on transport, the EU holds technology leadership but has limited installed capacity and planned production.

As a result, the EU is increasingly relying on imports to satisfy its rising demand. The EU is a net importer of clean technologies. For wind turbines, where it retains a trade surplus, its trade balance is deteriorating (the value of EU imports increased by 504% between 2012 and 2022). The EU mainly relies on increasing imports from Asia and China in particular. Concerning batteries, the value of imports grew by 7.5 times between 2017 and 2023. Moreover, for key components in heat pumps, the EU's trade deficit doubled between 2021 and 2022. In 2023, the value of the EU's imports from China stood at approximately EUR 43 billion for solar PV, wind, batteries and heat pumps. Battery imports from China represented over EUR 17 billion in turn[xvi]. For batteries and some solar PV components, the EU's dependency also extends to production machinery, creating possible bottlenecks when needs for maintenance or repair arise.

Despite the EU's ambition to maintain and develop manufacturing capacity for clean technologies, there are multiple signs of an evolution in the opposite direction. In some segments, EU companies are announcing production cuts in the EU, shutdowns or the partial or full relocation to other world regions. This includes those with lower production costs (e.g. China) and others with stronger incentives for production offsetting costs (the US and Canada). In other segments, projects expanding existing production capacity in the EU (100 projects related to the technologies covered in this analysis, as of August 2023) could be at stake if the challenges faced are not remedied.

THE ROOT CAUSES OF THE EU'S COMPETITIVENESS GAP

While the state of play differs by technology, stability and predictability of demand are a fundamental driver for investment in all clean technologies. Higher observed operating costs, dependency on critical raw materials, longer permitting times, a lack of skills, and an unlevel playing field with other world regions all hinder the EU's competitiveness in these technologies.

1. Higher operating and capital costs than in other world regions.

The EU faces higher costs when building new production facilities. Facilities in the EU and the US are 70% to 130% more expensive per unit of output capacity than those in China for solar PV, wind and battery manufacturing[xvii]. Furthermore, operating costs are higher. Higher costs are linked to the price of key inputs and raw materials, electricity and labour, that are higher compared with China in particular.

The EU suffers from higher raw material costs compared to other large manufacturing regions, including China. Some technologies (in particular wind turbines, solar PV and electrolysers) rely heavily on raw materials, including steel for wind towers, or on critical raw materials. For these inputs, the EU's share of global production is never higher than 5%[xviii]. For wind, for example, the EU's share of production in all required raw materials is only 2%, while China holds 43%. Electrolyser production requires at least 40 raw materials and the EU currently only produces 1% to 5% of these materials. The EU's industry has been affected by surging global raw materials prices, which have reversed the global trend towards reducing the cost of producing clean technologies[xix].

The EU's industry is particularly impacted by high energy prices. The manufacturing of the most energy-intensive components (e.g. wafers and polysilicon for solar PV) is particularly costly in the EU. The EU (similar to the US) has greater labour costs compared with China due to higher salaries and labour standards. As a result, for example, a number of EU-based wind blade factories – a labour intensive component – have relocated to other world regions.

In some cases, the EU suffers from longer lead times resulting in higher costs. This has, for instance, been demonstrated in all solar PV segments, where China has both the shortest construction times and the quickest ramp-up periods[xx].

2. High dependency on critical raw material imports.

Global mining and processing markets are highly concentrated, and mainly located outside the EU [see the chapter on critical raw materials]. Clean technologies have significant dependency on critical raw materials. In some cases, a single material is in demand for the production of several technologies (e.g. rare earth minerals are used in wind, heat pumps, EV motors and some electrolysers). Batteries use a large supply of five critical raw materials (lithium, manganese, natural graphite, cobalt and phosphorus). The EU is highly reliant on imports of these materials – up to 100% of its needs for refined lithium[xxi]. The most significant bottlenecks in the EU's supply chain have been identified for lithium and graphite. The wind industry is another example relying on the supply on critical raw materials. These include certain heavy rare earth elements used in offshore turbines deployed in the EU, in which EU OEMs are global leaders. Rare earth elements and permanent magnets show the highest supply risk and most critical bottlenecks for the wind industry. To meet EU targets, the demand for permanent magnets and rare earth elements will experience a five-fold increase by 2030[xxii].

3. An unlevel playing field driven by incentives and trade barriers.

All major economies have launched targeted, far-reaching programmes to sustain the development of local clean manufacturing. China has since the mid-2000s prioritised clean energy production using clear targets and subsidies, including cheap loans for R&D, manufacturing, power generation and consumer uptake. At the same time, it has notably protected its home market for solar PV, wind power-generation equipment and EV batteries. In continuity with its subsequent Five-Year Plans, China's three 'export pillars' all relate to clean technologies – solar cells, lithium-ion batteries, and electric vehicles. China has addressed the manufacturing of clean technologies in a holistic manner, with policies targeting raw materials sourcing, and the vertical integration and exploitation of adjacent industries to create local hubs. China also built a sophisticated intellectual property rights (IPR) protection system, and then restricted the export of IP to third countries. At the same time, it has strived to attract and localise foreign investment by deploying mandatory joint ventures and the localisation of R&D by foreign companies, along with an obligation to partner with local companies to win tenders. Manufacturers in China have also shown readiness to temporarily manufacture at a loss, even without subsidies, and have exported excess capacity at low prices. The European Commission, reported that China's subsidies on clean technologies have long been twice as high as those in the EU, relative to GDP[xxiii].

The US' Inflation Reduction Act (IRA) announced in August 2022 has been a game-changer in attracting investment. The IRA aims to de-risk investment in the US' supply chain, while reducing reliance on imports [see below for a comparison with EU initiatives]. The IRA has the potential to reduce the price gap experienced by the US in the production of clean technologies compared to China. Since the IRA was announced, investment in manufacturing facilities for clean technologies in the US has seen an upward trend. Total annual investment in the past two years was up 204% compared to the previous two years. For example, investment in batteries increased by 2.5 times between Q1 2023 and Q1 2024[xxiv].

Other world regions have in place their own unique mix of policies and incentives. India's Production Linked Incentive (PLI) scheme (part of the 'Self Reliant' programme) includes measures to boost the local manufacturing of high efficiency solar PV modules, alongside initiatives attracting investment by domestic and foreign companies in advanced chemistry cell batteries. Japan's 2022 Green Transformation programme features the plan to release JPY 20 trillion in transition bonds to catalyse public and private investment of JPY 150 trillion to scale up clean technologies. South Africa and Brazil have established local content requirements to boost the domestic production of solar PV and wind turbine components. Indonesia has adopted a similar approach for solar PV. Mirroring the US' approach, Canada announced USD 60 billion in clean energy tax credits for 2023 alone.

A comprehensive EU policy for clean technology manufacturing has only recently been announced, primarily in response to the US' IRA. This mainly relies on national actions under the framework of the NZIA Regulation. With the exception of initiatives to spur battery investment in particular and industrial alliances, until now, Member States have mainly acted in isolation when it comes to clean technologies. As a result, there has been limited collaboration and integration, and a lack of visibility of the industrial supply chain.

Compared to the US, overall public financial support in the EU – while potentially comparable for climate measures overall – is in practice less generous on clean technologies manufacturing. The EU's support is less targeted than that provided by the IRA to clean technologies and their manufacturing, with overall lower aid intensity. Accessing EU funds is also more complicated and less predictable than under the US IRA [see below].

The EU budget and other EU public financing sources are in fact not targeted to clean technologies manufacturing. During the 2021-2027 period, the majority of EU-level public funding is dedicated to the deployment of clean technologies (up to EUR 124 billion), followed by R&D (EUR 36 billion). Despite this, only EUR 8 billion could be available to support first-of-a-kind installations and production plants[xxv]. This makes the available EU-level public financing for manufacturing of clean technologies potentially five to ten times less generous than that under the US' IRA.

A significant part of the EU's potential to fund clean technologies manufacturing depends on the decisions of Member States. Since 2023, Member States have been required to spend 100% of Emissions Trading System (ETS) auction revenues for climate and energy related purposes. These revenues reached EUR 43.6 billion in 2023 alone (of which EUR 38.6 billion went directly to Member States). To date, there is no evidence that meaningful amounts of ETS revenues have been channelled to clean technologies manufacturing by Member States. Added to this, only a relatively small share of ETS revenues finance EU funds. The EU Innovation Fund is the only EU instrument targeting support for the manufacturing of clean technologies (with recent announcements on earmarking financial support for battery manufacturing specifically[xxvi]). However, it only offers relatively minor amounts. EUR 1.4 billion were made available in the 2023 call for proposals[xxvii]. Furthermore, EUR 720 million was disbursed under the first call for the European Hydrogen Bank, which also finances the manufacturing of technologies to produce hydrogen. Important potential lies with national State aid schemes for projects for clean technologies manufacturing: since the Temporary Crisis and Transition Framework has been in application (March 2023), and by June 2024, the Commission has authorised aid schemes worth EUR 14 billion[xxviii]. On the other hand, the procedure to confirm matching State aid has only been used once in over a year.

The average public aid intensity is higher in the US under the IRA (40%) than in EU programmes (17%-19%). The EU framework only in limited and targeted cases covers operating costs (significant in these industries in the EU). Regarding national schemes, the Commission recently observed based on draft National Energy and Climate Plans that, with the exception of five Member States, there were no national plans to help scale up the manufacturing of clean technologies[xxix].

Requirements for access to EU financing and to secure the approval of national State aid authorisation schemes and projects by the Commission are complex. The EU has complicated, lengthy procedures (for prior approval and reporting) to access financing and state aid approval The procedure to confirm matching State aid is particularly lengthy and complex, and has only been used once in over a year. On the contrary, the US' IRA operates on the basis of automatic access, faster clearance and fewer reporting requirements. The industry considers the IRA as attractive because of its targeting and the certainty it offers concerning access to funding.

FIGURE 6

	EU POLICIES	US IRA
→ **Scope of support**	Potentially in the scope of Union funds and national interventions, but **no specific earmarking** for clean technologies and their manufacturing (with a few recent exceptions, e.g. dedicated allocations for manufacturing under the Innovation Fund).	**Targeting** of specific clean technology categories with dedicated allocations for uptake by consumers, project/ deployment investment, production investment (fixed tax credit measured in USD cents per kWh of electricity produced). Overall, **less focus on innovation** and breakthrough technologies.
→ **Overall volume of support (for deployment and manufacturing)**	In 2021-2027, **EUR 578 billion under the EU budget for climate spending overall, including deployment**. In addition, since 2023 Member States have to spend all ETS revenues at the national level on climate measures (some EUR 38.6 billion in 2023). Part of these revenues finance the Innovation Fund, which also supports clean technologies. Volume potentially comparable to the IRA if the EU budget, EU sources (ETS revenues) and national funding are considered; and if innovation, manufacturing and deployment are included. However, the **lack of targeting or earmarking renders volumes inferior**.	**EUR 400 billion for clean technologies, including deployment**, although total support may be much higher, as several of the tax credits in the scheme are **not capped.**

→ **Support for manufacturing**	At EU level, no specific earmarking in principle, and the **estimated potential maximum of EU public funding for manufacturing from 2021 to 2027 is EUR 8 billion**. This stands in contrast to estimated investment needs for six technologies of EUR 50 to EUR 92 billion by 2030 (of which 17%-20% should come from public sources, if the EU average aid intensity for climate and energy is maintained). Most of the identified possible EU funding for manufacturing capacity tends to be limited to small companies, SMEs and small mid-caps (under the EIC Accelerator within Horizon Europe, and the Structural Funds). The State aid framework allows supporting manufacturing of clean technologies at national level.	For manufacturing, **estimated support starts at EUR 37 billion and could reach EUR 250 billion.** No differentiated treatment based on company size.
→ **Costs supported**	**Mainly CAPEX** costs under EU funding programmes and the State aid framework. OPEX only in few targeted cases (including matching State aid; non-profitable projects under the Innovation Fund).	**CAPEX and OPEX.**
→ **Aid intensity**	At the EU level, 17%-20% (based on an average of existing EU funding programmes pertinent to the climate and energy). At the national level, State aid intensity ranges from 15% to 75% for small enterprises in assisted areas.	**40%.**
→ **Time span of support**	EU budget allocations, **until 2027 (2026 for the RRF).** ETS revenues, to continue on an annual basis. The Innovation Fund, currently until 2030. The State aid framework includes permanent (e.g. Regional aid guidelines) and temporary rules (Temporary Crisis and Transition Framework until 2025).	**Ten years** (2022-2032).

→ **Means of support**	**Grants or loans.** Fixed Premium, Contracts for Difference (CfD) or Carbon-Fixed Contracts for Difference (under the Innovation Fund and the Hydrogen Bank). **Competitive bidding and auctions** in some cases (under the Innovation Fund and the Hydrogen Bank).	**Tax credits.** Only eligibility criteria, no scoring or competitive process.
→ **Process**	**Highly fragmented.** Four programmes for R&D, three programmes for manufacturing, seven programmes for deployment. **Complex** templates for applications discouraging companies from applying for competitive bidding. **Long time to money.** A **lengthy** assessment process by the European Commission or Member States. Reporting requirements to confirm financing or avoid funds from being recovered.	The IRA is **one single programme**. One process, for example, to apply and receive production tax credits for a given technology. **Easy** application templates. **Fast** evaluation.
→ **Incentives for local production**	Sovereignty seal for quality projects contributing to the EU's strategic autonomy in the manufacturing of clean technologies to facilitate access to various EU programmes. It is lost in case of relocation. NZIA Regulation: non-price and resilience criteria that could indirectly spur domestic production. No 'made in' clauses.	**Bonuses for the production or consumer uptake of products that are produced locally,** or with components produced by trade partners. The share of domestic content necessary to qualify for the bonus increases over the years. For example, the share of battery components that need to be manufactured or assembled in the US to qualify for a bonus for consumer uptake increases from 50% in 2023 to 100% in 2029.

A range of trade barriers is also in place around the world. The EU has low import barriers on clean technologies. On the other hand, in some segments (such as solar PV), barriers in the form of import duties or local content requirements in large markets (including the US and India) result in Chinese overcapacity mainly being redirected to the EU. The EU can, however, leverage its newly adopted regulatory framework on foreign subsidies. Investigations were opened earlier in 2024 into possible unfair advantages enjoyed by non-EU bidders in public procurement procedures for solar and wind in a number of EU markets. This is, however, a tool to be used on a case-by-case basis.

Other measures may result in the shrinking of the EU's export markets. Concerning the wind industry –in which the EU retains a trade surplus – local content requirements are in place in more than twenty countries around the world, including seven advanced economies. Bonus credits for domestic production, including those recently announced under the US' IRA, contribute to a potential reduction in size of EU export markets.

BOX 1

The EU's Net-Zero Industry Act

The EU's Net-Zero Industry Act (NZIA) Regulation sets indicative benchmarks for the manufacturing of clean technologies, their components and machinery in the EU. It envisages i) a 40% share of the production required to cover the EU's deployment needs for respective technologies and components by 2030; ii) 15% of global production by 2040. In addition, there is a mandatory target for the EU to geologically store at least 50 million tonnes of CO_2 a year by 2030. The NZIA also includes a set of innovative mandatory provisions that apply to an extensive, yet closed, list of clean technologies[04]:

- **The first EU rules harmonising the permitting of industrial manufacturing projects with binding time limits of nine to twelve months** (also covering environmental impact assessments, except the initial draft environmental impact assessment study) for 'Strategic Projects' or up to eighteen months for other projects. Member States are also required to designate Single Points of Contact to oversee and facilitate permitting, and to provide information to investors.
- **Mandatory non-price criteria in public procurement,** on: i) environmental sustainability (e.g. durability, the ease of repair and maintenance, access to services; environmental and carbon footprint criteria); ii) one criteria, either concerning social and employment considerations, cybersecurity, or time to deliver; iii) in case of significant dependency (of more than 50%, or one quickly reaching 40%) on a single third country not part of international procurement agreements, a resilience criteria would apply. It diversifies technology supply via a cap – no more than 50% of the value of a technology can be sourced from a single third country.
- **Non-price criteria in renewable energy auctions for at least 30% of annual auctioned volumes (or 6 GW of the volume auctioned) in a Member State.** Criteria relate to cybersecurity, the ability to deliver projects fully and on time, responsible business conduct, environmental sustainability, innovation, energy system integration, and resilience.
- **Reward of sustainable and resilient products in national subsidy schemes.** In the context of schemes incentivising the purchase of clean technologies by households, companies or consumers, Member States should promote the purchase of products with a high contribution to sustainability and resilience. They may decide to condition eligibility to support programmes to the issuance of a national label (a 'pass mark').
- **The possibility for Member States to designate 'Net-Zero Acceleration Valleys',** as clusters of industrial activity and for the testing of innovative technologies.
- **Regulatory sandboxes** to test innovative net-zero technologies under flexible conditions.
- **Skills Academies** developing learning programmes, which Member States would use to facilitate the recognition of credentials as a basis for formal qualifications.

The Regulation does not provide additional sources of financing, but encourages Member States to use 25% of their ETS revenues to support clean technology manufacturing. Implementation is the responsibility of individual Member States, but NZIA Strategic Projects can demand tailored advice on leveraging private and public financing for projects through the Net-Zero Europe Platform.

04. During the negotiations of the NZIA Regulation in ordinary legislative procedure, opinions of stakeholders diverged as to whether a concise list or a longer and open list would be most appropriate. Some stakeholders asked to uphold the principle of 'technological neutrality', while others have urged the prioritisation of key technologies in light of limited resources, and not to support unproven technologies that are not yet commercially available. The revision of the list of technologies in the scope of the NZIA will be based on technology needs stemming from the updates of National Energy and Climate Plans. The Commission will consider changing the list after each update to the Plans. Member States reserve the right to refuse to grant the status of Net-Zero Strategic Project to projects in a value chain for a technology that a Member State does not include in its energy supply.

4. Lengthy, complex permitting procedures.

National permitting processes for manufacturing projects can be complex, lengthy and unpredictable[05]. While complete and accurate data on the matter is not available, the permitting process can last up to four years, significantly increasing risks and costs for project promoters and investors. The organisation of permitting is not always rationalised. In some cases, for a given project in a Member State an average of 15 authorities (and up to 30 authorities) may be involved. Project promoters do not have access to readily available information on the authorities in charge and on the rules applicable to permitting at the national level. In some cases, authorities need the support of external consultants to complete the process. Furthermore, additional time is needed when complex environmental impact assessments are required (e.g. due to hazards linked to chemicals being stocked). The shortest permitting time observed is around six months in the Netherlands, which has digitalised the entire process.

When permitting procedures are concluded within a reasonable timeframe, they have nevertheless been found to be burdensome due to costs, a lack of transparency and uncertainty. Many of the barriers and challenges related to the permitting of industrial projects for clean technologies are the same observed in permitting for the deployment of renewable energy projects. The European Commission has found that most of the barriers identified apply to permitting for the manufacturing of batteries. The public sector in the EU has insufficient administrative capacity to effectively carry out procedures linked to permitting important for investment in clean technologies. 69% of municipalities report a lack of skills related to environmental and climate assessments[xxx].

5. The skills gap.

The clean technologies manufacturing industry is affected by shortages of workers and skills. One-third of EU jobs in clean technologies lie in manufacturing. Job creation in clean technology manufacturing grew by 12% from 2015 to 2020 (compared to a 4% growth rate for manufacturing jobs overall). Clean technology manufacturing saw job vacancy rates double from 2019 to 2023, with 25% of EU companies reporting labour shortages in Q3 2023. Several job profiles are still relatively recent in transitioning sectors and could benefit from the reskilling of the workforce in declining sectors. Activities complementing manufacturing – namely installations and maintenance – will also require additional workers and professional certifications for technicians are not harmonised across the EU.

The European Commission has recently concluded, based on draft National Energy and Climate Plans, that **most Member States have not proposed objectives or measures with dedicated funding to tackle skills gaps relevant to the implementation of the NZIA**. Ramping up the production of the clean technologies assessed in this analysis requires additional investment in skills. This investment is estimated to be between EUR 1.7 billion and EUR 4 billion, depending on the level of ambition of local production.

6. A gap spanning innovation and the commercialisation of clean technologies.

In the EU, spending on innovation in technologies relevant to Energy Union's decarbonisation priorities is lower than in major Asian economies (as a share of GDP and of business enterprise expenditure on R&D)[xxxi]. The Commission's assessment of draft National Energy and Climate Plans in December 2023 noted that there is an overall decrease in national budgets for R&I in clean technologies, and a severe lack of national objectives and funding targets.

The EU's research and innovation policy is not sufficiently linked to its industrial policy. For example, the Horizon Europe programme has not prioritised manufacturing processes, such as automation and robotics for wind power-generation equipment (this could deliver a reduction in operational costs in the EU). The same is true concerning batteries. Most financing in this segment is devoted to lithium-ion chemistry, while sodium-ion technology promises to reduce reliance on critical raw materials (this technology is being adopted in the EU mainly by companies that are found in areas of traditional strength, for example lead-acid batteries).

Finally, as in other innovative sectors, the EU faces barriers in bringing innovation to market and scaling up in the field of clean technologies. This financing issue notably affects both early-stage financing and growth

05. In some Member States, legally binding time limits are already in place for clean technology manufacturing permitting.

financing [see the chapter on innovation]. Moreover, venture capital (VC) investment mainly targets battery manufacturing (one company accounted for 35% of all VC investment in EU clean technology companies between 2017 and 2022). Concerning specific technologies, the EU lost market shares in VC in the space of a few years due to faster growth in the US and China. For example, regarding hydrogen and fuel cells, the EU represented 65% of global early-stage VC and 43% of late-stage VC from 2015 to 2019. However, this share declined to 10% and 26% globally, respectively, from 2020 to 2022[xxxii].

BOX 2

Example of leveraging the EU chemical sector for clean technology innovation[xxxiii]

Thanks to technology innovation, the EU remains a major producer and exporter of chemical products despite higher energy, raw material and labour costs compared to some of its international competitors.

Chemistry-related innovation is mission critical to clean energy transitions. There is a massive opportunity for the EU to secure a share of international markets in the following areas:

- Battery components (including electrolytes and electrodes that reduce reliance on mined critical minerals via new designs or recycling).
- Electrolysis components (including electrodes, membranes and catalysts for hydrogen production, CO/CO_2 conversion to chemicals and reduction of iron/copper/aluminium or etc.).
- Heat pumps and air conditioning (including heat transfer fluids that have low environmental impacts).
- Passive and evaporative heating and cooling (including insulation, dehydration and phase change materials).
- CO_2 capture materials (including solvents, sorbents and metal-organic frameworks).
- Low-emissions routes to building materials (including silicate-based cement and recycled materials).
- Thermal storage materials and high temperature resistant materials (including simple bulk materials and advanced coatings for deep subsurface operations).

Several of these areas display clear synergies with one another, due to the use of similar techniques or materials. Research collaboration and spillovers, along with the use of AI to screen and virtually test vast swatches of possible combinations of chemicals, can accelerate the pace of innovation.

7. The regulatory framework is not always aligned to the needs of EU industrial policy on clean technologies.

The regulatory framework in the EU can create barriers and uncertainties for manufacturing investment. As an example, EU manufacturers of batteries, electrolysers and refrigerants for heat pumps encounter barriers to investment linked to uncertainty related to the substances permitted for use in the EU market. The process for limiting the use of chemical substances under the Regulation on the registration, evaluation, authorisation and restriction of chemicals (REACH) empowers the European Chemicals Agency (ECHA) to adapt limits and impose bans at any moment. A possible upcoming ban on a set of PFAS substances (per- and polyfluoroalkyl substances) would impact the use of substances needed to produce clean technologies (batteries and electrolysers), for which there are currently no alternatives. A possible upcoming ban on a set of PFAS substances may also affect the EU industry for refrigerants used in heat pumps, at a time when EU producers are adapting their production lines due to an approaching phase-out of synthetic refrigerants. Moreover, diverging national standards for products and grids may impact the EU's industrial fabric. For example, inverter production in the EU is faced with a patchwork of grid standards, while lightning systems or paint colours for wind turbine markings differ across Member States and so do regulations for the transportation of turbine blades and decommissioning.

BOX 3

A closer look at solar PV technology

The described challenges for EU manufacturing are striking in the solar PV sector.

Fast global growth. A more than 400% increase in deployment from 2015 to 2022. Global demand accelerated in 2021 and 2022, during which time around one-third of all existing solar PV deployment occurred.

Ambitious EU deployment targets. 320 GW of solar PV should be achieved by 2025 (more than double that in 2020) and almost 600 GW by 2030. Estimated additional investment between 2022 and 2027 reach up to EUR 26 billion.

Non-binding, ambitious recent EU domestic production targets set out in the 2022 Solar Energy Strategy – 30 GW/year along the value chain by 2030. Despite this, in 2022 only 3% of the EU's demand was supplied by domestic production (less than 2 GW/year).

The EU's industry is more innovative, productive and sustainable. The EU remains a leader in solar PV cells incorporating perovskites, which are considerably more efficient than currently dominant single-layer crystalline silicon panels. EU companies are early adopters of the newest technologies, for instance heterojunction, delivering better performance and higher energy yield during its lifecycle (plus 6-7%, compared to PERC modules dominant in China) and tandem cells (which can generate 20-50% more energy than a single solar cell). In addition, at small scale, production is starting for innovative technologies replacing energy-intensive upstream steps in the supply chain.

An unlevel playing field caused by foreign subsidies and trade barriers. Since 2011, China invested USD 50 billion in new supply capacity, ten times more than the EU (based on conservative estimates), allowing it to manufacture at scale – from 0 GW to 300 GW capacity in 15 years, reaching technological maturity. The resulting overcapacity triggered a fall in global prices. This is combined with trade barriers that disadvantage the EU. Global trade barriers for solar PV cover 15% of demand outside China, with the US announcing in May 2024 a doubling of its already considerable tariffs on Chinese imports (from 25% to 50%).

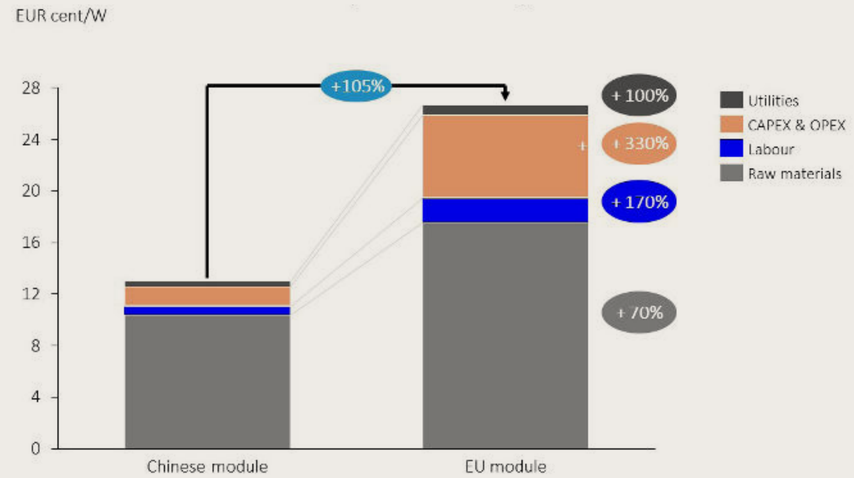
Notably, the US and China have had mutual antidumping duties on imports of certain components in place for years. Recently, the 2021 US Uyghur Forced Labour Prevention Act bans imports from the Xinjiang Uyghur Autonomous Region of China (where it is estimated that 45% of the world's supply of polysilicon for solar PV is produced). Furthermore, China, the US and India have put in place schemes rewarding domestic production (e.g. the US most recently, with the IRA offering bonus credits for domestic production, and India has rewarded national production since 2013 – with tighter requirements starting in 2024).

As a result, the EU is currently the largest open market for Chinese products. In contrast, in the EU solar glass duties are in place on imports from China, and are deemed by the EU industry as a further barrier to cost-competitive production. The value of the EU's imports of solar PV started rising after 2018 (when import duties on Chinese products in place since 2013 were lifted). Total EU imports of solar panels were worth less than EUR 4 billion in 2018, but rose to EUR 9 billion in 2021, and surged to EUR 22,6 billion in 2022. The value of imports from China reached around EUR 21.5 billion in 2022.

The IEA estimates that solar PV module manufacturing costs in China are around 35%-65% lower than in the EU. At the same time, some parts of the EU's industry estimates production costs for integrated cells and module manufacturing in the EU to be 70%-105% higher than in China (plus EUR 0.15-0.20/W higher). Furthermore, CAPEX costs have been estimated by the industry to be three times higher in the EU than in China.

FIGURE 7

Observed cost structure comparison in integrated cell and module manufacturing (EUR cent/W)



Source: expert interviews.

Unlike in the EU, in the US there is a perspective to bridge the production cost gap with China as a result of the IRA. Under the measured announced in the IRA, major cost savings are projected for US producers (for example, of 40% for wafers and ingots)[xxxiv].

As a result, with the exception of inverter production and some presence in polysilicon production, the EU's manufacturing base is disappearing. The EU only maintains some production of modules (9 GW/year), mainly via imported cells (cell production is in the range of 3 GW/year). In ingots and wafers, EU production is marginal and reliant on imported machineries. Companies have been affected by bankruptcy (leading to a polysilicon capacity decline by 12% since 2022) and temporary suspension, or paused production (for ingot and wafer manufacturing). Cell and module companies have announced that they are preparing to discontinue production in the EU, and/or invest in the US or China. In addition, the EU's industry has indicated that foreign investors (including those in China) do not see sufficient incentives for production in the EU.

BOX 4

The potential of battery manufacturing in the EU[xxxv]

Batteries are essential for decarbonising the energy and transport sectors in particular. As an emerging industry in the EU, next-generation battery manufacturing holds the potential to establish the EU as a global leader in this critical technology.

Increasing manufacturing output in the EU. Battery manufacturing output reached around 65 GWh in 2023 in the EU, growing by around 20% over the previous year. This compares to around 80 GWh of production and similar growth in the US, and around 670 GWh (and 50% growth) of production in China.

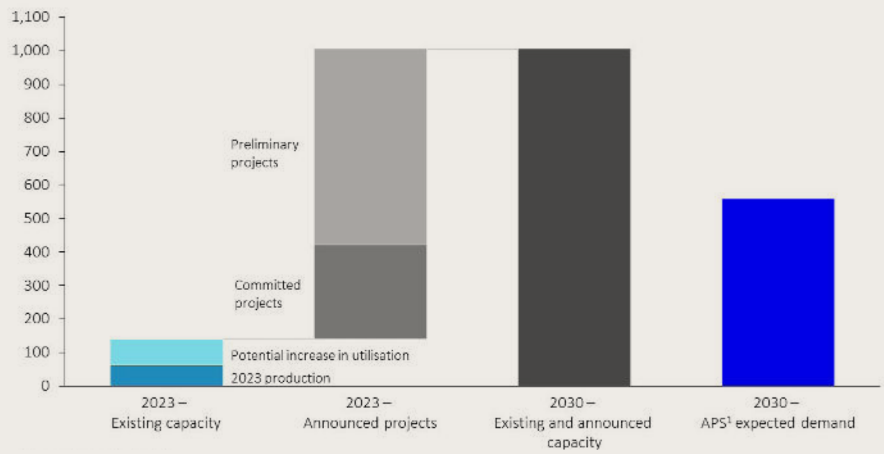
Demand growth in the EU. In the last year, robust growth in electric vehicle sales (18%) and even stronger growth in stationary battery storage (80%), were important drivers of battery manufacturing growth in the EU. Europe remains in the lead among advanced economies with respect to installed capacity in recent years, despite relatively high energy and labour costs. At the same time, it is estimated that roughly 50-70% of the battery cells contained in products deployed in the EU originate from China.

The IEA assessment concludes that the EU could meet the EU's domestic demand for batteries in 2030. Output from committed projects in the EU (i.e. projects under construction or that have reached financial investment decision), together with higher utilisation of existing capacity, could meet the EU's domestic demand for batteries in 2030 in a scenario in which deployment keeps pace with the EU objective of climate neutrality by 2050. If all preliminary projects also came to fruition, this would even imply a potential net export position for the EU in the same scenario. A stable regulatory and economic landscape, encompassing climate and energy policy along with trade policy, are the most important factors for committed projects to proceed. Rapid permitting, timely construction and smooth start of pilot lines, along with availability of skilled personnel, whilst already addressed or factored-in in investment decisions, are fundamental to make such project pipeline a reality.

Roughly half of the announced projects are from non-EU companies. This might result in missed opportunities for EU manufacturers to develop and maintain critical know how.

FIGURE 8

Potential evolution of battery production capacity in the EU (GWh)



1. Announced Pledges Scenario. Source: IEA, 2024.

There are promising signs of progress in the EU on next generation battery technologies. While most of the announced capacity is for manufacturing batteries with lithium-ion ('current generation') chemistries, incumbents in the lithium-ion battery market and more specialised new entrants are working on components and designs that look set to comprise the next generation of battery storage technology (sodium-ion and solid state batteries, among others.) These are set to reduce critical dependencies and improve costs. In the EU, deliveries of sample cells for sodium-ion batteries using Prussian White material for the cathode and avoid the use of lithium are due to start soon. A range of established firms from automotive and chemical sectors are working with start-ups on solid state batteries, which could offer improved safety, energy density and longevity over their lithium-ion counterparts.

Governments support next generation battery development, by funding research and through their role administering intellectual property protection via the patent system. Growth in public R&D spending in battery technology has averaged 18% per year over the past decade, significantly outpacing the growth in overall energy R&D spending (which was relatively flat over the same period) by governments. Europe also consistently ranks among the top three locations for patent applications for battery storage technologies globally, lagging only behind Korea and Japan during most of the recent period for which data is available.

Objectives and proposals

With different efforts targeting individual technologies, the EU should aim to:

- Secure a minimum share of EU autonomy in the supply of selected clean technologies and their components across the different steps of the value chain in an integrated way. This would increase the reliability and predictability of supply, enable faster ramping up of production in case of disruptions, help to retain know-how, and improve the visibility of supply chain cost structures.
- Ensure resilience to potential supply chain shocks, aiming for diversification.
- Create the conditions to develop and scale competitive EU industries focused on the most innovative, sustainable and highest value-added segments of value chains, where the EU can leverage its comparative advantages. Innovation and manufacturing should go hand in hand, to avoid the EU becoming the 'laboratory' of the world.

EU action to sustain a predictable demand of clean technologies is a prerequisite, addressed in the respective chapters [see the chapters on energy, energy-intensive industries, the automotive industry, and transport]. The short and medium-term proposals outlined in this chapter both build upon and expand the measures outlined in the NZIA.

FIGURE 9

	SUMMARY TABLE – CLEAN TECHNOLOGIES PROPOSALS	TIME HORIZON[06]
1	Ensure full, accelerated implementation of the NZIA.	ST
2	**Introduce in public procurement and in Contract for Difference auctions an explicit minimum quota for selected locally produced innovative and sustainable products and components** – where needed to reach EU manufacturing targets.	ST
3	Promote other forms of offtake for selected locally produced technologies, such as requirements and rewards in EU and EIB financing schemes, and in national support schemes.	ST
4	**Mobilise private and public financing for clean tech solutions, in particular by: i) streamlining and simplifying access to EU public funding, increasing the level of resources, extending the support to OPEX; ii) reinforcing dedicated financing schemes to attract private capital; iii) introducing dedicated growth equity instruments.**	ST/MT
5	Define clean technologies as one of the strategic priority areas of a refocused 10th EU Framework Programme for research and innovation (with prioritised access to funding for innovation, a dedicated new Competitiveness Joint Undertaking, and breakthrough innovation programmes).	ST
6	**Diversify supply sources and establish industrial partnerships with third countries.**	ST
7	Develop and enforce a single model of sustainable and innovative technology certification.	MT
8	Optimise foreign direct investment and protect EU know-how, by leveraging knowledge transfer clauses and protecting intellectual property rights.	ST/MT
9	Pool a skilled workforce, via mutual recognition of skills across the EU and facilitation of work permits to attract talents.	MT
10	Reinforce EU level coordination, in collaboration with industry and research centers, starting with: supply chain monitoring, definition of standards and minimal critical capacities, and coordination of R&D efforts (e.g. Joint Undertakings and IPCEIs).	ST/MT

06. Time horizon is indicative of the required implementation time of the proposal. Short term (ST) refers to approximately 1-3 years, medium term (MT) 3-5 years, long term (LT) beyond 5 years.

1. Ensure full, accelerated implementation of the NZIA.

Swift and effective implementation of the NZIA will help to reverse the current downward trend of the EU's competitiveness in clean technologies. The Commission should push forward or accelerate a set of actions to:

- **Secure complete, reliable and up-to-date data for entire value chains.** Data will be fundamental, for example, for the preparation and updating of secondary legislation envisaged in the NZIA. To this end, the European Commission should update customs codes to cater for clean technologies and propose possible updates to the EU's statistical system. It should, moreover, further reinforce its analytical basis in the European Commission's Joint Research Centre (JRC) and draw as much as possible on data from the EU industry and the International Energy Agency (IEA).
- **Reinforce administrative capacity in Member States** to implement the NZIA, in particular, rules concerning permitting.
- **Present an impact assessment and legislative proposal to review and increase the share of the auction volumes subject to non-price criteria by 2026**.
- **Operationalise the NZIA Academies**. The European Commission should complete the assessment of skills shortages mandated by the NZIA as soon as possible. In line with proposal seven in the chapter on closing the skills gap, the NZIA academies should be made operational by 2026 thanks to public-private partnerships.

The Net Zero Europe Platform should be operational as soon as possible and provide effective support to Member States. For example, the Platform should adopt recommendations for Member States on the public procurement of innovative solutions as early as 2025. These recommendations would ensure that contracting authorities act as a 'launch customer' for clean technologies. While no deadline is currently foreseen for the Platform to prepare recommendations, immediate action is needed to spur measures by Member States.

Member States can also secure an accelerated timeline for some NZIA provisions. To achieve this, they should:

- **Designate their National Contact Points for permitting.** Ensure that they are appropriately staffed and provide effective support for investment decisions.
- **Include NZIA implementation in National Energy and Climate Plans**. Dedicated chapters in the Plans should include the assessment of investment needs and plans for manufacturing projects – including for the allocation of financing by the public sector and incentives to stimulate private financing. This will provide opportunities from better linking clean technology deployment and production arising from enhanced planning.
- **Accelerate the implementation timeline of the NZIA non-price criteria,** while taking into account the Commission's guidance in secondary legislation. Commission guidance will be key to accompanying Member States in the definition and application of clear and transparent, comparable criteria which are easy to access, apply and measure.
- **Open applications for companies to submit their initiatives as Strategic Projects as soon as possible.** This measure could leverage the support from the Commission (common templates published online, and assistance in coordinating between Member States, ensuring transparency towards companies).
- **Step up permitting, including by digitalising permitting procedures.** EU financial support should be provided to this aim. The Commission should also lay down plans for an EU-wide tool to which national systems could be linked in the medium term to generate efficiencies and spur collaboration. While NZIA deadlines for permitting only apply to new submissions, Member States could apply NZIA permitting deadlines to projects already undergoing permitting procedures.
- **Evaluate the potential for an industrial cluster/s (Net-Zero Valleys).** The outcome of this exercise should be communicated to the Commission within a few months of the entry into force of the NZIA.

2. **The European Commission should expeditiously adopt criteria for innovative and sustainable technologies. On the basis of this, Member States should introduce in public procurement and in Contract for Difference (CfD) auctions an explicit minimum quota for selected locally produced products and components** – where needed to reach EU clean tech manufacturing targets. Quotas should be put in place when the EU (despite the NZIA) cannot (re-)gain autonomy in strategic industries. Such quotas should be limited in volume, progressively adapted over time in light of the possible ramping up of EU production, and combined with criteria orienting local production to the most innovative and sustainable solutions. In parallel, it is important that the Member States plan in due time upcoming auctions and public procurement procedures. The measure could be applied to different schemes of public procurement and CfD (such as the ones for renewables described in the energy chapter, or the ones for industrial decarbonisation in the energy intensive industries chapter).

3. **Promote other forms of offtake for selected locally produced innovative, sustainable technologies, such as requirements and rewards in EU and EIB financing schemes and in other national support schemes.** Further measures can be considered to promote the offtake of locally produced innovative and sustainable technologies, where the EU (despite the NZIA) cannot (re-)gain autonomy in strategic industries.

   Wholesalers and distributors could commit to include in their portfolios a range of EU-made technologies meeting high sustainability and resilience criteria.

   EU financing and support programmes and EIB schemes should include requirements for the offtake of locally produced innovative and sustainable technologies.

   Member States could reward locally produced technologies as part of national financial support schemes for businesses and consumers (e.g. subsidies via vouchers, or schemes such as the French one for the uptake of EVs according to green eligibility rules). As in the previous proposal, such measures should only apply to strategic technologies on which the EU (despite the NZIA) cannot (re-)gain autonomy and should be based on guidelines and criteria developed by the European Commission, for sustainable, innovative technologies that contribute to the EU's resilience.

4. **Mobilise private and public financing for clean tech solutions.**

   In the short term, the EU should:

- **Maximise opportunities under the Innovation Fund** by i) earmarking a share of financing for the manufacturing of specific clean technologies and segments of the value chain. Projects which seek deeper integration along the entire EU value chain (including the sourcing of critical raw materials) should be rewarded in assessments; ii) offering CfDs and Carbon Contracts for Difference to support the manufacturing of clean technologies [as also discussed in the chapter on energy-intensive industries].

- **Use EU ETS revenues to invest in manufacturing capacity.** This should be achieved by incentivising Member States to devote a share of their ETS revenues to the manufacturing of clean technologies and providing technical support to this end.

- **Mobilise the new Competitiveness IPCEI instrument for State aid for cross-border projects** [see the governance and competition chapters]

In line with the chapter on sustaining investment, the next Multiannual Financial Framework (MFF) should streamline funding devoted to the manufacturing of clean technologies, be of adequate size and offer to companies a single entry point. It should feature support for both CAPEX and OPEX (for a limited period of time for specific segments, while production is ramped up).

Gradually move the national State Aid for clean tech at EU level. In the transition period, while the budget at EU level for clean tech is streamlined and reinforced, the State aid Temporary Crisis and Transition Framework (TCTF) for strategic investment in the net-zero transition could be extended beyond 2025. In addition, the TCTF could include social conditions linked to skilling and reskilling [see further proposals on skills below].

The EU should also de-risk and mobilise private investment in clean tech. Several instruments exist already but should be increased in size, better target clean technologies via dedicated windows, cover first deployments/'first of its' kind technologies and leverage public-private partnerships[07]. For example:

- **Institutional investors should be incentivised to invest in clean technologies manufacturing** by promoting the creation of equity funds for clean technologies by the EIB or National Promotional Banks (NPBs); topping up InvestEU for the green transition and clean tech; ensuring adequate support for clean tech under the European Tech Champions Initiative.

- **Public guarantee and counter-guarantee schemes should be provided by the EIB or/with NPBs to commercial banks**, to cover the largest share of investment risks presented by clean technology manufacturing projects. In particular, the recent EIB initiative (EUR 5 billion) supporting wind power-generation equipment manufacturing in the EU as part of the European Wind Power Action Plan should be replicated and expanded to other clean technologies, as appropriate.

5. Define clean technologies as one of the strategic priority areas of a refocused 10th EU Framework Programme for research and innovation (with prioritized access to funding for innovation, a dedicated new Competitiveness Joint Undertaking, and breakthrough innovation programmes).

Clean technologies should be one of the strategic priority areas of a refocused 10th EU Framework Programme for research and innovation. The programme could prioritise innovation strengths that could have a broad impact on clean energy transitions: new chemical formulations for materials that enable breakthroughs on clean energy technologies at their use and end-of-life phases; innovative technologies to produce materials like steel, cement and chemicals at near zero emissions; and applied technologies and their deployment. It would imply: i) new Competitiveness Joint Undertakings for applied and breakthrough industrial research where the EU can lead on the next generation technologies (e.g. batteries). This would help to attract adequate resources for the deployment of (first of its kind) technology, particularly for large-scale projects and related infrastructures [see the chapter on innovation]; ii) a dedicated focus in the revamped breakthrough innovation programmes.

Successful projects should be bound by a knowledge sharing framework. Under this framework, beneficiaries could disseminate findings among the EU's industry community, when needed to support the scaling up of innovation to commercial level, while ensuring the confidentiality of commercially sensitive information. In parallel, effort is needed to ensure that knowledge yielded from EU-funded projects remains protected from industrial espionage, in line with the recently agreed Council Recommendation on research security.

6. Diversify supply sources and establish industrial partnerships with third countries.

In addition to the sound implementation of the 'resilience criteria' in public procurement and auctions under the NZIA, the EU should:

- **Introduce (realistic) import diversification targets per technology.** This is similar to the approach adopted under the Critical Raw Materials Act. These targets may focus on a few product categories where there is significant dependency on third countries and the EU's supply is highly concentrated. Targets need to be balanced with a cost analysis indicating the impact of diversification.

- **Establish industrial partnerships between the EU and third countries in the form of offtake agreements across the supply chain or co-investment in manufacturing projects.** The EU could: i) map with EU business consortia the potential for these partnerships in terms of supply chain imports or exports, and local EU manufacturing in like-minded third countries; ii) rely on the support of the EIB for offtake agreements worldwide; iii) craft networks of countries that take responsibility for different parts of the supply chain, according to their comparative advantage (e.g. resource availability, refining or manufacturing infrastructure presence) based on a shared

07. For example, the model of the EU-Catalyst partnership with the EIB plans to mobilise up to EUR 840 million between 2023 and 2026 to accelerate the deployment of and rapidly commercialise innovative technologies.

list of trustworthiness criteria (e.g. environmental footprint, labour rights, cybersecurity and data security). These criteria could be applied in local market schemes (e.g. for funding, certification, or public procurement). The Global Gateway could be leveraged for investment contributing to these goals.

7. Develop and enforce a single model of sustainable and innovative technology certification.

In line with the simplification exercise [see chapter on governance], compliance with the various Environmental, Social and Governance (ESG) standards for respective clean technologies set out in different legal texts could form the basis for a single EU model of 'sustainable and innovative' technology certification. By consolidating EU requirements (and in specific circumstances overriding national systems), this would provide a clearer and simplified roadmap for manufacturers. Such a certification would allow easier mutual recognition of environmental, social and due diligence features. It could be accompanied by a rating system within the EU and labelling that could also be recognised by partner countries outside the EU. In parallel, the EU could also consider general standard requirements for 'promising' new technologies that could be awarded a seal to facilitate their market uptake.

The EU should better support Member States in ensuring appropriate market surveillance and the effective implementation of EU rules. Insufficient market surveillance and, as a result, poor enforcement (and potentially compliance) are continuously cited as a major shortcoming in the implementation of the EU Eco-design and Energy Labelling Directives. This is due to the limited resources of national market surveillance authorities (MSAs) and a lack of effective coordination between them. This is a clear case where the rationalisation of national authorities entrusted with enforcement [see chapter on governance] would help foster more effective implementation.

8. Optimise foreign direct investment and protect EU know-how, by leveraging knowledge transfer clauses and protecting intellectual property rights.

Leverage knowledge transfer from foreign direct investment (FDI). The EU could facilitate the creation of joint ventures or cooperation agreements for knowledge transfer and sharing between EU and non-EU companies. For example, foreign companies benefitting from EU or Member State financial support should be bound by local recruitment and apprenticeship clauses, similar to the practice under the US' IRA.

At the same time, outbound EU investment in clean technologies deserve a screening mechanism to ensure that EU companies retain essential IPR and know-how.

9. Pool a skilled workforce, including via mutual recognition of skills across the EU and facilitation of work permits to attract talents.

The proposals presented in the chapter on skills will benefit the clean technology industry, as well as Member State authorities involved in permitting procedures.

To boost clean technology manufacturing, **the EU should map skill needs** and ensure that the **training programmes** of NZIA Academies are used by companies. Member States, when designating NZIA Acceleration Valleys and Strategic Projects, should encourage project promoters to engage with and contribute to the Academies.

Moreover, **Member States must ensure the recognition of skills and qualifications** for clean tech manufacturing and related services (e.g. for installation technicians for solar PV, heat pumps, wind turbines).

Alongside this, Member States could facilitate **work permits** (e.g. a Green/Blue card) for skilled professionals in critical segments (e.g. batteries) and introduce measures to activate more people to the labour market, notably women and young people not in employment, education or training (NEETs).

EU funding for clean tech skills should primarily be mobilised for initiatives aiming at achieving the above objectives.

10. Reinforce EU-level coordination in collaboration with industry and research centres, starting with: supply chain monitoring, definition of standards and minimal critical capacities, and coordination of R&D efforts (e.g. Joint Undertakings and IPCEI).

Clean technologies industries in Europe would strongly benefit from increased centralisation and coordination of specific activities, in collaboration with industry and research centres. Key activities where centralisation would be beneficial include:

- **Monitoring supply chains, production and innovation gaps**. Secure data and analytical autonomy for the EU, based on the input of industry, research centres and public authorities.
- **Identifying minimum critical capacities** for each segment of the supply chain for given clean technologies, and regularly reassessing barriers to investment.
- **Optimising EU legislation** to boost clean technology manufacturing. EU legislation (e.g. on bans or phasing out of specific substances; or on environmental protection and grid standards), should take into account the impact on the manufacturing of clean technologies and offer opportunities for EU manufacturers to benefit from economies of scale (e.g. via common standards on environmental protection and grids). Regulatory sandboxes should be considered, to allow companies not to comply on a temporary basis with specific rules (environmental or other) to test their products in a controlled environment.
- **Coordinating R&D efforts**. Coordinate national efforts and develop EU-level research joint undertakings or partnership for clean technologies to secure sufficient, world-class R&D support to foster the development of emerging technologies (e.g. osmotic energy[08]) and sustain technologies undergoing rapid transformation (e.g. clean building materials[09]; industrial heat pumps[10]).
- **Promoting market uptake, proposing policy recommendations to create or harmonise demand at the EU level.** Facilitate the entry of novel technologies and business models to the market by issuing labels/seals for promising technologies [see proposal 7 above]. Certify compliance with new models of ESG standards [also as in proposal 7 above] for given key technologies.
- **Advising.** Support applications for IPCEIs and notifications of State aid schemes; in collaboration with EIB as appropriate, point to available public and private financing opportunities; offer advice on IPR protection and exports.

08. Osmotic energy is a non-intermittent renewable power source, with a fully local production chain. The EU hosts the only pre-industrial osmotic power projects in the world. Other world regions have acknowledged the potential of this technology and have started investing in commercial upscaling. To advance, the sector needs support to develop pre-commercial prototypes and, later, to scale up manufacturing capacity.

09. While EU innovation in building materials is accelerating (e.g. zero-carbon concrete and 3D-printed modular buildings), construction materials are highly capital-intensive and bringing innovation to scale-up production requires support. This category of clean technologies is supported in the US under the IRA.

10. The EU holds technological leadership in large heat pumps and invests in research for novel industrial applications and prototypes for industrial heat pumps operating at temperatures above 160°C. A local supply chain exists in the EU, but the market is still nascent (e.g. in 2019, only 19,000 heat pumps were in use in industry, compared to 20 million in buildings in 2022) and production is tailored to customers.

ENDNOTES

i IEA, Net Zero Roadmap: A Global Pathway to Keep the 1.5 °C Goal in Reach, 2023.

ii IEA, World Energy Investment, 2024.

iii IEA, Energy Technology Perspectives, 2023.

iv IEA, Advancing Clean Technology Manufacturing - An Energy Technology Perspectives Special Report, 2024.

v IEA, Energy Technology Perspectives, 2023.

vi IEA, Advancing Clean Technology Manufacturing - An Energy Technology Perspectives Special Report, 2024.

vii Ibid.

viii European Commission, Communication from the Commission to the European Parliament, the European Council and the Council – Report on EU policy initiatives for the promotion of investments in clean technologies (Preliminary assessment of measures taken by the EU to stimulate investment into clean technologies and the impact of the US Inflation Reduction Act on investment) (COM(2023) 684 final), 2023.

ix Based on BloombergNEF, IEA, 2024.

x European Commission, Joint Research Centre, 2024.

xi Regulation (EU) 2024/1735 of the European Parliament and of the Council of 13 June 2024 on establishing a framework of measures for strengthening Europe's net-zero technology manufacturing ecosystem and amending Regulation (EU) 2018/1724, 2024.

xii European Commission, Staff Working Document - Investment needs assessment and funding availabilities to strengthen EU's Net-Zero technology manufacturing capacity (SWD(2023) 68), 2023.

xiii European Commission, Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions Securing our future – Europe's 2040 climate target and path to climate neutrality by 2050 building a sustainable, just and prosperous society (COM(2024) 63), 2024.

xiv Solar Power Europe, New report: EU solar reaches record heights of 56 GW in 2023 but warns of clouds on the horizon – Press release, 2023.

xv Tapoglou, E., Tattini, J., Schmitz, A., Georgakaki, A., Długosz, M., Letout, S., Kuokkanen, A., Mountraki, A., Ince, E., Shtjefni, D., Joanny Ordonez, G., Eulaerts, O.D., Grabowska, M., Clean Energy Technology Observatory: Wind energy in the European Union - 2023 Status Report on Technology Development, Trends, Value Chains and Markets, Publications Office of the European Union, 2023.

xvi European Commission, (forthcoming) Clean Energy Technology Observatory (CETO), 2024 Status Reports.

xvii IEA, Advancing Clean Technology Manufacturing - An Energy Technology Perspectives Special Report, 2024.

xviii Carrara, S., Bobba, S., Blagoeva, D., Alves Dias, P., Cavalli, A., Georgitzikis, K., Grohol, M., Itul, A., Kuzov, T., Latunussa, C., Lyons, L., Malano, G., Maury, T., Prior Arce, A., Somers, J., Telsnig, T., Veeh, C., Wittmer, D., Black, C., Pennington, D., Christou, M., Supply chain analysis and material demand forecast in strategic technologies and sectors in the EU – A foresight study, Publications Office of the European Union, 2023.

xix Kim, T.-Y., Critical minerals threaten a decades-long trend of cost declines for clean energy technologies, 2022.

xx IEA, Solar PV Global Supply Chains, 2022.

xxi Carrara, S., Bobba, S., Blagoeva, D., Alves Dias, P., Cavalli, A., Georgitzikis, K., Grohol, M., Itul, A., Kuzov, T., Latunussa, C., Lyons, L., Malano, G., Maury, T., Prior Arce, A., Somers, J., Telsnig, T., Veeh, C., Wittmer, D., Black, C., Pennington, D., Christou, M., Supply chain analysis and material demand forecast in strategic technologies and sectors in the EU – A foresight study, Publications Office of the European Union, 2023.

xxii European Commission, Commission Staff Working Document – Investment needs assessment and funding availabilities to strengthen EU's Net-Zero technology manufacturing capacity (SWD(2023) 68), 2023.

xxiii European Commission, Communication from the Commission to the European Parliament, the European Council, the Council, the European Economic and Social Committee and the Committee of the Regions – A Green Deal Industrial Plan for the Net-Zero Age (COM(2023) 62), 2023.

xxiv Rhodium Group-MIT/CEEPR, Clean Investment Monitor.

xxv European Commission, Staff Working Document – Investment needs assessment and funding availabilities to strengthen EU's Net-Zero technology manufacturing capacity (SWD(2023) 68), 2023.

xxvi European Commission, Remarks by Executive Vice-President Maroš Šefčovič following the College meeting on EU-UK rules of origin on electrical vehicles and batteries, 2023.

xxvii European Commission, Commission opens €4 billion call for proposals for net-zero technologies under the Innovation Fund – Press release, 23 November 2023.

xxviii European Commission, Directorate-General for Competition.

xxix European Commission, Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions – EU wide assessment of the draft updated National Energy and Climate Plans An important step towards the more ambitious 2030 energy and climate objectives under the European Green Deal and RePowerEU (COM(2023)796), 2023.

xxx European Investment Bank, Investment Report 2022/2023: Resilience and renewal in Europe, 2023.

xxxi Georgakaki, A., Kuokkanen, A., Letout, S., Koolen, D., Koukoufikis, G., Murauskaite-Bull, I., Mountraki, A., Kuzov, T., Długosz, M., Ince, E., Shtjefni, D., Taylor, N., Christou, M., Pennington, D., Clean Energy Technology Observatory: Overall Strategic Analysis of Clean Energy Technology in the European Union - 2023 Status Report, Publications Office of the European Union, 2023.

xxxii Ibid.

xxxiii IEA, 2024

xxxiv IEA, Data and statistics, last updated 21 November 2022.

xxxv IEA, 2024

6. Automotive

The starting point

The automotive industry has traditionally been one of Europe's industrial engines. Nevertheless, the industry is undergoing rapid, profound transformation with a shift in demand to third markets, towards green mobility and 'software-defined cars'. As a result, the EU's traditional leadership in the automotive industry has been eroded. The automotive supply chain in the EU is currently suffering competitive gaps, both concerning cost and technology.

THE AUTOMOTIVE INDUSTRY'S ECONOMIC CONTRIBUTION

The automotive industry is a structurally important segment of the EU's economy[01]. It is a major employer, providing directly and indirectly (downstream industry) jobs for 13.8 million Europeans, representing 6.1% of total EU employment. 2.6 million people work directly in the manufacturing of motor vehicles, which is 8.5% of the EU's manufacturing employment. The automotive industry contributes 8% of European manufacturing value added, and it has a EUR 117 billion surplus in (extra-EU) trade, which corresponds to approximately one-fifth of the value of auto-

01. Information based on Eurostat (Structural Business Statistics, ComExt) for NACE 2-digit aggregate C29 (Manufacture of motor vehicles, trailers and semi-trailers), which comprises C29.1 (Manufacture of motor vehicles), C29.2 (Manufacture of bodies for motor vehicles; manufacture of trailers and semi-trailers), and C29.3 (Manufacture of parts and accessories for motor vehicles).

TABLE OF ABBREVIATIONS

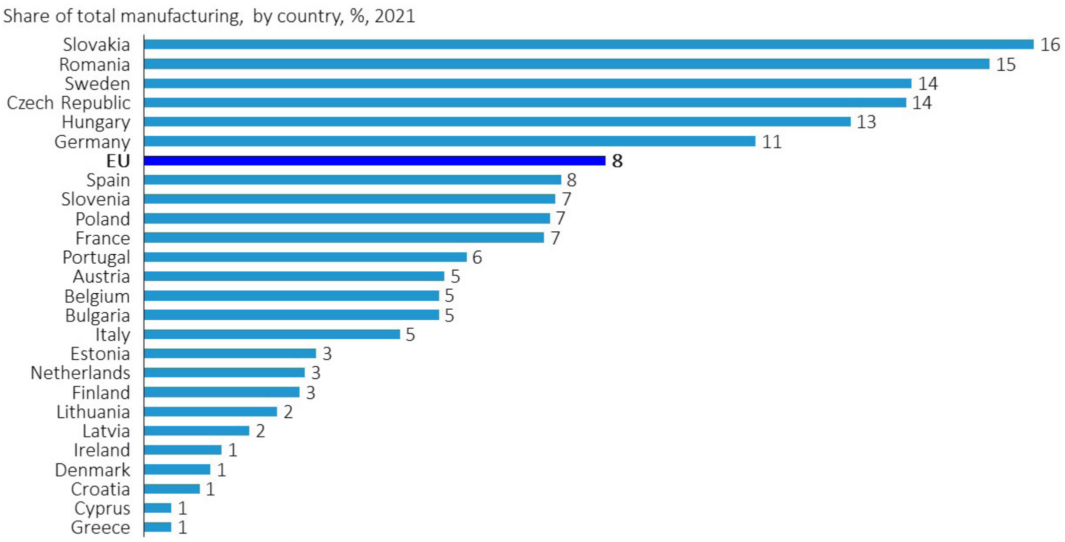
AD	Autonomous driving
AFIR	Alternative Fuels Infrastructure Regulation
AI	Artificial intelligence
ASEAN	Association of Southeast Asian Nations
BEV	Battery electric vehicle
CAPEX	Capital expenditure
CBAM	Carbon Border Adjustment Mechanism
CEF	Connecting Europe Facility
CO_2	Carbon dioxide
CSRD	Corporate Sustainability Reporting Directive
EBA	European Battery Alliance
ETS	Emissions Trading System
EV	Electric vehicle
FID	First industrial deployment
FTA	Free trade agreement
HDV	Heavy-duty vehicle
ICE	Internal combustion engine
IFR	International Foundation of Robotics
IPCEI	Important Project of Common European Interest
IRA	Inflation Reduction Act
LDV	Light-duty vehicle
MERCOSUR	Southern Common Market
MFN	Most favoured nation
NOx	Nitric oxide
OEM	Original equipment manufacturer
PHEV	Plug-in hybrid vehicle
PPA	Power purchase agreement
R&D	Research and development
RD&I	Research, development and innovation
RRF	Recovery and Resilience Facility
SDV	Software-defined vehicle
TEN-T	Trans-European Transport Network
UNECE	United Nations Economic Commission for Europe
WTO	World Trade Organization
ZEV	Zero-emission vehicle

motive production. The EU remains a net exporter of vehicles both in terms of the value of net trade and the number of vehicles, and it is also a net exporter of car parts. Around 75-80% of the value of vehicles traditionally comes from car part suppliers[i].

Automotive is a sector with important upstream and downstream linkages. The sector is an important source of input demand from upstream industries, such as metals, chemicals, plastics, and textiles, and it generates demand in downstream sectors, including ICT, repair, and mobility services.

The economic relevance of the automotive sector significantly differs across regions and Member States within the EU. Automotive accounts for only 0.5% of total manufacturing in Cyprus and Greece at the lower end, and 16% in Slovakia, at the upper end of the scale [see Figure 1][02].

FIGURE 1
The relevance of the automotive industry by Member State



Source: European Commission, 2024. Based on Eurostat, 2024.

The EU automotive industry has historically had a privileged international position and can count on many areas of excellence. Out of the ten biggest automotive companies in the world in terms of revenue, four have their headquarters in the EU[ii]. The sector is a good example of the advantages derived from the EU's Single Market, given the presence of highly integrated European supply chains. As an example, approximately 22% of the value added in the production of 'French-made' cars relies on inputs generated in other EU Member States, whereas in Germany, this figure accounts to 14%[iii].

Automotive is a leading sector in terms of innovation in Europe. The European automotive industry is R&D-intensive. More precisely, R&D spending amounts to around 15% of the industry's gross value added (which qualifies it as 'advanced manufacturing'). With a EUR 59 billion R&D budget (2021), it accounts for one third of European corporate R&D investment.

A SECTOR UNDERGOING PROFOUND TRANSFORMATION

The automotive sector is undergoing the biggest structural transformation in over a century. Its transformation combines an evolution in the industry's geographical footprint and the formation and convergence of multiple value chains (including the EV, digital, mobility and circular-economy value chains) which differ substantially from the production and the lifecycle of traditional internal combustion engine (ICE) vehicles[iv].

02. For a further (regional) breakdown, see: Hindriks, I., Hogetoorn, M., Rodrigues, M., Zani, R., Kaczmarzyk, I., Ravera, D., Gelibolyan, K., State of play and future challenges of automotive regions, European Committee of the Regions, 2024.

A shift in demand towards third markets, in line with the shift in the geography of global economic activity and the growth in per-capita incomes in emerging economies. The demand for cars has been on the rise in various global regions, notably in China, but is less dynamic in the EU, where the market is more mature and public transportation alternatives are generally more developed. As vehicles tend to be produced close to customer markets (including regional part supplier networks) to avoid trade and regulatory barriers, benefit from lower transport costs, and connect to the aftersales market, the shift in the geography of global demand away from Europe dampens the positive impact of world demand on production in the EU in terms of value added and employment[v].

The rise of electric vehicles (EVs). ICE markets have been shrinking and EV markets, comprising battery electric vehicles (BEVs), and plug-in hybrid vehicles (PHEVs), have been growing strongly in recent years. Globally, the market share of EVs in new passenger car sales has increased from 14% in 2022 to 18% in 2023, and it is expected to further expand to 30% in 2026[vi]. In 2023, EVs accounted for 22.3% of new car registrations in Europe (14.6% BEVs, 7.7% PHEVs)[vii]. The transition of automotive manufacturing towards EVs means a far-reaching change in the technology, production processes, skills demand and inputs needed by car manufacturers and supplier networks. Major industry reorientation is needed, including the reskilling of workers and leaner supplier networks, as well as the development of charging infrastructure. Electromobility eliminates not only tailpipe CO_2 emissions, but also other exhaust emissions (NOx, atmospheric particulate matter) and noise, which improves air quality, particularly in urban agglomerations[03].

Integration with the digital value chain. While automotives has been traditionally a 'hardware-based' mechanics industry, the value of vehicles is increasingly located in software. Estimates suggest that electronics and software may represent up to 50% of a cars' value in 2030[viii]. Artificial intelligence (AI) and digital technologies will change car-based mobility in the areas of connected vehicles, advanced controls for driver support, and autonomous vehicles [see the Box below]. The digitisation of vehicles requires new skills and infrastructure in automotive manufacturing and mobility services.

Integration with the mobility value chain. This includes the emergence of new business models, such as car sharing, new financing models, and energy services. The availability of charging and refuelling infrastructure for low-emission cars is a key enabling condition for the take-up and development of a large domestic market for EVs [see also the chapter on transport]. The European Commission's Impact Assessment for the 2040 climate targets quantifies overall investment needs for recharging and refuelling infrastructure of EUR 15 billion per year during 2031-50, based on an assumption of around 20% of zero- and low-emission vehicles in traffic by 2030[ix], of which around EUR 4 billion relate to fast-charging points along the Trans-European Transport Network (TEN-T) in line with the AFIR (minimum) targets.

Integration with the circular economy value chain in the automotive sector. Recovery and recycling of end-of-life materials relates especially to batteries, but also extends to other components (car bodies, electronics and plastics), where the EU can currently leverage a strong position in terms of the regulatory framework, collection networks, and technical know-how [see the chapters on critical raw materials and on energy-intensive industries for a discussion of the business case for circularity for various materials].

BOX 1

AI use cases in the automotive industry

The global automotive industry has been one of the earliest adopters of automation technologies, from assembly lines to industrial robots. It is one of the most automated industries (in terms of robot density)[04]. Automotive now stands as a industry that could leverage AI innovation to go beyond earlier automation and deliver a deep transformation of the way in which vehicles are designed, manufactured, operated and serviced.

03. Particle emissions from brake wear is also reduced in EVs due to regenerative braking, whereas the emission performance in terms of tire and road wear depends on the weight of the vehicle. The Euro 7 regulation on vehicle emissions (adopted in Spring 2024 and with the new norms applying from 2026-27 for LDVs and 2028-29 for HDVs) includes, for the first time, non-exhaust emissions (microplastics from tyres and particles from brakes) and includes minimum requirements for battery durability in EVs and hybrid cars.

04. According to data from the International Foundation of Robotics (IFR), there were almost 3,000 robots per 10,000 workers in the automotive industry in South Korea, and around 1,500 in Germany and the US in 2021.

- **AI can optimise the development, prototyping and production of cars and components**. AI-powered (generative) algorithms can enhance vehicle design by optimising structures and components, and improve performance, while reducing weight and material use. AI-driven predictive analytics can help to anticipate breakdowns and to predict car part depreciation and maintenance needs, allowing for proactive servicing and the optimisation of maintenance intervals, minimising downtime. AI can also facilitate vehicle testing and homologation, including through the automatic generation of documentation. More broadly, AI can improve automotive supply chains by predicting demand, reducing lead times, streamlining logistics operations, thereby lowering costs (including overhead) and raising quality for manufacturers and suppliers. AI has the potential to reduce equipment failure on assembly lines, lower maintenance costs, increase the accuracy of the detection of quality problems, reduce inventories, accelerate the time to market in R&D, and increase labour productivity[x].
- **AI can be used for driver assistance and warnings to fully automated driving**. Deep learning models and neural networks enable vehicles to perform driver awareness monitoring, object detection and avoidance, lane keeping and emergency braking, traffic sign recognition, speed adaptation and cruise control, parking assistance, and fuel or power efficiency assistance. In advanced forms used today, assistance programmes are taking over cars for short times, while drivers retain the possibility to take back control. However, AI holds promise for the development of fully autonomous cars (i.e. vehicles cruising autonomously in all circumstances), which currently exist only as prototypes, by 2030. In this context, AI models can help to reduce the environmental impact of driving by maximising engine or battery performance, reduce emissions, and enhance fuel efficiency compared to conventional vehicles.
- **AI facilitates the collection and analysis of data for post-production services and drivers' risk assessment**. This includes cybersecurity and the protection of car-related IT systems, but also AI-powered services to assist drivers, for example, insurance and claims settlement.

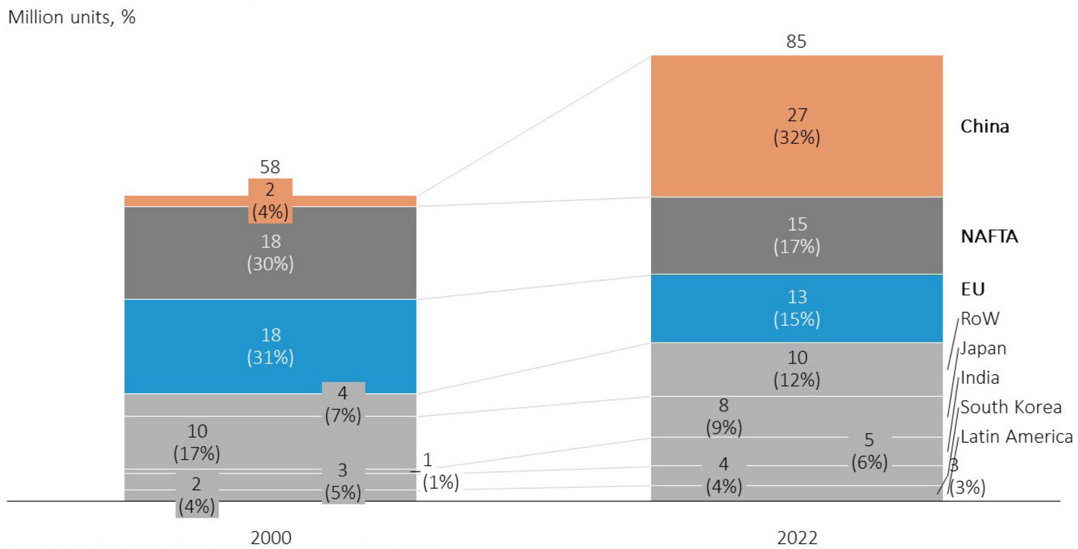
While the AI revolution is underway, most Original Equipment Manufacturers (OEMs) have started with pilot projects or proofs-of-concept. Tapping the future potential of AI still faces multiple challenges:

- **Access to quality data to train algorithms**. Current assisted driving and future autonomous driving requires a large range of driver data to assess situations and improve AI interventions. However, incentives for data sharing within the industry, while key to improve the precision and quality of the services, are limited.
- **Supportive legal frameworks**. The large data needs of AI in the automotive sector, including drivers' data, raise questions concerning data ownership and confidentiality. In addition, road access for automated vehicles is fragmented. Type approval of vehicles was harmonised within the EU framework for car homologation in 2022, but road access regulation remains a national competence. Road access for highly or fully automated cars is allowed only in a few Member States under very restricted conditions in terms of the authorised areas and the number of vehicles. Legislation also differs across Member States regarding legal liability (the 'driver' or the manufacturer) and insurance coverage in case of damage. Similar to the EU, road access is a State-level competence in the US, and legislation is fragmented within the country. China recently adapted its legislation to allow the deployment of automated vehicles in public transport, but always requires a back-up driver able to intervene.
- **Market-oriented R&D to nurture disruptive innovation and expedite AI uptake**. There is a need to support disruptive innovation and new hardware applications for the automotive sector created by start-ups and research teams. For example, development could be supported by public-private partnerships, bringing public actors and OEMs together with EU companies active in the field of AI. Key use cases and applications maximising value added and socioeconomic impact in the EU could be the focus of this model for collaboration.

THE EU'S ERODING COMPETITIVE POSITION

In this fast-moving context of shifting demand and value chain reconfiguration, the EU's position in the sector already shows signs of eroding competitiveness. The number of vehicles produced in the EU has been declining over the past two decades [see Figure 2], while the number of vehicles produced in China has been growing fast. After accounting for the increased quality and value of cars, also the production in EU automotive at constant prices declined in 2019 and during the COVID-19 pandemic, and it has not yet recovered to previous levels[xi]. EU vehicle exports in unit terms have fallen from 7.45 million vehicles sold abroad in 2017 to 6.26 million in 2022, a decline by 16%[xii].

FIGURE 2
The shift in vehicle production

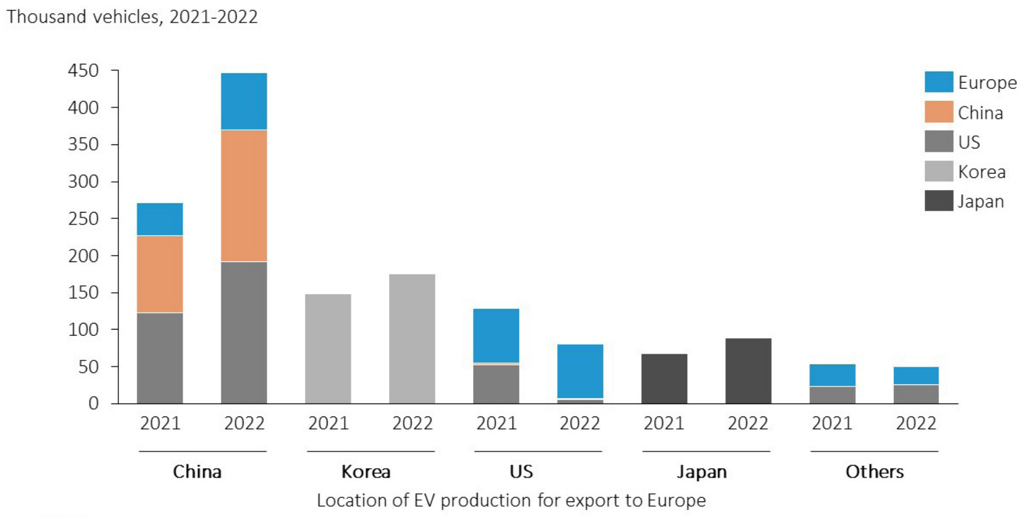


Source: European Commission, 2024. Based on International Organization of Motor Vehicle Manufacturers, 2023.

At the same time as vehicle production in the EU weakened, EU vehicle imports from China have increased strongly. China is now the largest source of car imports into the EU in terms of the number of cars (a fivefold increase from 114,000 vehicles in 2017 to 561,000 in 2022). In 2022, China accounted for 14% of the vehicles imported into the EU, making it the biggest non-European supplier[xiii]. In particular, the EU is lagging in the fast-growing 'New Energy Vehicle' space (BEVs and PHEVs). European brands accounted for only 6% of BEV sales in China in 2022 (compared to 25% of ICE vehicle sales). Conversely, Europe is leaving room in this area of the market. Chinese brands accounted for almost 4% of BEV sales in the EU in 2022, up from just 0.4% three years earlier[xiv]. Moreover, Chinese carmakers' market share for EVs (BEV and PHEV) in Europe has risen from 5% in 2015 to almost 15% in 2023. By contrast, the share of European carmakers in the European EV market (new registrations) has fallen from 80% to 60% during the same period[xv].

FIGURE 3

Electric car imports to Europe by country of production and manufacturer headquarters



Source: IEA, 2023.

Automotive production in the EU is suffering from higher costs, lagging technological capabilities, increasing dependencies, and eroding brand value. Estimates suggest approximately 30% higher overall vehicle productions costs in the EU compared to China, with significant differences in transformation cost between EU Member States. Chinese OEMs are one generation ahead of Europeans in terms of technology in virtually all domains, including EV performance (e.g. range, charging time, and charging infrastructure), software (software-defined vehicles, autonomous driving levels 2+, 3 and 4), user experience (e.g. best-in-class Human Machine Interfaces and navigation systems), and development time (e.g. 1.5 to 2-year development time, compared to three to five years in Europe). As discussed in the chapter on critical raw materials, it is estimated that, without action, only a very minor share of European raw material needs will be covered by projects in Europe by 2030. China, to the contrary, will control most of the upstream value chain (including more than 90% of lithium refining capacity at present, and more than 70% of the supply of lithium-ion battery cells). Innovative EVs have, finally, also eroded brand value and customer loyalty towards EU companies, as indicated by the decline in market share of European OEMs.

In the context of these transformation challenges and the reshuffling of global demand, EU producers have been undergoing changes at the company level. This includes the slicing of cross-border operations (differentiation between headquarters, production, and sales) that allows firms to operate close to the respective customer markets and exploit location-specific advantages. Most EV exports from China to the EU in 2021-22, e.g., concerned brands headquartered in either the EU or the US[05] [see Figure 3]. At the same time, foreign ownership of European brands' equity has increased (e.g., Chinese investment in Volvo, MG).

Beyond OEMs, the transition from ICE vehicles to EVs, and particularly BEVs, has also far-reaching implications for the network of car part suppliers. Traditional ICE vehicles are mechanically more complex, notably with respect to the mechanical components of the powertrain, and car part suppliers highly specialised in this environment have provided largely complementary products in the past. BEV powertrains, by contrast, are more compact and easier to manufacture, and suppliers therefore increasingly compete in this area to provide OEMs with similar components. This increased competition among suppliers threatens their existence. Competition in the supplier market is reinforced by new entrants from outside the industry (e.g. manufacturers of electric engines, electronics, software, and batteries) and through the insourcing by OEMs of car part production to keep their staff, given reduced demand for classical manufacturing jobs (metal and machinery workers) in BEV production[xvi]. Similarly, more software and data-driven vehicles are likely to affect the ability of car part suppliers to compete with OEMs in the after-market (maintenance and other services). In areas in which the transition from ICE cars to BEVs fundamentally alters car part demand (notably the engine or powertrain), existing production sites may be closed and rebuilt in different

05. This pattern still held in 2023, although the share of Chinese-owned brands in EU imports from China has increased further. See: Rhodium Group, Ain't no duty high enough, 2024.

locations, depending on relative investment and production costs, instead of converting existing facilities. From the perspective of global competition, many European car part producers have been global market leaders in their market segments, but Chinese OEMs are catching up to produce vehicles using less content from European car part suppliers[xvii].

THE ROOT CAUSES OF THE EU'S EMERGING COMPETITIVENESS GAP

Multiple factors are driving the loss of EU competitiveness in the automotive sector. EU climate policies set ambitious targets for low-carbon road transport (primarily EVs), as well as for the production of less polluting ICE vehicles. However, the EU's supply chain is taking time to adjust. At the same time, China has moved faster and at a larger, coordinated scale across the entire EV value chain and can now enjoy lower costs (know-how, economies of scale, lower labour costs) and a technological edge. By contrast to the EU, the US has reacted with large stimulus (IRA) combined with trade barriers to respond to an increased global supply of Chinese EVs.

The EU's climate policy is demanding ambitious targets from the automotive sector in terms of GHG emission reduction for road transport. These targets set in motion a shift to zero tailpipe CO_2 emissions for new LDV (car and van) registrations by 2035. Furthermore, they introduce a target to reduce HDV (truck and bus) tailpipe CO_2 emissions for newly registered vehicles by 65% by 2035, and by 90% by 2040 compared to 2019 values. At the same time, more stringent norms are being introduced to produce less polluting ICE vehicles, including Euro norms entailing a reduction of exhaust and particle emissions. In addition to this, national or local authorities in Member States have established vehicle emission limits for urban access (Urban Access Regulations). Starting in 2027, road transport will also be integrated in the EU Emission Trading System (ETS 2) by including emissions from transport fuels. The costs of ICE vehicle mobility will raise by implication, strengthening the incentives for the adoption of low-emission cars, especially BEVs.

Multiple pieces of legislation have overlapped during the past decade, and more can be expected in the incoming years towards 2030. Legislation has not always been fully coherent. Some examples include: i) CBAM excludes Scope 3 emissions (indirect emissions embodied in production inputs and not under direct control of the company), whereas the Corporate Sustainability Reporting Directive (CSRD) includes them. This difference in criteria and examination processes for carbon impact implies that the same imported material can have different CO_2 figures attached to it under the two regimes, with additional monitoring and reporting costs, and it illustrates a certain arbitrariness in the assessment of carbon footprint; ii) another example is the (parallel) reporting requirements in the CSRD, which relate to the GHG emission footprint of enterprises, as opposed to disclosure requirements in the Batteries Regulation, which relate to the GHG emission footprint of batteries relative to the energy they provide over the life cycle, raising the question of the appropriate criterion to assess the environmental performance of a battery producer. Furthermore, legislation has not always been properly assessed with the contribution of all relevant stakeholders (e.g. the Euro 7 impact assessment was shared before and has been challenged afterwards by the industry). New legislation has been initiated by different Commission services (e.g. DG GROW, TRADE, CLIMA, ENV and FISMA) without a one-stop clearing house assessing the timing of the implementation and its impact on the industry.

The EU emission legislation has not succeeded so far in reducing CO_2 emissions from road transport. Despite 90% reduction of pollutants per car from Euro 1 to Euro 6 emission norms, CO_2 emissions from road transport (passenger cars) have increased by more than 20% between 1990 and 2019[xviii]. This is due to the increased number of registered cars and the fact that cars have gotten bigger and heavier on average (60% heavier since 1990)[xix]. There has been a decline in the average CO_2 emissions (per km) from newly registered cars in recent years, however, linked to the increase in EV registrations[xx].

The technological neutrality principle, which has been a guiding principle of EU legislation, has not always been applied in the automotive sector. With the latest review of the legislation setting CO_2 emission standards for vehicles based on a 'tank to wheel' approach, the EU has set up a framework for the rapid market penetration of zero-emission vehicles (ZEV), and in particular BEVs. The CO_2 emission standards for LDVs and HDVs regulate emissions at the tailpipe. The ambitious target of zero tailpipe emissions by 2035 will lead to a de facto phasing out of new registrations of LDVs with internal combustion engine (ICE)[06]. The legislation also includes the call for the Commission to make a proposal allowing the registration of vehicles running on CO_2 neutral fuels after 2035. Carbon neutral alternative fuels would be based on a net or life cycle emission assessment [see the Box on alternative fuels][07]. Related regulations outside the EU vary across countries. Targets in the U.S., for example, are more varied or softer (no nation-wide regulation, but nine States plan to ban ICE car sales starting in 2035)[xxi]. Following additional provisions in the legislation on CO_2 standards for LDV, the European Commission is also working on a methodology (by 2025) for those manufacturers who may want to report voluntarily data on CO_2 emissions throughout the full lifecycle of cars and vans sold in the EU market. The carbon footprint of EVs (emissions associated with the production of the vehicle and its components) is generally higher than the one of ICE vehicles at the production stage, due to the energy intensity and the carbon footprint in battery manufacturing at current technologies (including raw material mining and processing)[xxii,08].

BOX 2

The potential of alternative fuels

The EU defines 'alternative fuels' as fuels or power sources, which serve (at least partly) as a substitute for fossil oil sources in the energy supply for transport, and which have the potential to contribute to the decarbonisation and enhance the environmental performance of the transport sector.

Battery electric vehicles (BEVs) are the dominant decarbonisation technology and generally considered to be the future of road transport under the net-zero emissions target, especially from a tank-to-wheel perspective. Nevertheless, other alternatives to gasoline and diesel fuels are available for specific fleet segments (heavy duty vehicles, critical services and infrastructure, regions with underdeveloped EV charging infrastructure), or to reduce carbon emissions in road transport for the existing fleet of ICEs.

By their consistency, alternative fuels can be split into liquid fuels and (liquified) gases. The various fuels vary with respect to their potential to reduce GHG emissions, their energy efficiency (energy released during combustion compared to energy needed for fuel production), and their technical and infrastructure requirements[xxiii].

Liquid fuels: biodiesel, renewable diesel, ethanol, and e-fuels

- **Biodiesel** is a renewable non-hydrocarbon fuel produced from vegetable oils or animal fats reducing lifecycle GHG emissions because CO_2 from combustion is (partly) offset by CO_2 absorbed from growing the feedstocks used to produce the fuel. Biodiesel is blended with petroleum diesel for use in diesel vehicles, and it relies on the same infrastructure for distribution.
- **Renewable diesel** ('synthetic diesel') is a fuel made from fats and oils (biomass), but it is processed to be chemically the same as petroleum diesel, with reduced CO_2 and NOx emissions. It can be used as replacement fuel or blended with any amount of petroleum diesel (use in standard diesel cars). Renewable diesel is fully compatible with the infrastructure for petroleum diesel distribution.
- **Ethanol** can be produced as a renewable fuel from various feedstocks (e.g. corn and cellulose). From a lifecycle perspective concerning emissions, CO_2 released by burning ethanol is offset (partly, depending

06. An overall assessment of EV driving emissions would also have to consider the emission intensity of electricity generation at the margin. See: Rapson, D., Bushnell, J., 'The Limits and Costs of Full Electrification', Review of Environmental Economics and Policy, Vol. 18, No. 1, 2024, pp. 26-44. Rapson, D., Muehlegger, E., 'The Economics of Electric Vehicles', Review of Environmental Economics and Policy, Vol. 17, No. 2, 2023, pp. 274-294, emphasise that the optimal BEV subsidy from the perspective of emission externalities would depend on the emission intensity of electricity generation.

07. CO_2-neutral fuels could emit at the tailpipe amounts of CO_2 previously absorbed during the production of the fuel. On the limits of alternative fuels and the importance of future innovation, see also the discussion in: Rapson, D., Muehlegger, E., 'Global transportation decarbonisation', Journal of Economic Perspectives, Vol. 37, No. 3, 2023, pp. 163-188.

08. Improving circularity (recycling) in battery production, by implication, carries the potential to substantively reduce the emission footprint of EV production. See: Linder, M., Nauclér, T., Nekovar, S., Pfeiffer, A. and Vekić, N., The race to decarbonize electric-vehicle batteries, McKinsey & Company, 2023.

on the feedstock) by CO_2 captured by growing feedstock crops. Low-level blends (up to 10% ethanol, and rest gasoline), can be used in any conventional gasoline vehicle with the same infrastructure for distribution. Higher concentrations of ethanol in fuel require flexible-fuel vehicles, with some possibility for retrofitting.

- **E-fuels** (electrofuels, or 'synthetic fuels') are hydrocarbon fuels that are produced from hydrogen and CO_2. The CO_2 can be taken from carbon capture, or biomass. E-fuels can be used to replace fossil fuels or be blended (e.g. with any amount of petroleum diesel for use in standard diesel cars). E-fuels are fully compatible with the infrastructure for petroleum fuel distribution. The combustion of e-fuels emits CO_2 captured during production. E-fuel production is energy-intensive and less energy-efficient than the direct use of electricity for driving (BEVs).

The use of biomass-based fuels is limited by the available biomass and the land needed to grow the necessary feedstock. Biofuels compete with alternative and prioritised land and crop uses. The performance of alternative fuels compared to BEVs in terms of GHG emissions reduction, compared to electric powertrains, depends largely on the energy mix used in electricity production.

(Liquified) gases: natural gas, propane, and hydrogen

- **Renewable natural gas** (biogas) and conventional natural gas must be compressed or liquefied for use in vehicles. The use of biogas reduces methane emissions in the atmosphere, whereas burning natural gas lowers CO_2 emissions to some extent compared to gasoline. The use of natural gas as fuel requires natural gas vehicles, with the possibility of retrofitting, suitable mainly for HDVs given the required tank size. A separate fuelling infrastructure would be needed compared to gasoline and diesel.
- **Autogas** is a gas (propane and butane) produced as a byproduct of natural gas processing and crude oil refining. It can reduce the amounts of some harmful air pollutants and GHG emissions compared to conventional diesel and gasoline, but it requires suitable vehicle models that are available mainly for heavier duty. Autogas also requires a separate fuelling infrastructure, which is partly in place within the EU with a network of over 46,000 filling stations and over 15 million vehicles running on propane.
- **Hydrogen** releases no GHG emissions from burning. Contrary to the use of other fuels in combustion engines, hydrogen combustion in a fuel cell produces electric power that is then used to feed an electric engine. The low energy content of hydrogen requires high pressure, low temperatures, or chemical processes for compact storage. A different infrastructure is required for fuelling. GHG emissions over the lifecycle depend on the energy used for hydrogen production, but the energy efficiency remains lower than for direct electrification.

The push towards rapid market penetration by EVs has not been followed in the EU by a synchronised push towards the conversion of the supply chain. In the mid-2010s, several Member States started to provide incentives for the adoption of electric vehicles (purchase subsidies, tax incentives, and infrastructure development). However, the European Commission only launched in 2017 the European Battery Alliance (EBA) to build a sustainable battery value chain in Europe – covering all steps from access to raw materials to battery recycling. The EBA strives to reduce the dependency on imports and to strengthen the EU's competitiveness in the rapidly growing battery market.

By contrast, at the same time as the EU introduced new legislation, China has pursued a strategy aiming to dominate the global auto industry. The 'Made in China 2025' strategy[09] and the '14th Five-Year Plan' covering the period 2021-25 declared New Energy Vehicles a strategic industry[xxiv]. China has focused on the development and deployment of BEVs since 2012 with large and simultaneous investments (at least EUR 110-160 billion by 2022) in all

09. While 'Made in China 2025' has expanded capacity and employment in Chinese manufacturing, there is little systematic evidence for associated gains in productivity, innovation, and company profitability. See: Branstetter, L., Li, G., 'Does "Made in China 2025" Work for China? Evidence from Chinese Listed Firms', NBER Working Paper No. 30676, 2022. Branstetter, L., Li, G., Ren, M., 'Picking Winners? Government Subsidies and Firm Productivity in China', NBER Working Paper No. 30699, 2022.

the industries involved in the EV lifecycle, from raw materials mining to battery production and recycling (see also the clean technologies chapter). In particular, China has secured access to volatile and concentrated raw material markets and has developed at scale the required battery production capacity, at the beginning privileging lower production costs over higher performance. In addition, China has employed various strategies to encourage foreign automotive OEMs to produce and sell in the Chinese market, or form partnerships with Chinese OEMs (e.g., through joint ventures, or technology transfer agreements). Policy has defined common standards and facilitated access to technologies, data, and resources for automotive production. In addition to the supply push, China has created a large domestic market for EVs. China is today the largest market for EVs, having accounted for 60% of new EV registrations worldwide in 2023, which allows Chinese producers to reap economies of scale in production.

The US has reacted to the ascent of China's EV industry by increasing import barriers and targeted stimulus to the domestic value chain. The US standard Most Favoured Nation (MFN) import tariff for passenger cars is 2.5%, but tariffs on car imports from China are 27.5%. The latter was recently increased to 100% for EVs from China. The US has stimulated investment throughout the value chain, starting upstream [as discussed in both the chapters on critical raw materials and clean technologies], particularly through producer and consumer tax credits in the Inflation Reduction Act (IRA). As an example, considering gigafactories, investment in the US used to require USD 90 million in private financing per GWh before IRA. Now, US investment only needs USD 60 million in private financing, like China, with the IRA helping to bridge the gap. In Europe, the average CAPEX required is still about EUR 80 million/GWh.

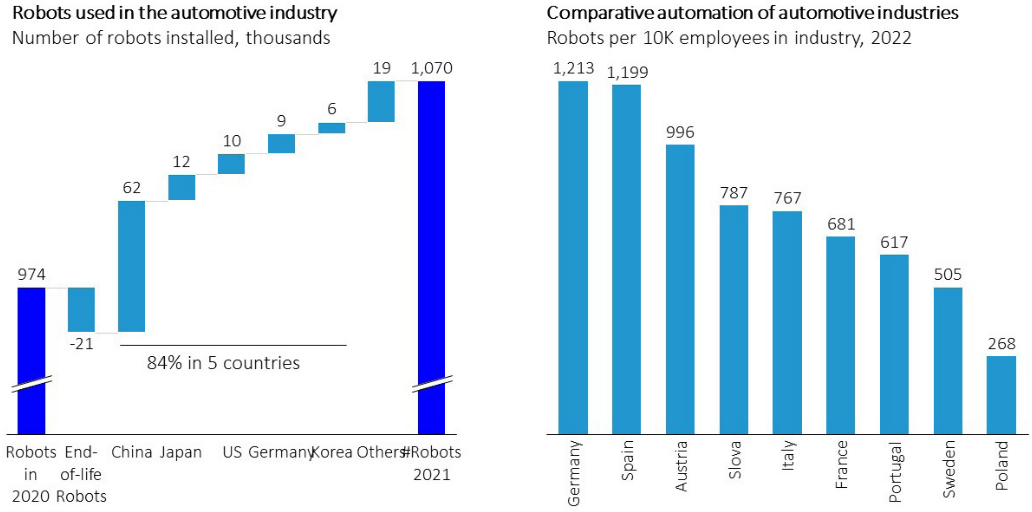
The EU has also increased tariffs on EV imports from China recently. In July 2024, the European Commission has imposed provisional countervailing duties ranging from 17.4% to 37.6% on imports of BEVs from China, on top of the existing 10% overall import duty for cars, based on the conclusion that BEV production in China benefitted from unfair subsidisation. Consultations continue with a view to reaching a solution that addresses the concerns raised by the EU. The provisional duties will apply for a maximum duration of four months, within which a final decision must be taken on definitive duties (for a period of five years), through a vote by EU Member States (with the Commission proposal being adopted unless there is qualified majority against it)[10].

Operational expenses also affect the cost competitiveness of EU car manufacturing in addition to higher investment costs. Structurally higher energy costs [see the chapter on energy] and labour costs (up to 40% higher nominal unit labour cost in the EU compared to China)[11] today contribute to the serious competitive disadvantage for the EU on the cost side. Higher energy costs are especially relevant for the energy-intensive battery production. Labour is becoming an increasing bottleneck for the automotive transition, not only in terms of labour costs, but also because of relevant skills shortages. The automotive industry is a leader in robotisation, accounting for around one-third of industrial robot installations per year. China is investing substantial amounts in robotisation, despite having lower labour costs than Europe [see Figure 4]. Automation tends to substitute lower-skilled workers, such as assemblers, machine operators or metal workers. Projections for 2020-30 expect engineering and ICT occupations to account for 90% of job growth in the EU's automotive industry (90,000 jobs). In the labour market, the automotive sector will then compete increasingly with all other sectors employing ICT skills at an increasing scale[xxv] [see also the chapter on skills].

10. The EU decision is based on Regulation (EU) 2016/1037 on the protection against subsidised imports from countries not member of the European Union. Estimates by Felbermayr, G., Friesenbichler, K., Hinz, J., Mahlkow, H., 'Time to be Open Sustainable, and Assertive: Tariffs on Chinese BEVs and retaliatory measures', Kiel Policy Brief, No. 177, 2024, suggest that additional tariffs of 21% on average on BEV imports from China would reduce car imports from China by 42% and increase value added in the EU car industry by 0.4% in the long run.

11. OECD data show that nominal unit labour costs, i.e. nominal wage costs divided by output volume, in the motor vehicles industry were 30%-40% higher in the EU compared to China in 2010-2018.

FIGURE 4
Automation in the automotive industry



Source: IFR Robotics, 2022.

The limited affordability of EVs constitutes a persistent barrier to greater overall fleet modernisation. There is a 'price premium' on EVs. The cheapest available new EV on the European market in 2023 was 92% more expensive than the cheapest available ICE car, and the price premium was still higher in the US market (146%). The problem of affordability has been addressed in China, to the contrary, where the cheapest available EV is 8% less expensive than the cheapest ICE car (i.e. a negative EV premium).[12] Higher EV prices compared to those for ICE vehicles in the same market segment reflect especially the higher costs of batteries and electric powertrains compared to the ICE engine. This engine-related cost gap becomes more important in terms of overall costs for smaller cars, where batteries account for approximately 40% of total material costs. Recent survey results for EU Member States identify higher prices as the key impediment to private Battery Electric Vehicle (BEV) uptake. The 2024 consumer survey of the European Alternative Fuels Observatory[xxvi] suggests that many drivers of non-electric vehicles would consider buying a BEV if models in the price range of EUR 20,000 were available[13]. Further impediments for EV uptake are the low residual value of EVs and higher insurance premia. In addition, insurance premia for EVs tend to be higher than for ICE cars, due to higher average damage, and repair or (battery) replacement costs[xxvii].

Low EV uptake in the corporate car segment is also holding back the European BEV market. Corporate cars account for 60% of EU sales have a higher turn-over than cars in the private vehicle market. Company cars tend to drive longer distances, implying larger CO_2 savings from electrification. Taxation of company cars is a key factor to push for EV take up[xxviii].

Bottlenecks with respect to the charging infrastructure remain and risk dampening EV uptake too. The installation of charging infrastructure for electric passenger cars and vans (LDVs) has increased in recent years, and the market has become increasingly competitive. Charging capacity (the location and number of public charging points, multiplied by their performance) still varies across Member States, in close correlation with the uptake of EVs [see also the chapter on transport]. An increase in the number of EVs throughout Europe will require a large and

12. While average EV retail prices have risen in the EU and the US since 2015, they have fallen in China. Factors behind the EU-China differential in EV premia are Chinese industrial policy, including the early-mover advantage and related economies of scale in EV production, lower battery manufacturing costs in China, and the fact that small EVs in China have smaller batteries and lower range (city cars) than small European EVs. In the European market, Chinese EVs sell at higher prices than the same model in the Chinese market, which reflects trade costs, but also some pricing to market. See: Lyon, V., Le Mouëllic, M., Weber, T., Heller, K., Rahme, R., Spitzbart, J., Salomon, N., Sbai El Otmani, H., The High-Stakes Race to Build Affordable B-Segment EVs in Europe, Boston Consulting Group, 2023. JATO Dynamics, The EV price gap: A divide in the global automotive industry, 2023. Rhodium Group, Ain't no duty high enough, 2024.

13. In particular, two thirds of the survey participants find BEVs currently too expensive. The price that the medium respondent would be willing to pay for a BEV is EUR 20,000 compared to EUR 15,000 for an ICE vehicle. In March 2024, there were 115 BEV models (and 286 model variations) with a range between 300 km and more than 600 km available in the EU, but only 13 (mostly small) BEV models with a purchase price between EUR 20,000 and EUR 35,000 and an average range of around 200 kilometres. The survey respondents also considered range an important limitation of current BEVs, after the higher price. 34% indicate a minimum desired range of 300-500 km, and 47% of 500 km and more ('range anxiety').

geographically broader roll-out of charging capacity[14]. The conditions for the electrification of heavy-duty vehicles (HDV), requiring more powerful chargers, are still more complicated, as discussed in the transport chapter. While there are clear regulatory frameworks for carmakers (emission targets) and corporate logistics (corporate sustainability reporting, inclusion of road transport in ETS 2) that increase the demand for EVs and charging infrastructure, there is no parallel obligation for energy providers to supply stable and powerful grid access of sufficient capacity for charging.[15] Access to space may also become a relevant constraint for charging infrastructure (urban areas, motorways) as the fleet grows, which would call for fast charging options, in turn requiring a more powerful grid.

In this context, if the EU is not able to rapidly adjust to this new competitive environment, the automotive sector may lose ground at an even faster pace. According to some industry experts, even more than 10% of local EU production may be displaced in the following five years.

14. Currently, there are around 4.7 million BEVs and 3.5 million PHEVs registered in the EU. Modelling for the 2040 climate target plan projects around 42 million BEVs and 14 million PHEVs in the EU by 2030, and 160 million BEV and 31 million PHEV in 2040. There are, at present, around 660,000 publicly accessible charging points with an average power output of above 30 kW. At an average power output of 30 kW per recharging point, the fleet-based targets in the Alternative Fuels Infrastructure Regulation (AFIR) would require around 2.2 million charging points by 2030 and 7.7 million by 2040. Currently, Member States tend to fulfil their targets for network density given the number of registered EVs, but 80% of charging is done at private properties (home, workplace, depots). The aim of the binding AFIR targets is to achieve a sufficient minimum roll-out of charging infrastructure throughout the EU to ensure a basic recharging capacity. Market forces are expected to deliver any additional infrastructure where required, based on market demand. Data are from the European Alternative Fuels Observatory. Data for network density across EU Member States can also be found in IEA, Global EV Outlook 2023, 2023.

15. The need for a cross-industry (charging points, electric grids, electricity generation) and cross-country perspective (density, interconnectivity) in the development of charging infrastructure is also emphasised in ACEA, European EV Charging Infrastructure Masterplan, 2022.

Objectives and proposals

To ensure that the EU remains a leader in the global automotive industry, preserving jobs, R&D facilities, and manufacturing within the region, two key objectives should be pursued with different time horizons:

- In the short term, avoid the radical displacement of production away from the EU's automotive sector or the rapid takeover of EU plants and companies by State-subsidised competitors.
- In the medium term, re-establish a competitive leading position for the EU for the 'next generation' of vehicles and maintain the European production base with current technological advantages as long as international markets show demand.

To achieve these objectives, the European automotive industry needs to supply vehicles that are affordable for internal consumption and attractive in export markets, across segments. Proposals with different time horizons include short-term measures to maintain competitive transformation costs in the EU, as well as short-term measures to reduce regulatory burden, ensure coherence, predictability and appropriate timing and consultation for future legislation. Moreover, short-to medium-term measures are needed to relaunch a competitive ecosystem for the future of the automotive industry overall. For example, coordination and integration need to be increased along the value chain (e.g. from minerals to batteries) and through horizontal enablers (e.g. digital and AI), as well as by reinforcing standards, and addressing innovation gaps and re-skilling needs.

FIGURE 5

	SUMMARY TABLE AUTOMOTIVE PROPOSALS	TIME HORIZON[16]
1	Ensure competitive transformation costs, starting with energy sourcing and labour automation.	ST/MT
2	**Develop an EU industrial action plan for the automotive sector, increasing coordination both vertically and horizontally in the value chain.**	**ST/MT**
3	**Ensure regulatory coherence, predictability and appropriate timing and consultation for upcoming regulation. Adopt a technology-neutral approach in the review of the Fit-for-55 package.**	**ST/MT**
4	Encourage standardisation.	ST
5	Set up reinforced Net-Zero Acceleration Valleys dedicated to the automotive ecosystem.	MT
6	Support the development of recharging and refuelling infrastructure.	MT
7	**Ensure that a coherent digital policy for the automotive sector is in place, encompassing the data ecosystem and AI development needs.**	**MT**
8	Support common European projects in the most innovative areas, such as affordable European EVs, software-defined vehicle and autonomous driving (SDV and AD) solutions of the future, and the circularity value chain.	ST/MT
9	Bridge skills gaps and address reskilling needs.	ST/MT
10	Level the global playing field and enhance market access.	MT

16. Time horizon is indicative of the required implementation time of the proposal. Short term (ST) refers to approximately 1-3 years, medium term (MT) 3-5 years, long term (LT) beyond 5 years.

1. **Ensure competitive transformation costs.** Transformation costs depend mainly on energy and labour costs, on the level of automation, and the overall productivity of operations.

   To achieve the security of supply while decarbonising electricity generation, it will be fundamental to [see the chapter on energy for more detail]:

   - Strengthen clean energy supply, including generation, storage, and grid infrastructure.
   - Promote long-term power purchase agreements (PPAs). This will provide possibilities on the demand side to insulate corporate energy costs from short-term price fluctuations on commodity markets.

   Further automation in the automotive industry (e.g. beyond production) has the potential to raise labour productivity and soften constraints concerning labour shortages. To achieve this, it will be necessary to:

   - Level the playing field with competitors when automation is subsidised. As discussed, our competitors show higher labour productivity also because of higher degrees of automation, sometimes in spite of lower labour costs and thanks to subsidies.
   - The recommendations on adult learning and curricula in the chapter on skills could contribute to more and improved skills in relation to automation and robotisation.

2. **Develop an EU industrial action plan for the automotive sector, increasing coordination both vertically and horizontally in the value chain.** Europe lacks a targeted and forward-looking industrial strategy in the automotive sector, addressing, in particular, the question of how to compete with China and the US, which both substantially support their automotive industries. With the convergence of multiple value chains (EVs, digital, mobility and circularity), a comprehensive approach is needed covering all stages – from R&D to mining and supplying raw materials, refining, components, data sharing, manufacturing, and recycling.

   The Competitiveness Coordination Framework could be used to reach a greater level of coordination among policies on the supply of raw materials, on clean technologies, energy, infrastructure development, AI and data management, and trade. Such coordination would be supported by the Competitiveness IPCEIs, Competitiveness Joint Undertakings (as defined in the governance chapter)[17], targeted public support to investments, and policy and regulatory reforms where needed.

3. **Ensure regulatory coherence, predictability, appropriate timing, and consultation for upcoming regulation. Adopt a technology-neutral approach in the review of the Fit-for-55 package.**

   As put forward in the chapter on governance, it is important to **ensure consistency of legislation across the value chain** - e.g., reconciling restrictions on the use of certain chemicals with the build-up of a circular battery value chain. Furthermore, reporting requirements for companies should be proportionate to the goal they pursue.

   Specifically, given the fast-paced evolution of the automotive sector and related legislation, it is particularly important for this sector to ensure transparency of policy agendas, including the calendar of upcoming legislative proposals and consultations. Enhancing certainty on the legislation in force and giving industry adequate time to adapt products and processes will be important to stimulate corporate investment and R&I in automotives.

   As far as the automotive industry is concerned, the review of the Fit-for-55 package includes the review of the CO_2 fleet emission regulation and of the Alternative Fuels Infrastructure Regulation (AFIR). This review **should follow a technologically neutral approach and should take stock of market and technological**

17. As described in the governance chapter, the Competitiveness IPCEI would replace the current IPCEI (Important Projects of Common European Interest) framework and extend its scope to cover first-of-its-kind and industrial infrastructure. For applied and breakthrough industrial research, a Competitiveness Joint Undertaking would attract adequate resources for the deployment of new technologies, particularly for large-scale projects and related infrastructure. Member States should be encouraged to pool national resources and private risk capital be attracted under simplified rules.

developments. The review should also consider the monitoring of the ramp-up of BEVs, their supply chain, related infrastructure needs, and an assessment of the potential and competitiveness of carbon-neutral fuels. The review should also contain an updated impact assessment, carried out in consultation with the industry stakeholders and other relevant partners, of the EU long-term emission reduction targets and their trajectory.

Vehicles operating in Europe in 2040 are expected to still include approximately 45% of ICE and hybrid cars[xxix]. Emissions reduction for these car types is also important to reach decarbonisation targets. An increase in the market penetration of low-emission fuels could compensate for a slower than expected uptake in BEVs. One requirement with respect to regulatory certainty and guidance for R&D and investment in alternative fuels is the clarification of the methodology for emission-neutral fuels, which is still missing.

The European Commission shall present by 2025 a methodology for the **life-cycle assessment ('cradle to grave') of GHG emissions for LDVs**. This will be more encompassing than the 'tank-to-wheel' comparison. The life-cycle assessment methodology may help detecting further levers of emission reduction in the automotive industry, including the strengthening of raw material circularity.

4. **Encourage standardisation.** Common standards are essential to benefit from economies of scale and connectivity in the Single Market, and to create exemplary standards with global range. Standard setting should involve different stakeholders, including industry, scientists, and relevant NGOs in the regulatory process to establish comprehensive and inclusive standards. China, e.g., has used common standards successfully to standardise the mobility ecosystem.

   The automotive sector in the EU would greatly benefit from advanced standards in the areas of:

   - **Charging protocol**: This includes charging points, plugs and ports, and communication features, such as the Vehicle-to-Charging Point communication protocol (also enabling bi-directional charging), and the Charging Point-to-management system protocol.
   - **Recycling** (e.g. battery and vehicle recyclability, recycled material rates, and repairability rates).
   - **New technologies** (e.g. cybersecurity systems, standardised data formats, autonomous vehicles, standardised software programming languages, and data exchange protocols).
   - **Physical interfaces and touchpoints.**

   Moreover, it is important to ensure that United Nations Economic Commission for Europe (UNECE) regulations and EU legislation are consistent, especially for the areas of technical harmonisation and life-cycle assessment. Harmonisation of the process for homologating (approval by the relevant official authority) and obtaining type approval for vehicles has, in general, still not been achieved in the EU. UNECE regulations are transposed into EU legislation, often with additional requirements and narrower limit values. EU directives are then transposed into national law in different ways and with different timetables. National legislatures sometimes add further elements. Differences in homologation and type approval processes within the EU cost time and addexpenses to the manufacturing and distribution of vehicles.

5. **Set up reinforced Net-Zero Acceleration Valleys dedicated to the automotive ecosystem.** As analysed in the chapter on clean technologies, the Net-Zero Industry Act foresees the development of Net-Zero Acceleration Valleys, which are territories that concentrate several companies involved in developing a certain technology. The objectives are to create clusters of net-zero industries (exploiting synergies and positive agglomeration externalities, such as resource sharing and collaboration). The acceleration zones also seek to increase the attractiveness of the EU as location for manufacturing activities, and to streamline the administrative procedures for setting up net-zero manufacturing capacity. The zones would follow a value chain approach specialised, for example, in battery development, battery recycling, hydrogen development, IT, or raw material refining.

   These zones would call for geographically concentrated policy support to stimulate innovative automotive ecosystems in the EU, with focus on the new generation of EVs and on software-defined vehicles. Possible policy instruments could include State aid to manufacturing investment, and temporarily reduced tax rates and labour charges.

6. **Support the development of recharging and refuelling infrastructure, better integrating energy and transport policies.** Recharging and refuelling infrastructure for light and heavy-duty vehicles is necessary for the market uptake of EVs, but as discussed it is unevenly distributed across the EU and still very underdeveloped for HDVs.

   As also argued in the chapter on transport, measures should be implemented to address the bottlenecks, including i) **access to the grid, based on capacity mapping** (to future-proof investment in recharging infrastructure and long-term electricity grid planning), deadlines for granting access, and **obligations** to propose alternative locations to investors when access cannot be granted; ii) **guidelines for charging infrastructure accessibility, and technical specifications** for communication protocols (including for bi-directional charging and roaming) to streamline operations and improve the interoperability of networks within Member States and within the Single Market; iii) **flexible pricing rules** for electricity network charges to optimise network operation by allowing price signals to smooth power consumption (e.g. higher prices in peak hours compared to lower ones during calmer hours) and production (injection)[18].

   Public support for recharging infrastructure should be focused to areas of low demand (remote areas) and HDV charging, where the business case is still less mature. The EU provides financial support to recharging and refuelling infrastructure under the Connecting Europe Facility (CEF), blending grants with additional loans or guarantees from the EIB, the EBRD, and national promotional banks, or private financing, to stimulate private investment. Structural funds can equally be used for investment in charging infrastructure.

   Return differentials across charging locations could be narrowed while limiting investment support to the funding gap. Bundling concessions for locations with higher and lower traffic could avoid that operators would invest only in the most profitable locations[xxx]. Providing funding for projects in multiple areas, some more profitable than others, could equally dampen the power of decreasing returns to investment across locations. Finally, competitive bidding for locations, which limits financial support to the funding gap (the amount that would incentivise the most efficient provider to invest) is common practice in many Member States funding schemes and should be encouraged further.

7. **Ensure that a coherent digital policy for the automotive sector is in place.** Policies to support innovative AI use cases [see the chapter on digitalisation and advanced technologies] should address:

   - Data and system interoperability and common standards for data sharing,
   - Data handling (privacy),
   - Liability issues [see the Box on AI].

   Harmonized frameworks at the EU level for automatic driving solutions would improve regulatory coherence across Member States, in particular:

   - Developing a regulatory framework for the testing of driver assistance and automated systems.
   - Taking steps to ensure the compatibility of traffic rules and infrastructure for driver assistance and automated systems across Member States, including data infrastructure and data protection.
   - Establishing a basic framework ensuring the legality of automated driving solutions and the possibility to deploy them at scale.

18. Evidence in: Bailey, M., Brown, D., Shaffer, B. and Wolak, F., 'Show Me the Money! A Field Experiment on Electric Vehicle Charge Timing', NBER Working Paper No. 31630, 2023, suggests substantial flexibility of EV charging compared to other forms of electricity demand and strong responsiveness of EV owners to financial incentives (reducing charging during peak hours by shifting to off-peak hours).

- Extending the competencies of the European Road Safety Observatory to lead the safe deployment of automated driving solutions through a unified regulatory framework.

8. **Support common European projects in the most innovative areas.** Important Projects of Common European Interest (IPCEIs) are a State Aid instrument, focusing on highly ambitious cross-border research, development and innovation (RD&I), and first industrial deployment (FID) activities. Member States pool resources in strategic sectors and technologies of common European interest, where the market alone does not deliver efficient outcomes, for example because of market failure. The EU could consider supporting IPCEIs in the automotive sector, where scale, standardisation, and collaboration will make a difference. Three possible examples are:

   - Software-defined vehicles and autonomous driving (SDV and AD) solutions [see the dedicated box in the chapter on digitalisation and advanced technologies].

   - The circularity value chain in automotive, where scale is an important factor for effective end-of-life material recycling, including for critical raw materials [see the chapter on critical raw materials].

   - The small or affordable European EV, where cooperation may allow important cost reduction through technological progress regarding battery technologies and electric powertrains, and economies of scale (volume and modularisation).

9. **Bridge skills gaps and address reskilling needs.** The transition towards electromobility, the digitisation of cars, and the further automation of car manufacturing will continue to change skills requirements in the automotive industry, including a growing demand for ICT and electrical engineering skills and falling demand for mechanical engineering and manual labour.

   To support up- and reskilling of the workforce, Member States and particularly affected regions shall establish a common training framework. The framework [see also the chapter on skills] would build on a common set of minimum knowledge, skills, and competences necessary for specific professions. It would pool expertise and at the same time facilitate the mutual recognition of qualifications and related certificates[19]. The common framework could take the form of an 'Automotive Skills Academy', borrowing from the Skill Academies for cleantech sectors envisaged by the NZIA [see the chapters on skills and on clean tech], after monitoring the success of the latter. For automotives, the framework should include massive upskilling and reskilling in domains such as EV maintenance, cybersecurity, data processing, and automation.

   The framework can build on the Automotive Skills Alliance. The latter could develop and provide courses for expert training, and act as platform for lifelong learning centres. The objectives of skill monitoring and the mutual recognition of training and training certificates across Member States and employers should also be maintained [see also the chapter on skills]. It will be important to particularly target SMEs with less capacity to develop their own training infrastructure and programmes and with possibly particularly acute reskilling needs (e.g. car part suppliers exposed to the transition for ICE vehicles to EVs).

10. **Level the global playing field and enhance market access.**

   The EU should contribute to enhancing the global competitiveness of European vehicle manufacturers with supporting trade measures, in line with the key principles for trade policy discussed in Part A. Moreover, specific actions with reference to the sector include:

   - Promote technical harmonisation and standardisation at the highest global level, e.g., at the UNECE World Forum for Harmonisation of Vehicle Regulations and the WTO Technical Barriers to Trade Committee. Both the EU's own legislation and automotive regulations within third countries should align with UNECE regulations.

19. Skills intelligence, reskilling needs, and the benefits of mutual recognition and harmonised education and training offers were already emphasised in the Automotive Skills Agenda in 2020. Standardised trainings and the mutual recognition across the EU of related qualifications have also been recommended in High Level Group on the Competitiveness and Sustainable Growth of the Automotive Industry in the European Union, GEAR 2030 Final Report, European Commission, 2017.

- Diverse origin sourcing of raw materials for the EU automotive industry's green and digital transitions through the conclusion of bilateral strategic partnerships. A Critical Raw Materials Club should be created with like-minded countries. Excessive dependency on a limited number of countries for raw material sourcing and key automotive components should be avoided [see also the chapter on critical raw materials].

- Consider extending the coverage of industries in case of significant trade distortions driven by CBAM. A potential risk to EU automotive competitiveness is downstream leakage from the ETS covering upstream industries, in other words, cost advantages for imports with a higher carbon footprint for as long as automotive remains outside of CBAM. The Commission should carefully monitor the impact of the CBAM design on downstream industries (including automotives) in the 2025 review and take appropriate actions in case of distortions [see also the chapter on energy-intensive industries].

ENDNOTES

i See: High Level Group on the Competitiveness and Sustainable Growth of the Automotive Industry in the European Union, GEAR 2030 Final Report, European Commission, 2017.

ii Waas, A., Sadek, P., Hofmann, B., Gruener, J., European auto industry is at a crossroads, Boston Consulting Group, 2023.

iii Connell Garcia, W., Garrone, M., Reshaping the road ahead: Exploring supply chain transformations in the EU automobile industry, Single Market Economics Briefs, No. 3, 2024.

iv Most of these challenges are already discussed (at an earlier stage) in High Level Group on the Competitiveness and Sustainable Growth of the Automotive Industry in the European Union. See: High Level Group on the Competitiveness and Sustainable Growth of the Automotive Industry in the European Union, op. cit., 2017.

v See, for example: Mayer, T., Vicard, V., Wibaux, P., Will Chinese Auto Export Boom Transform into Local Production in Europe?, CEPII Policy Brief, No. 45, 2024.

vi IEA, Global EV Outlook 2024, 2024. Connell Garcia, W., Garrone, M., op. cit., 2024.

vii Data provided by the European Alternative Fuels Observatory.

viii See: CEDEFOP, Sectors in transition – the automotive industry, 2021. Burkacky, O., Deichmann, J., Guggenheimer, M., Kellner, M., Outlook on the automotive software and electronics market through 2030, McKinsey & Company, 2023.

ix European Commission, Impact Assessment Report accompanying the document Securing our future Europe's 2040 climate target and path to climate neutrality by 2050 building a sustainable, just and prosperous society (SWD(2024) 64), 2024. The investment volume is expressed at 2023 prices.

x Breunig, M., Kässer, M., Klein, H., Stein, J., Building smarter cars with smarter factories: How AI will change the auto business, McKinsey Digital, 2017.

xi Evidence from Eurostat.

xii ACEA, The Automobile Industry Pocket Guide 2023/2024, 2023.

xiii ACEA, op. ed., 2023.

xiv ACEA, Fact sheet: EU-China vehicle trade, 2023.

xv IEA, op. cit., 2024.

xvi On challenges of the powertrain transition for car part suppliers, see e.g.: Rennert, H., Gasser, K., Rose, Ph., van Arsdale, S., Hertle, L. and Frauenknecht, P., Electric Vehicle Transition Impact Assessment Report 2020 – 2040: A quantitative forecast of employment trends at automotive suppliers in Europe, PwC and CLEPA, 2021.

xvii The particular challenges and adjustment needs for supplier networks are also highlighted in: European Commission, The transition pathway for the EU mobility industrial ecosystem, 2024.

xviii European Commission, EU Transport in Figures - Statistical Pocketbook, 2023.

xix Pardi, T., 'Heavier, faster and less affordable cars: The consequence of EU regulations for car emissions', ETUI Report 07, 2022.

xx European Environment Agency, CO2 emissions performance of new passenger cars in Europe, 2024.

xxi See, for example: Dornoff, J., 'CO2 emission standards for new passenger cars and vans in the European Union', ICCT Policy Update, 2023.

xxii IEA, Comparative life-cycle greenhouse gas emissions of a mid-size BEV and ICE vehicle, 2021.

xxiii For overviews, see: European Alternative Fuels Observatory, Alternative fuels. U.S. Department of Energy, Alternative Fuels Data Center.

xxiv See, for example: Alochet, M., Comparison of the Chinese, European and American regulatory frameworks for the transition to a decarbonized road mobility, École Polytechnique, 2023.
DiPippo, G., Mazzocco, I., Kennedy, S., Goodman, M., Red Ink: Estimating Chinese Industrial Policy Spending in Comparative Perspective, Center for Strategic & International Studies, 2022.
Also reported in: Bickenbach, F., Dohse, D., Langhammer, R., Liu, W-H, 'Foul Play? On the Scale and Scope of Industrial Subsidies in China', Kiel Policy Brief, No. 173, 2024.
Fredriksson, G., Roth, A., Tagliapietra, S., Veugelers, R., 'Is the European automotive industry ready for the global electric vehicle revolution?', Bruegel Policy Contribution, No. 28, 2018.

xxv See: CEDEFOP, op. cit., 2021. Engineering and ICT jobs include design, engineering, electronics, software development, ICT and data management, and automation.

xxvi European Alternative Fuel Observatory, Consumer Monitor 2023, 2024.

xxvii Dai, X., Lechner, R., 'Insuring electric vehicles: A growing opportunity but with near-term challenges', Swiss Re Institute Economic Insights, 2024.

xxviii Transport & Environment, Europe's BEV market defies odds but more affordable models needed, 2024.

xxix Renault Group, Worldwide powertrain mix forecast, 2022.

xxx See also: IEA, op. cit., 2024.

7. Defence

The starting point

The EU's defence sector is critical to ensure Europe's strategic autonomy in facing increasing external security threats, as well as driving innovation through spillovers across the entire economy. Nevertheless, the EU's defence industrial base faces challenges in terms of capacity, know-how and technological edge. As a result, the EU is not keeping pace with its global competitors. Moving forward, new and emerging industrial segments will require massive investment and new technological capabilities, while the EU's strategic defence priorities may continue to diverge from those of the US, calling for immediate policy action at the EU level.

New geopolitical threats have put the spotlight back on the EU's defence capacities. The past years have seen the return of war in the EU's immediate neighbourhood, together with the emergence of new types of hybrid threats, including the targeting of critical infrastructure and cyber attacks. The EU faces an immediate and long-term military threat at its borders (from Russia), while experiencing broader neighbouring security threats in Africa, the Mediterranean and the Middle East. The EU will have to take growing responsibility for its own defence and security, with its ally the US potentially focusing progressively to a greater extent on the vast distances of the Pacific Rim (e.g. in the format of AUKUS). Europe will also face, in the current geopolitical context, a serious issue of nuclear deterrence. The EU's technological and industrial competitiveness in the field of defence will be key to meet current and future needs to ramp up capacity in the context of increasing global defence budgets.

The defence sector is also a key driver of innovation for the entire economy. Historically, the defence sector has been the origin of diverse innovation that has now been mainstreamed in the civilian world[i]. One example is the use of carbon fibre for structural components, of infrared for surveillance, lidar in cars, the internet, GPS positioning, satellite imaging, the three-point seat belt (derived from harnesses designed for military jet pilots). Silicon Valley's early growth in the 1950s and 1960s was largely supported by defence investment, well before today's venture capital industry emerged. More recently, innovation and technological breakthroughs in civilian sectors are increasingly applied in the field of defence, especially as defence solutions become more dependent on digital tools.

The EU's defence industry is still highly competitive at the global level in specific domains – nevertheless, the sector suffers from a combination of structural weaknesses. The European defence sector has an estimated annual turnover of EUR 135 billion in 2022 and strong export volumes[ii] (more than EUR 52 billion in 2022), with the sector estimated to employ around half a million people. Some EU products and technologies are superior or at least equivalent in quality to those produced by the US in multiple areas, such as main battle tanks and related sub-systems, conventional submarines and naval shipyard technology, rotorcraft and transport aircraft. At the same time, the EU's defence sector faces structural weaknesses in terms of overall public spending, industrial footprint, coordination and product standardisation, international dependency, innovation, and governance.

TABLE OF ABBREVIATIONS

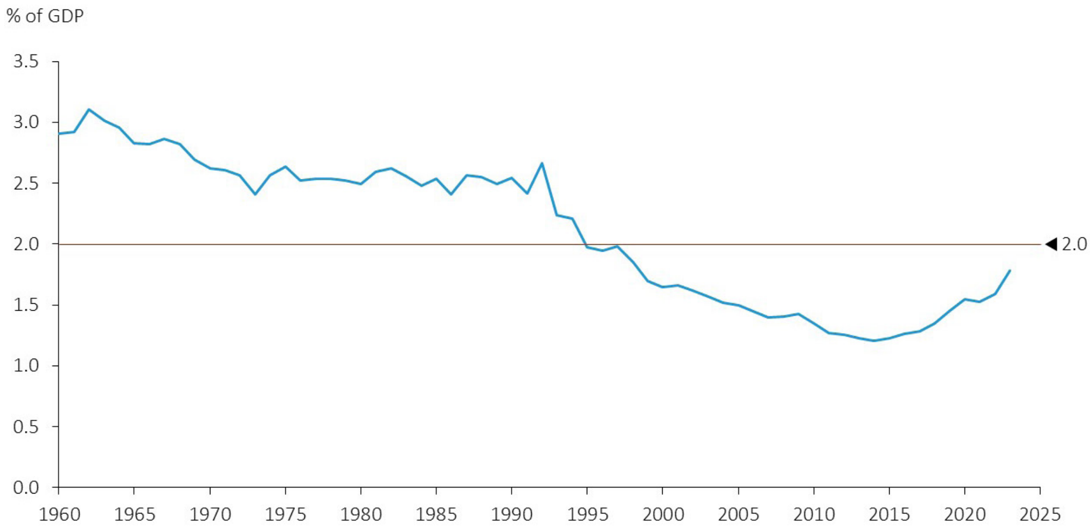
EDA	European Defence Agency	**R&D**	Research and development
EDF	European Defence Fund	**R&T**	Research and technology
EDIP	European Defence Industry Programme	**SME**	Small and medium-sized enterprises
EDIS	European Defence Industrial Strategy	**UAV**	Unmanned aerial vehicle
EIB	European Investment Bank	**USV**	Unmanned surface vehicle
NATO	North Atlantic Treaty Organization	**UUV**	Underwater unmanned vehicle

INSUFFICIENT PUBLIC DEFENCE SPENDING

Public defence spending by EU Member States is insufficient in the current geopolitical environment. Thanks to a prolonged period of peace in Europe and to the security umbrella provided by the US[iii], military spending in the EU has been in decline for fifty years [see Figure 1]. The absence of demand and long-term procurement planning has deprived the European defence industry of the ability to predict potential demand, which has in turn been reflected in decreasing industrial capacity. However, this trend of Member States' declining defence spending has reversed starting in 2014, with a strong increase in defence spending following Russia's invasion of Ukraine in 2022.

FIGURE 1

EU Member States' defence expenditure

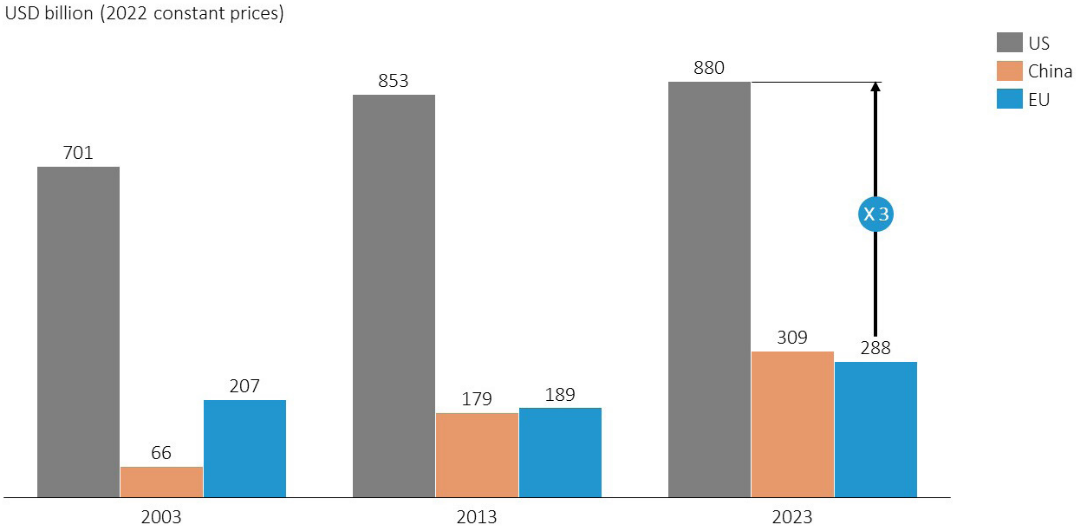


Source: SIPRI. Accessed 2024.

The EU's defence expenditure is currently approximately one-third of that of the US, with spending rapidly increasing in China. According to the SIPRI database, the US' defence expenditure in 2023 was estimated at USD 916 billion, while the cumulative expenditure of EU Member States' spending was estimated at USD 313 billion (expressed in current prices). China's defence budget was estimated at USD 296 billion, but according to several sources it could be significantly higher. It should be noted that the purchasing power of China's defence budget is significantly higher than what the conversion based on exchange rates shows, as China can rely on a large domestic defence industry[iv]. The US and China accounted for around half of the world defence spending in 2023, with the US' defence budget worth around 37% of global spending. Following years of underinvestment, the EU has a long way to go to restore industrial capacity and, consequently, increase military capabilities. Only ten Member States spend more than or equal to 2% of their GDP in line with (2014) NATO commitments. If all EU Member States who are members of NATO who have not yet reached the 2% target would do so in 2024, this would translate into approximately an additional EUR 60 billion in defence spending. In June 2024, the European Commission estimated that additional defence investments of around EUR 500 billion are needed in the EU over the next decade[v].

FIGURE 2

EU-27 defence spending compared to the US and China



Source: SIPRI. Accessed 2024.

LIMITED ACCESS TO FINANCING

Besides public funding, access to private financing remains a key challenge for the EU's defence industry. This is true in particular for SMEs and mid-caps, which form the backbone of supply chains and are key innovation actors. A 2024 study[vi] on access to equity finance for defence SMEs estimates the equity financing gap at EUR 2 billion and a debt financing gap of up to EUR 2 billion for SMEs in the defence sector. These estimates are conservative, as they account only in part for companies engaged in developing dual-use technologies. Access to finance is often hindered by the interpretation given by financial institutions to the EU's Sustainable Finance Frameworks and Environmental, Social and Governance (ESG) frameworks. Furthermore, the complexity of the regulatory frameworks related to defence industrial activities (for production, export, use, access to information, etc.) and to defence procurement, including within the EU Single Market, represent additional obstacles for potential investors.

While the European Investment Bank (EIB) Group deploys financial instruments to address prevailing market failures, it largely excludes support to the defence industry, which has a negative signalling effect to the wider financial sector. The EIB's exclusion policies for core defence activities are also applied by other public banks (including National Promotional Banks and other financial institutions) and, in turn, by private banks, investors and asset managers. This greatly limits the possibility of the defence sector to fully benefit from EU financial instruments and private financing. Overall, until the last few years, defence activities were not recognised as strategic and key for resilience and innovation in the EU, which also excluded them from funding (including by public investors). Whereas the defence industry is de jure eligible for most EU funding programmes (e.g. the Cohesion Funds), it is generally underrepresented among EU-funded projects. In May 2024, the EIB Group waived a previous requirement that dual-use projects eligible for financing in the area of security and defence derive more than 50% of their expected revenues from civilian use[01]. The EIB Group also updated its rules for security and defence SME financing, opening credit lines for dual-use projects by smaller companies and innovative startups whose activity is partly in defence. No changes were made to the EIB Group's eligibility, excluded activities and excluded sectors list for core defence activities.

A FRAGMENTED INDUSTRIAL FOOTPRINT

The EU's defence industrial footprint is fragmented, while it requires scale. The overall structure of the European defence industry is characterised by mainly national players operating in relatively small domestic markets, producing relatively small volumes. There is large heterogeneity in terms of size of Member States' defence industries

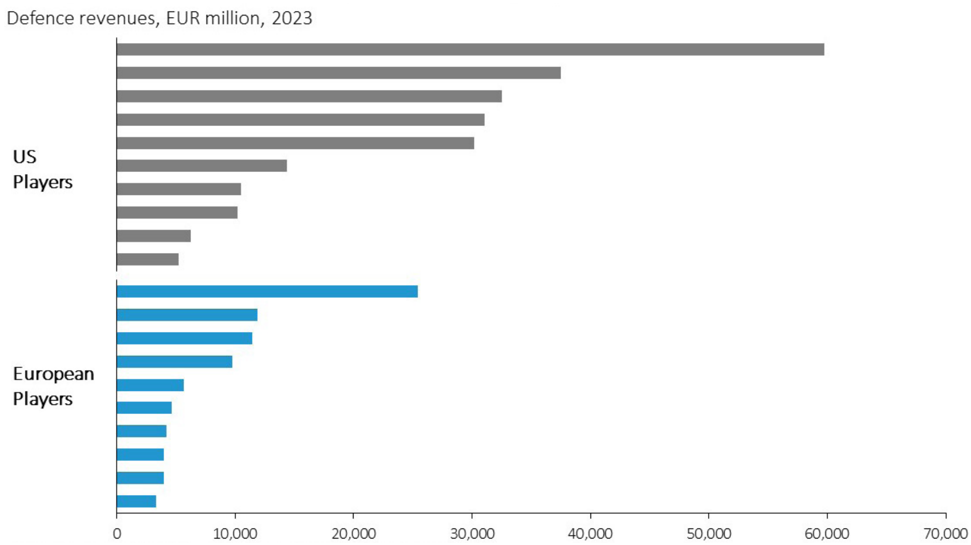
01. This means that projects and infrastructure used by the military or police that also serve civilian needs are now eligible for EIB Group financing.

across the EU, with the majority of arms production located in a small number of Member States. Defence companies from Western Europe tend to be present in all domains (ground, naval, air and space), often creating overlap and duplication, while in other parts of the EU there is more specialisation. Complementarity arising from specialisation can be considered a source of resilience when the EU's defence industry is viewed as a whole[vii].

Despite several initiatives, Member States have so far been unable or unwilling to conduct overall consolidation and integration of the EU's defence industrial base. This has been mainly due to concerns related to national sovereignty and autonomy, as well as an unwillingness by Member States to forego national capabilities in determined segments, and implement cross-border industrial rationalisation. This has resulted in a large degree of fragmentation in the EU's defence industrial base at the European, but also in certain instances at the national level (e.g. in France, Germany and Italy in the field of land defence) [see the Box below].

Differently from the EU, the US has pursued a consolidation strategy of its defence industry. After the Cold War, the US conducted (as mandated by the Department of Defence) defence industry consolidation on the grounds that the US defence market would have not supported a large, fragmented industrial base. Since 1990, the US' industrial base has shrunk from fifty-one to five main players. This industrial structure in the US has delivered the high capacity and scale required by the US armed forces, however it may also carry risks in terms of dependence on a small number of suppliers. The Department of Defence is now opposing any further consolidation of its Tier 1 players, but increasingly also of Tier 2 and even Tier 3 players. Further consolidation is opposed on the grounds that it would be detrimental to competition, the improvement of industrial performance, prices, and deter innovation.

FIGURE 3
Comparison of major European and US players



Source: Elaboration on Defence News Top 100. European players include European non-EU companies.

In some defence sub-sectors in the EU, consolidation has been driven by industry (e.g. helicopters), **while in others there is still a long way to go**. In particular, excessive fragmentation is still present in sectors including naval surface vessels, conventionally powered submarines, wheeled and tracked combat vehicles (at the level below the main battle tank), non-combat vehicles, defence electronics, missiles, space and at the soldier system level. A multitude of assault rifles, handguns and individual systems also exist on the EU's defence market.

EU competition enforcement may inhibit consolidation of the defence industry. General EU competition rules apply to the defence sector. Member States may only exceptionally derogate from these rules for military activities which are necessary to protect their essential security interests. In particular, for dual-use products (which can be used both for defence and civilian purposes), EU competition enforcement may prevent or discourage businesses from merging and scaling up, particularly those creating market power.

BOX 1

A case for further defence industrial asset integration in the EU

Further defence industrial asset integration and consolidation – focused on critical and strategic domains – would strengthen the EU's defence industrial base and improve its strategic autonomy. Overcoming the duplication of industrial capacities across Member States by promoting the structural cross-border integration of defence industrial assets in selected segments among groups of Member States would enable economies of scale and reduce costs (and, hence, defence expenditure). It would also allow establishing EU companies that serve multiple markets (larger than their national market) and that are more globally competitive. The future of defence products will increasingly rely on very complex 'systems of systems', which need to be highly interoperable. In particular, in this segment the integration of defence industrial assets in the EU would increase the accessibility and availability of the most advanced capabilities (especially in complex next-generation defence systems) for European national armed forces.

While there are various initiatives seeking to establish defence industrial cooperation among EU Member States, only a few have delivered the type of structural asset consolidation at the European level which overcomes duplication and overlaps, and achieved significant scale in the specific domain it concerned. The success of some of these initiatives has been hindered by the unwillingness of participating Member States (and their companies) to forego national industrial capabilities in determined segments and to implement cross-border industrial rationalisation.

Several conditions are needed to structurally integrate European companies in the defence sector. These include:

- Full political support by participating Member States for structural consolidation of technological and industrial assets.
- Readiness by the participating Member States to accept mutual interdependence in selected defence segments and ensure the security of supply.
- No full mirroring and duplication of capabilities, readiness to scale back existing industrial capacities, where needed.
- A commonly agreed specialisation strategy among companies from participating Member States reallocating capacities and reinforcing respective domains of excellence.
- Deep specialisation of industrial sites located in different participating Member States though the creation of 'poles of competence' in specific fields, functions, technologies or sub-systems aiming to create scale and synergies together.
- Integrated and autonomous corporate decision-making within single industrial groups, the absence of Member State involvement in corporate decisions, operational integration of the supply chain, and a common R&D strategy focused on developing future capabilities.

The development of the EU's defence industrial base depends on the successful integration of commercial technologies, often championed also by SMEs, in defence applications. Critical technologies for security and defence increasingly come from commercial non-defence companies – often SMEs – that are at the forefront of digital and technological innovation. At the same time, innovative SMEs (often from smaller Member States) face barriers for entry into the European defence market, which is characterised by rather closed and nationally protected supply chains. This prevents SMEs from providing digital capabilities to the defence industry and from being part of cross-border EU defence supply chains. Furthermore, dual-use programmes are not sufficiently developed in the EU. These programmes have the potential to bring several benefits, including enhancing collaboration between civilian and defence sectors, driving deep technical innovation also addressing military needs, mitigating risk by leveraging common technologies across different end uses, and expanding the use of private capital for the development of emerging technologies.

LACKING COORDINATION AND STANDARDISATION

A lack of coordination at the EU level and product standardisation weaken the EU's defence industrial base. Member States do not systematically exploit the benefits of coordination at the EU level, of standardisation and interoperability, joint procurement, acquisition and maintenance, or pooling and sharing of resources. This results in inefficient defence expenditure compared to the EU's competitors, as well as uncoordinated and insufficient defence investment. Furthermore, it ultimately prevents the EU's defence industry from benefitting from economies of scale. Increased demand for security and defence equipment alone, without coordination at the EU level, will not strengthen Europe's defence industrial base. On the contrary, it may further exacerbate some of today's existing problems.

European collaborative procurement of defence equipment accounted for only 18% of expenditure on defence equipment procurement in 2022[viii]. This percentage represents the procurement for ongoing cooperative projects by sub-groups of Member States, not necessarily the EU-27. This figure is significantly below the benchmark of 35% agreed upon in the European Defence Agency (EDA) frameworks. There is no shared mapping of the EU's manufacturing capacities in defence, including with respect to the complexities of cross-border supply chains, which results in an inability to address capacity constraints and bottlenecks in a timely manner. At the same time, when EU Member States organise and cooperate, it pays off. One example is the A330 Multi-Role Tanker Transport, developed through collaborative projects by the EDA and NATO, which allow participating countries to pool resources, make use of the capabilities of the aircraft and share operation and maintenance costs.

A lack of demand aggregation between Member States makes it more difficult for the industry to predict actual needs (for each type of equipment) in the medium and long term. In turn, this decreases the EU industrial base's overall capacity to meet demand, further depriving the EU's industry from orders and opportunities. The more public financial resources are channelled and spent through EU and collaborative programmes, the larger the scale of aggregated demand the industry has to address, and the more it needs to consolidate to provide competitive responses to this demand. Similarly, the EU invests EUR 1 billion in defence research and development on a yearly basis, while the bulk of overall defence investment (including on R&D) takes place at the Member State level. In the absence of coordination, this EU-Member State imbalance in investment expenditure is a weakness when it comes to developing technology and projects requiring very large investment.

In more operational terms, a lack of defence product standardisation across the EU has recently become evident on the battlefield in Ukraine. While EU Member States are encouraged to use NATO standards for defence equipment, there is very large heterogeneity in specifications, a lack of common certification and mutual recognition between Member States. For 155 mm artillery alone, EU Member States have provided (from their stocks) some ten different types of howitzers to Ukraine (not counting four other types sourced from NATO countries). Some have even been delivered in different variants, creating serious logistical difficulties for Ukraine's armed forces. There are many other examples. Currently, five different types of howitzers are manufactured in Europe, whereas the US produces only one. There are twelve European types of battle tanks, while in the US there is only one[ix]. As for the fighter jets, the Eurofighter, Rafale and Gripen represent only one-third of the total European fleet, with US fighter jets comprising the rest. Finally, in defence shipbuilding, the largest programme in Europe constructs only 14% of its fleet.

Increased internal demand, without reinforcing coordination, may aggravate supply bottlenecks in the European defence market. Given that European domestic demand was relatively limited until 2022, European defence companies focused on exports. High reliance on third countries' orders created a tendency to prioritise these orders rather than Member States' needs in case of shortages. However, the situation has changed dramatically since the beginning of Russia's war of aggression against Ukraine, with Member States substantially increasing orders. In this context, if Member States continue not to sufficiently coordinate their defence spending and procurement plans, a supply-crisis could occur with Member States competing between each other on the constrained European defence equipment market, provoking price surges and crowding-out effects for concerned products.

Intra-EU competition and insufficient cooperation also affect the performance of EU companies in terms of export markets. The US, Europe and other players, are all competing on international markets for defence orders and strategic influence. The lack of a 'single EU authority' for the defence industry (like the US State Department) undermines the EU's export capacity and ability to maintain its competitive edge given that business deals in this industry do not follow only an economic, but also a political logic.

A HIGH DEGREE OF INTERNATIONAL DEPENDENCY

EU Member States are highly dependent on non-EU defence solutions, especially from the US. The vast majority of European defence investment has recently been diverted to the US and to other international defence industry players (including Israel and South Korea). The choice to 'buy in the US' is part of the legacy of World War II and the Cold War. However, even today in the context of increased defence investment and increased awareness of how crucial it is to own and protect critical technologies, Member States continue to procure non-EU products and solutions. Of a total of EUR 75 billion spent by Member States between June 2022 and June 2023, 78% of procurement spending was diverted to purchases from suppliers located outside the EU, out of which 63% based in the US[02]. US Foreign Military Sales in Europe increased by 89% between 2021 and 2022. At the same time, the US market remains closed for European companies[03].

The choice to procure from the US may be justified in some cases because the EU does not have some products in its catalogue[04], but in many other cases a European equivalent exists, or could be rapidly made available by the European defence industry. It should be noted that the choice to buy US equipment is not directly linked to NATO's coordination role, including in the context of the war in Ukraine. At the same time, some US defence products are not always suitable for European needs and will be even less so in the future, as the US adjusts its military capabilities (in terms of range, endurance, etc.) to react to new threats in the Pacific and re-prioritise the provision of equipment and spare parts. What are then the main reasons for Member States to prefer procurement from the US?

- Administrative simplicity and better visibility of what is available, notably under the US Foreign Military Sales programme, under which the Member State signs a government-to-government purchase agreement with the US and the US administration takes care of contracting the industrial provider and managing the contract with the latter.
- Poor knowledge from Member States of what is the actual offer from the European defence industry. This is combined with a lack of demand consolidation from EU governments, which impacts scale and demand.
- Real or perceived faster availability, and the perceived quality and price of US products.
- Having closer ties with US military apparatus and prioritising interoperability with the US first, as some Member States do not conceive military intervention without the US' involvement.

Driven by increased demand, other emerging non-EU manufacturers have also entered the EU market. The availability of large stocks of non-EU defence products (e.g. from Turkey and South Korea) means they can be made readily available ('off the shelf'), resulting in increased speed to market, making them more attractive compared to domestic solutions. Besides aggravating external dependencies, this has further increased fragmentation and decreased interoperability between Member States' armed forces, representing further missed opportunities for the EU's defence industry.

LIMITED INVESTMENT IN RESEARCH, DEVELOPMENT AND INNOVATION

The EU's investment in defence research and innovation is much lower than that of its industrial competitors. The EU and its Member States lag behind in particular the US in terms of defence Research & Development and Research & Technology investment in defence. In 2022, Member States cumulatively invested a total of EUR 9.5 billion in defence R&D, out of which EUR 3.5 billion in defence R&T. This was topped by EUR 1.2 billion from the

02. A breakdown of the data showing which Member States have procured the most US equipment is not available. These are mostly government-to-government agreements which, therefore, do not appear in relevant statistics.

03. A typical example is the acquisition of F-35 fighter jets by several EU Member States, when neither the A400M nor the MRTT tanker have access to the US' Air Force procurement, despite no equivalent being offered by the US' industry.

04. Europe does not produce strategic airlifters, heavy utility helicopters, long-range missile defence interceptors, 5th generation combat aircraft, and unmanned aerial vehicles (UAVs). Europe has, in fact, missed one (if not two) generation(s) of UAVs.

European Defence Fund (EDF) for collaborative efforts in defence R&D, bringing total funding to approximately EUR 10.7 billion[x]. The level of EU investment is very far from the US Department of Defence's budget in 2023, which allocated USD 140 billion for Research, Development, Test and Evaluation[xi]. The US has prioritised R&D and R&T spending over all other military spending categories since 2014, and it is continuing to do so with the largest relative percentage increase for the category in the 2023 defence budget[xii]. This consolidated trend demonstrates the US approach in retaining global technological leadership.

EU Member States generally lack dedicated research capabilities in defence. This makes large-scale defence R&D investment more difficult to implement. Traditionally, a relatively small number of European universities and research centres have established a close relationship with Ministries of Defence and the defence industry. In 2022, collaborative defence R&T in the EU reached EUR 237 million[xiii], which as percentage of total defence R&T was only 7.2% (compared to the benchmark of 20% set by Member States).

Complex next-generation defence systems in all strategic domains (air, land, space, maritime and cyber) will require massive research investment that exceeds the capacity of any Member State alone. Defence is a highly technological industry which operates on the basis of very long development cycles due to the disruptive nature of the technologies it needs to mature. As a result, the industry requires stable long-term investments, but at the same time it faces small production series and high capital expenditure. No EU Member State can effectively finance, develop, produce and sustain on a purely national basis all the necessary defence capabilities and enabling infrastructure. This reality is highlighted by the ever-faster pace of technological innovation needed to maintain state-of-the-art capabilities[05].

The European Defence Fund (EDF) provides financial support, mainly through grants, to cross-border collaborative R&D defence products. For the 2021-2027 period, the Fund has a budget of nearly EUR 8 billion, of which EUR 2.7 billion for collaborative defence research, and EUR 5.3 billion for projects in collaborative capability development. For several critical military capacities, such as next-generation rotorcraft and tactical cargo aircraft, the EDF has served to incentivise Member States to align their requirements, as well as the industry to collaborate on solutions. This approach, given the size of emerging challenges, would need to be confirmed and significantly amplified. Furthermore, additional support is required to sustain the commercialisation and industrialisation of successful EDF research outcomes.

Similar to other critical sectors of the economy, the European defence industry faces substantial skills shortages. This is the case for both for R&D and production, strongly affecting the industry's ability to become more globally competitive. Concerning technological skills, there are strong synergies and overlaps with the needs of other sectors (such as space, aerospace and ICT), which underlines the need for cross-fertilisation and collaboration with other sectors. However, the defence sector is particularly marked by stigma (especially among younger people), suffers a lack of diversity in the labour force, and experiences difficulty in retaining skills.

WEAK AND FRAGMENTED GOVERNANCE AT THE EU LEVEL

For historical reasons, governance at the EU level of defence industrial policy is weak and fragmented. EU Member States have lacked the political will, as well as an effective mechanism to pool resources and jointly finance, procure, maintain and upgrade defence products or technologies. Similarly, they were largely unwilling to integrate their defence industrial capacities to achieve efficiencies and scale. The EU does not have a centralised authority entrusted with the appropriate structure to manage industrial defence and security initiatives, to provide funding on a more integrated basis, or with a clear political mandate to act in this domain. This is in part also related to the traditional division of roles and responsibilities between the EU Common Foreign and Security Policy (CFSP), the Single Market and industrial policies under the Treaty on the Functioning of the European Union (TFEU). The current institutional set-up would need to be strengthened to define a new governance model for defence industrial policy between EU bodies (the European Commission, the European External Action Service (EEAS) and the European Defence Agency (EDA)).

05. New research frontiers include highly innovative, multi-disciplinary and high-risk developments across all domains. For example, in the land domain, major technological innovations are required to realise soldier augmentation systems, starting with exoskeletons to gradually move into brain-machine interface developments. In the naval domain, large unmanned surface vehicle (USV) and deep/autonomous underwater unmanned vehicles (UUV) are a new frontier requiring an extremely complex 'system of systems' approach. These are all possible areas in which to develop pan-European solutions.

A number of initiatives have been launched recently, nevertheless there is still a long way to go to address the identified challenges in a structural manner. Key initiatives launched over the last two years include:

- European defence industry reinforcement through common procurement Act (EDIRPA) established a short-term EU instrument seeking to reinforce European defence industrial capacities through common procurement by EU Member States.
- The Act in Support of Ammunition Production (ASAP) aims to strengthen the responsiveness and ability of the EU's defence industry to ensure the timely supply of ammunition and missiles.
- The Defence Joint Procurement Task Force (DJTPF) aims to provide one million rounds of artillery ammunition for Ukraine through a joint effort.

On 5 March 2024, the Commission and the High Representative presented the first European Defence Industrial Strategy (EDIS) and the related European Defence Industry Programme (EDIP), which is a regulation implementing measures identified in the strategy. The strategy and the programme have the objective of addressing many of the challenges described in this chapter. Among others, they propose a set of measures "to spend more, better, together, and European" in the field of security and defence. The proposed EDIP regulation has been transmitted to the European Parliament and the Council, with adoption by co-legislators foreseen for the upcoming mandate of the Parliament.

BOX 2

A closer look at specific domains

While the starting point and overall trends are common to the EU's entire defence sector, the state of play (and consequent domain-specific actions) partially differ by area. In particular:

- In the air domain EU Member States have a strong position, with an already a high level of industrial consolidation, but more efforts are needed to ensure maintaining that position and improving competitiveness particularly with respect to US solutions on the EU market.
- In the naval domain, Member States are still affected by the over-fragmentation of their industrial base due to the desire of many national navies to maintain a significant level of autonomy.
- The land domain is one of the most fragmented due to the technological and financial entry barrier being relatively low. However, there is a need to develop a new generation of systems which will subsequently increase investment needs and will require stronger cooperation.
- The cyber defence domain is critical, time-sensitive and technologically accessible. Further cooperation at the EU level will be needed, as other actors are building or already hold a technological and operational advantage.
- In the space domain, complete autonomy is a capability that all main powers and many emerging and regional powers are pursuing. In this field, EU Member States are losing their competitive edge following the latest developments in the global space industry [described in the chapter on space].

Objectives and proposals

The overarching goals of EU action should be to:

- Expand and develop the EU's defence industrial and technological base so that it can meet new European defence and security needs with the necessary scale, speed, freedom of action, and enhanced autonomy.
- Reinforce the capacities, readiness, output and efficiency of the EU's defence industrial base to guarantee long-term sustainability, technological and industrial competitiveness.
- Strengthen European R&D in defence to support the technological advancement of the EU's defence industry and to maximise technological spillover with other sectors (in both directions).

FIGURE 4

	SUMMARY TABLE DEFENCE PROPOSALS	TIME HORIZON[06]
1	Proceed with the swift implementation of the proposed European Defence Industrial Strategy (EDIS) and the adoption of the European Defence Industry Programme (EDIP).	ST
2	**Substantially increase the aggregation of demand for defence assets between groups of Member States and pursue the further standardisation and harmonisation of defence equipment.**	**ST**
3	**Develop a medium-term EU Defence Industrial Policy which supports cooperation, the Europeanisation and integration of SMEs into supply chains, the structural cross-border integration of defence industrial assets.**	**MT**
4	**Provide EU-level funding for the development of the EU's defence industrial capacities.**	**MT**
5	Improve access to finance for the European defence industry, including by removing restrictions on access to EU-funded financial instruments.	ST
6	Introduce a reinforced European preference principle and substantive incentive mechanisms to valorise European defence solutions and excellence over non-EU solutions.	ST
7	Ensure that EU competition policy enables industrial defence consolidation to reach scale, where needed.	ST
8	Concentrate efforts and resources on common EU R&D/R&T defence initiatives and maximise technological spillover between civil and defence innovation cycles.	LT
9	Deepen competences at the EU level for defence industrial policy to be reflected in the EU institutional set-up.	MT
10	Improve coordination and combine the acquisition of US systems by sub-groups of EU Member States.	ST

06. Time horizon is indicative of the required implementation time of the proposal. Short term (ST) refers to approximately 1-3 years, medium term (MT) 3-5 years, long term (LT) beyond 5 years.

1. **Proceed with the swift implementation of the proposed European Defence Industrial Strategy (EDIS) and the adoption of the European Defence Industry Programme (EDIP).** This is to be complemented by the additional proposals laid out in this chapter.

2. **Substantially increase the aggregation of demand for defence assets between groups of Member States and pursue the further standardisation and harmonisation of defence equipment.** Increasing the share of joint defence expenditure and joint procurement to address critical capability gaps would create the favourable conditions to further consolidate industrial capacities. Demand aggregation would allow the selective consolidation of supply in determined segments using new and harmonised defence programmes, emerging technologies and capabilities requested by a group of Member States as key drivers of the EU's defence market. This approach would further stimulate gradual industrial specialisation within EU, through EU or multi-country government-to-government agreements, especially in areas that require very large investment in infrastructure and technology. More systematic standardisation (in line with NATO standards), the harmonisation of requirements, common certification and a mutual recognition policy would help to achieve interoperability, and even interchangeability.

3. **Develop a medium-term EU Defence Industrial Policy.** This policy should set strategic objectives and, by using targeted measures and incentives, it should support industrial cooperation, the Europeanisation of supply chains, the structural cross-border integration of defence industrial assets between groups of Member States, consolidation seeking to increase scale, and the specialisation of industrial sites along 'poles of competence', involving industrial actors of all sizes. The industrial policy would also define regulatory frameworks that aim to remove entry barriers and establish an integrated Single Market for defence products, facilitating the participation and integration of SMEs (including from civilian sectors) into defence supply chains. Among other objectives, the policy would establish dedicated mechanisms for maintaining and building up spare industrial capacities, and a prioritisation mechanism at the EU level to manage crisis situations. These mechanisms would include the deployment of funds to ramp up and maintaining 'idle' or 'warm' capacity, privileged access to raw materials and energy, dedicated rules to allow for the rapid expansion and construction of additional facilities, in line with the proposed EU security of supply regime.

4. **Provide EU-level funding for the development of EU defence industrial capacities.** New EU financial resources could be leveraged on financial markets and channelled through the creation of an ad hoc instrument, in line with the proposals in the sustaining investment chapter. These resources would be used for the implementation of the proposed medium-term EU Defence Industrial Policy and the EDIP. In particular, they would be used for new joint defence R&D programmes under the EDF, for the joint development and procurement of critical and strategic capabilities in the EU, for incentive mechanism supporting further integration, consolidation and technological innovation of Europe's defence industrial base.

5. **Improve access to finance for the European defence industry, including by removing restrictions on access to EU-funded financial instruments.** In the context of constrained public budgets, defence companies should be enabled to make full use of EU-funded financial instruments to mobilise private capital and sustain the very large investment needs of the defence sector. Relevant measures would include: the modification of the EIB Group's Lending Policies on the exclusion of defence investment, extending beyond dual-use projects; clarification of the EU Sustainable Finance Frameworks and Environmental, Social and Governance (ESG) Frameworks on the financing of defence products; the increased provision of debt and/or equity financing to defence SMEs and small mid-caps, in line with the proposed Fund to Accelerate Defence Supply Chain Transformation (FAST); the scaling-up of funding dedicated to the industrialisation and commercialisation of projects supported by the EDF.

6. **Introduce a reinforced European preference principle and substantive incentive mechanisms to valorise European defence solutions and excellence over non-EU solutions.** A European preference principle could be introduced in the form of political commitment or through reformed public procurement legislation, which would indicate that EU solutions would need to be considered as first options. Substantive incentive mechanisms of financial nature to buy and procure European solutions could be supported by EU funding under existing or

new instruments. Targeted eligibility criteria could give access to funding only for solutions provided by EU-based companies, similar to the mechanisms used by the European Defence Fund (EDF) and the proposals under the European Defence Industry Programme (EDIP).

7. **Ensure that EU competition policy enables industrial defence consolidation to reach scale where needed.** Place more weight on criteria related to the innovation-enhancing potential, security and resilience, needs for coordination and co-deployment, in line with the horizontal proposals on competition policy.

8. **Further concentrate efforts and resources on common EU R&D and R&T defence initiatives and maximise technological spill-over between civilian and defence innovation cycles**, to better integrate commercial technology in defence applications and exploit dual-use products and solutions. In particular, support should be provided for the joint development of new strategic industrial segments in defence which require new cutting-edge technological capabilities and large investment. The involvement of the most innovative and high-tech companies from the civilian sector, in particular SMEs and start-ups from across the EU, should be encouraged and supported concerning the development of new defence solutions. A number of new or very challenging segments in defence (e.g. drones, hypersonic missiles, directed-energy weapons, defence artificial intelligence, seabed and space warfare) call for a joint strategic pan-European approach. This approach could be developed through new dual-use programmes and the proposed European Defence Projects of Common Interest, which would ensure the necessary industrial cooperation, as well as ensuring that EU and national funding are in place for the development of appropriate systems and infrastructure.

9. **Deepen the competences at the EU level for defence industrial policy to be reflected in the EU institutional set-up.**

   - **Define a new and more streamlined governance model across EU bodies** (the Commission, the EEAS and the EDA), empowering the Commission in its coordination role in the field of defence industrial policy.

   - **Establish a Defence Industry Commissioner**, with the appropriate structure and funding to define, coordinate and implement an EU defence industrial policy fit for today's new geopolitical context.

   - **Integrate further defence industrial policy objectives** in discussions between Member States in the Foreign Affairs Council Defence formation.

   - **Entrust a centralised EU Defence Industry Authority** to perform an EU defence joint programming and procurement function, i.e. to procure centrally on behalf of Member States. The authority would be managed by the European Commission and co-chaired by the HRVP/ Head of the European Defence Agency and the Commission. It would be advised by sector-specific groups composed of representatives from industry and EU Member States. The authority would provide a full overview of the offer and capabilities of the EU's defence industrial base, making use of the proposed European Military Sales Mechanism.

   - **Review EU internal rules and procedures for decision-making in the field of defence industrial policy** to achieve simplification, streamlining and faster policy action, in particular in crisis situations.

10. **Improve coordination and combine the acquisition of US systems by sub-groups of EU Member States.** Demand aggregation in this case would aim to achieve better terms and, where needed, European specifications of US defence products, including local production and support, freedom of action rights, customisation and IPR transfer. To partly rebalance trade in defence, the EU and its Member States could further promote the use of European defence solutions within NATO.

ENDNOTES

i Moretti et al., The Intellectual Spoils of War? Defense R&D, Productivity and International Spillovers, NBER Working Paper No. 26483, 2021.

ii The Aerospace, Security and Defence Industries Association of Europe (ASD), Fact & Figures 2023. Please note that the data presented include also non-EU European countries which are members of the ASD.

iii EconPol Europe Policy Report, European Defence Spending in 2024 and Beyond, Vol 8., 2024.

iv International Institute for Strategic Studies (IISS), Military Balance Blog, China's defence budget boost can't mask real pressures', 2024.

v Opening remarks by the European Commission President following the meeting of the European Council of 27 June 2024.

vi European Commission, Directorate-General for Defence Industry and Space, Access to equity financing for European defence SMEs, 2024.

vii Béraud-Sudreau, L., Scarazzato, L., Beyond Fragmentation? Mapping The European Defence Industry In An Era Of Strategic Flux, Centre For Security, Diplomacy And Strategy, 2023.

viii European Commission, A new European Defence Industrial Strategy: Achieving EU readiness through a responsive and resilient European Defence Industry, JOIN/2024/10 final, 2024.

ix European Defence Agency (EDA).

x European Defence Agency, Defence Data 2022 Key findings and analysis, November 2023.

xi United States Department of Defence, Fiscal Year 2024 Budget Request.

xii Stockholm International Peace Research Institute (SIPRI).

xiii European Defence Agency, Defence Data 2022 Key findings and analysis, November 2023.

8. Space

The starting point

The global space sector stands at the forefront of technological innovation, contributing to cutting-edge advancements, the resilience and security of modern societies – either directly or through spillovers. Satellite services, data and their applications are key enablers and form a fundamental part of modern infrastructure, for example, in the fields of:

- **Transport**. Positioning, navigation and timing (PNT) are necessary to all transportation industries, including smart transportation. Other space-based applications are used in autonomous mobility systems and for infrastructure monitoring.
- **Communication**. The ubiquitous availability of satellite communications has for years been a pillar of television transmission and broadcasting. Today, new Low Earth Orbit (LEO) constellations are delivering broadband communication everywhere – in remote locations, on airplanes, ships, and in land vehicles.
- **Environment, agriculture and response to natural disasters**. Earth Observation is key to understanding the Earth's geology, to mapping and understanding climate change and weather. Earth Observation instruments are among the largest producers of digital data, which is used to build models that allow day and night monitoring of land and sea resources, air quality, pollution, and natural crisis management. With the advent of supercomputing and AI, these models have increasingly been used to predict the evolution of the environment, and its effect on infrastructure, agriculture, farming and fishing.
- **Energy**. Satellites collect data (on water temperatures, waves, tidal flows and wind speeds) which are used to map, locate and operate infrastructure for offshore renewable energy generation, including ocean energy and floating wind or solar photovoltaic installations. Accurate weather data helps to improve energy generation and address electricity fluctuations (both in supply and demand).

TABLE OF ABBREVIATIONS

ASI	Italian Space Agency
ASIC	Application-specific integrated circuit
CNES	National Centre for Space Studies
DARPA	Defence Advanced Research Projects Agency
DLR	The German Aerospace centre
EAR	Export Administration Regulation
EEE	Electrical, Electronic and Electromechanical
EIF	European Investment Fund
ESA	European Space Agency
EUSPA	EU Space Programme Agency
FPGA	Field-programmable gate array
GNSS	Global Navigation Satellite Systems
GPS	Global Positioning Systems
IRIS	Infrastructure for Resilience, Interconnectivity and Security by Satellite
ISS	International Space Station
ITAR	International Traffic in Arms Regulations
LEO	Low Earth Orbit
NASA	National Aeronautics and Space Administration
PNT	Positioning, navigation and timing
R&D	Research and development
RF	Radiofrequency

- **Financial markets**. Timing from Global Positioning Systems (GPS) is used on world financial markets.

- **Security and defence**. These fields have driven some of the above applications, are heavily dependent on satellites and their instruments to identify threats on the ground and in the air, verify the situation on ground, secure communication between all platforms in hostile territory, intercept and disrupt communications. The above civilian and security applications have raised attention concerning the need to protect space assets from hostile or accidental threats.

Beside the direct benefits listed above, space activities have several spillover effects for society: economic (including the exploitation of data and services); technological (from solar panels to the most efficient communication protocols); industrial (raising the quality of products given the need for the uninterrupted operation of space systems); robotics and remote operations; complex operations planning.

The value of the space economy is substantial, and is set to grow significantly with the adoption and implementation of space solutions across more and more sectors in the broader economy. The value of the global space economy in 2023 stood at USD 630 billion and estimates for the future indicate that it could reach USD 1.8 trillion by 2035, growing at an average of 9% per year[i]. Taking into account the broader economy, where space plays a key enabling role for other core industries – in terms of creating new markets and generating value-added – the estimated value of the sector already stands at over USD 3 trillion[ii]. Future growth will mostly arise from the exploitation of space-enabled data, but also from the development of entirely new space-based industrial segments in sectors, such as pharmaceuticals (for research and drugs development), semiconductor production, and biotechnologies (with 3D printing). However, to benefit from the growth of all these segments, more traditional space assets (e.g. access to space) remain essential strategic enablers [see the Box on launchers]. Besides the big space powers (i.e. the US, Europe, China and Japan), total investment in space in the rest of the world has experienced impressive growth, with total investment increasing from EUR 163 million in 2020 to EUR 566 million in 2023 (predominantly originating from Canada, India, Israel and Australia)[iii].

The space industry is undergoing deep structural change, with increased participation by private companies and rapid growth among innovative start-ups. The term 'New Space' indicates the emerging private space industry (including start-ups) characterised by an innovative business model and new technological trends, disruptive innovation, shorter lifecycles in delivery and more risk-taking. New Space is radically transforming the space industry, which is moving towards new funding schemes (private financing), risk-openness, the fast-delivery of products and services, and lower costs. The decommissioning of the International Space Station (ISS), foreseen for 2031, is one of the events expected to trigger an acceleration in the development of new commercial and national space capabilities. In the future, large space projects will not only be based on multi-country partnerships, but are expected to be driven also by public-private partnerships, smaller groups of countries, commercial demand and solutions. Unlike in the past, advanced technological capabilities will be provided by private companies and platforms. This will create a market where services are available for both government and private customers.

The EU has developed world-class strategic space assets and capabilities, with technical competences on par with other space powers in most areas. The EU is a space power with significant industrial capabilities and know-how, particularly regarding the assembly and integration of systems (i.e. the last stages of the value chain). The EU funds, owns and manages critical space infrastructure, which is a unique feature of the space sector for the role played by the EU. More than 250,000 highly skilled jobs are directly supported by the EU Space Programme with estimated value-added between EUR 46 and 54 billion. The EU space sector masters cutting-edge space technologies, fostering innovation in areas including materials and satellite communication. European companies are leaders in satellite manufacturing, they produce high-quality satellites for various purposes, contributing to the EU's position in the global satellite market.

- **In the field of satellite navigation**, Galileo provides the most accurate and secure positioning and timing information, including for military applications from 2024. Galileo's High Accuracy Service is much more precise than any other Global Navigation Satellite Systems (GNSS), including the US' GPS or China's Beidou. A few illustrative figures: 10% of the EU's GDP is enabled by satellite navigation; around four billion smartphones and more than 900 phone and tablet models are enabled by Galileo; 69% of new agriculture machinery is supported by Galileo.

- **In Earth Observation**, Copernicus offers the world's most comprehensive Earth Observation data, including for environmental monitoring, disaster management, climate change monitoring, and security. The Earth Observation market is led by the US and Europe, with market shares of 42% and 41% respectively.

- **In secure communications**, as of 2027, the IRIS² (Infrastructure for Resilience, Interconnectivity and Security by Satellite) Constellation will offer highly resilient satellite communications in support of government applications, including surveillance (e.g. border surveillance), crisis management (e.g. humanitarian aid) and the connection and protection of key infrastructures (e.g. secure communications for EU embassies).

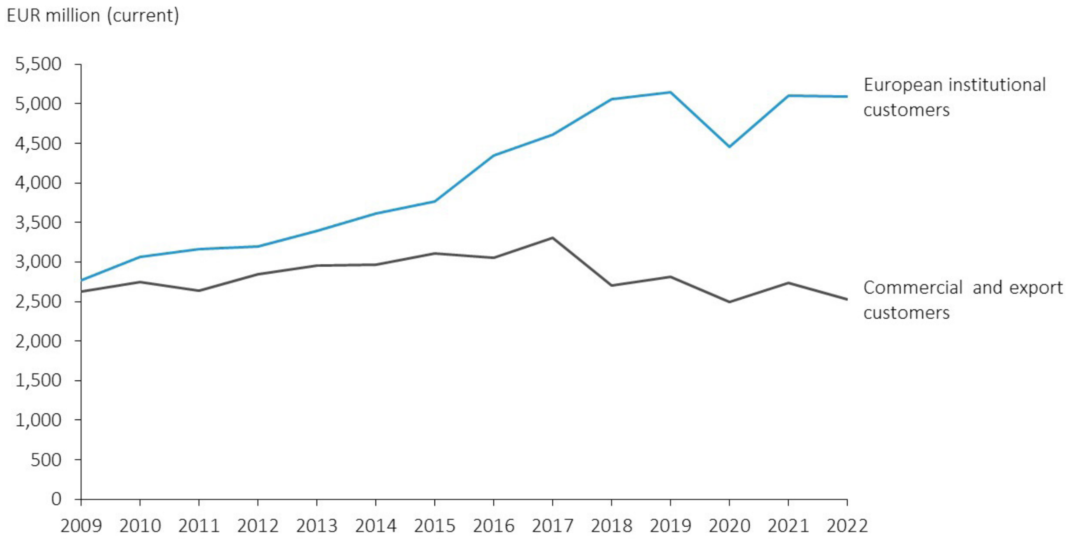
Overall, the European space industry has remained competitive during the past decades. This is noteworthy especially considering that the share of public funding (i.e. the institutional market to which European space companies had access) has been considerably lower compared to that of its main competitors. The EU's space industry is a net contributor to Europe's trade balance, exporting globally complete satellite systems, launch services, equipment and subsystems[iv]. The New Space ecosystem is also booming in the EU, with more than 800 space companies created in the last decade, some of which are the most innovative worldwide[01]. The EU is the region attracting the second most investment in New Space ventures globally, however the US leads by far with significant growth during the past three years.

Nevertheless, the EU has arguably lost ground in space activities and lagging further behind may quickly translate into deeper strategic dependence. Europe represents about 12% (EUR 5.6 billion) of the global upstream market value and 23% (EUR 83 billion) of the downstream market[v]. The EU's domestic market is relatively large, yet fragmented, and represents the core market of the European space industry. The EU has lost its leading market position in commercial launchers (Ariane 4-5) and geostationary satellites. As a result, it had to rely temporarily on the US' Space X rockets to launch satellites for its strategic programme Galileo [see the Box below]. Similarly, Starlink's success is disrupting European telecom operators and manufacturers. Today, whilst retaining technical competitiveness in the space segments of Earth Observation, navigation and exploration, the EU lags behind the US in rocket propulsion, mega-constellations for telecom and satellite receivers and applications (a market much larger than the other space segments). The EU is also highly dependent on imports of high-end electronic components (semiconductors) and detectors.

Indeed, EU commercial and export sales have experienced a downturn in the past years. While sales to European public entities increased (except for in 2020), commercial and export sales have witnessed a stepped decrease since 2017, with the 2022 level close to 2009 figures [see Figure 1]. The last few years have been characterised by severe disruptions to supply chains, caused both by the COVID-19 pandemic and Russia's war of aggression against Ukraine. Final sales decreased from EUR 8.6 billion (in 2021) to EUR 8.3 billion (in 2022), with the main losses in launcher systems and satellite application systems. The profitability of the European space sector has been rapidly decreasing.

01. Companies, such as ICEYE (Earth Observation/remote sensing), The Exploration Company (space transportation) or D-Orbit (in-orbit services and logistics) have established themselves as global market leaders, even though they had to resort mainly to non-EU capital to finance their growth.

FIGURE 1
EU space industry final sales by customer agent



Source: Eurospace, 2023.

BOX 1

The crisis of Europe's launchers

Autonomous access to space is a prerequisite for the EU's strategic autonomy. At the same time, European launch systems face key strategic challenges.

European launch systems allowed the deployment and replenishment of the EU-owned satellite constellations Copernicus, Galileo (and soon IRIS²), which all contribute to the resilience and security of the EU and its Member States.

Europe's development and launch service management was executed in an inter-governmental context, under the European Space Agency (ESA). ESA Member States have funded the development of Ariane and Vega launchers since the 1970s. Since 2022, the governance of European launchers is in crisis, following the ceasing of Ariane 5 operations, the end of Russian Soyuz launches, the grounding of Vega C, delays in development of Ariane 6, and uncertainty concerning to their competitiveness.

Several privately funded EU start-ups are striving to develop new space transportation solutions, also in light of the temporary non-availability of Ariane and Vega. However, Europe has historically had a limited institutional demand for launch systems, accounting for only a small part of the global market (at around 1%). This makes European launch service companies highly dependent on large, accessible markets to scale up and develop. At the same time, the open commercial market is very restricted, with the US and China's markets dominated by domestic players, often protected by legislation; while the European market remains relatively open[02].

02. 70% of the satellite launch market is captured either by countries' own space institutions (e.g. in the US, China and Russia), or by companies that develop both satellites and launchers. Nearly 20% of total missions have already been contracted (to national launch vehicles of non-EU governments), leaving only 10% open for the European launch providers during the 2023-2032 period.

The EU's commercial competitors, mainly from the US and China, have developed new capacities which are not accessible to Europe (e.g. micro and super-heavy launchers, reusability, new propulsion, etc.). As a result, they are proposing attractive launch-service prices on the commercial market. The emergence in the market of reusable launchers has been a game-changer. Reusability allows US' Space X (with its Falcon launchers holding a very high launch cadence) to address its own needs (40%), the US' institutional needs (over 30%), and commercial needs. The access to a high volume of government contracts and a vertically integrated model translate into high capabilities, and allow Space X to offer very low-cost launch services on the commercial market. In China, the first stage of Long March 8 is expected to reach ten-time reusability by 2025. In July 2023, a private Chinese company launched the first launcher (ZQ-2) powered by a liquid methane-oxygen engine.

The launchers and space transportation programmes driven by the ESA and its member countries have failed to react to this global technology evolution, due to complex decision-making, a governance structure characterised by a 'geographical return' principle, and the absence of a European preference approach.

In response to this situation, the European Commission, as the largest institutional customer in Europe, is examining different options to reshape the governance model for launchers. As a first step, in 2023 the Commission and the ESA presented the Flight Ticket Initiative. The initiative is a radical change in launcher policy based on a service-driven approach, greater competition, and a preference for European solutions. The initiative aims to set up a pool of five launch service providers, including four new commercial entrants. These providers should be ready to offer launch services in the 2024-2026 period for the needs of the Commission and the ESA, who will act as anchor customers.

Given that the accessible launch market is very limited, ultimately for European companies to succeed and be competitive globally, they should be able to rely on full European pooled institutional launch demand and to have access to multiple launches. While the Flight Ticket Initiative strives to increase healthy competition, developing new capacities and efficiencies, it also carries the risk of creating unnecessary divisions between Member States' national space programmes and companies, further fragmentating the EU's industrial base.

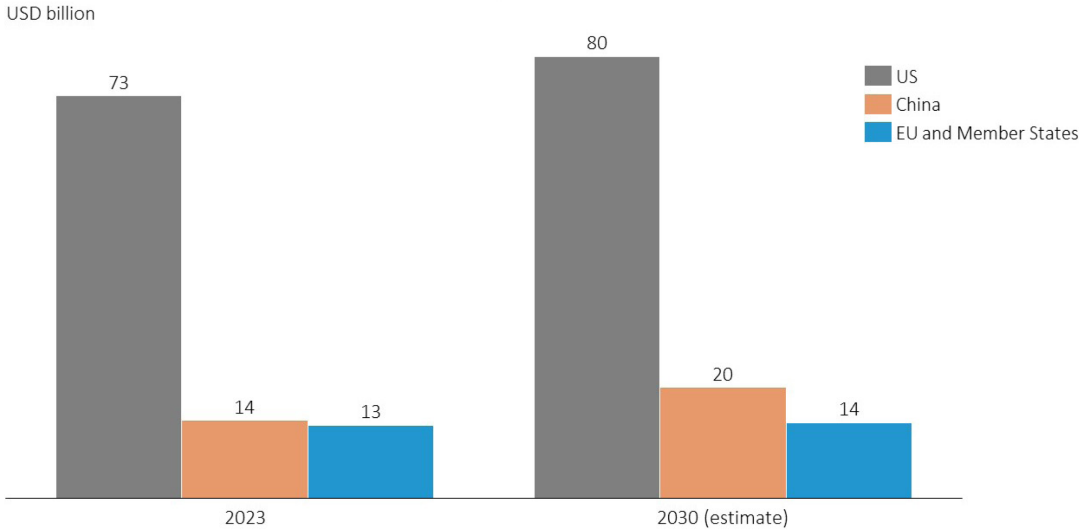
THE ROOT CAUSES OF THE EU'S COMPETITIVE GAP

→ Lower public funding for space policy

Public investment plays a crucial role for the development of the space industry. The space sector is supported by public investment for necessary infrastructure, the establishment and support of ambitious space programmes which create markets and enable the development and growth of private space companies. The EU's industrial base suffers from forty years of investment, which on average ranged between 15% and 20% of that in the US. This has created an imbalance with our main competitors in terms of industrial capacity and a specialised workforce.

The EU's public funding for space activities is falling behind that of its competitors, with public expenditure dominated by the US, and growing very rapidly in China. After the Second World War, Europe recognised the strategic value of space technology, and following the US' approach under NASA, it developed joint R&D projects to pool EU and national resources. While this approach allowed the EU to quickly fill its competence gaps and develop a European industry with key capabilities, it did not match the large-scale military procurement of the US' Department of Defence, or that of the Russian or more recently Chinese government. In 2023, public expenditure on space in the EU and its Member States accounted for about USD 13 billion, compared to the US' USD 73 billion, i.e. more than five times larger. Budgetary projections indicate that the US government's space expenditure is expected to continue increasing, while European funding will stagnate. China is expected to overtake Europe in the next few years, reaching an expenditure of USD 20 billion by 2030.

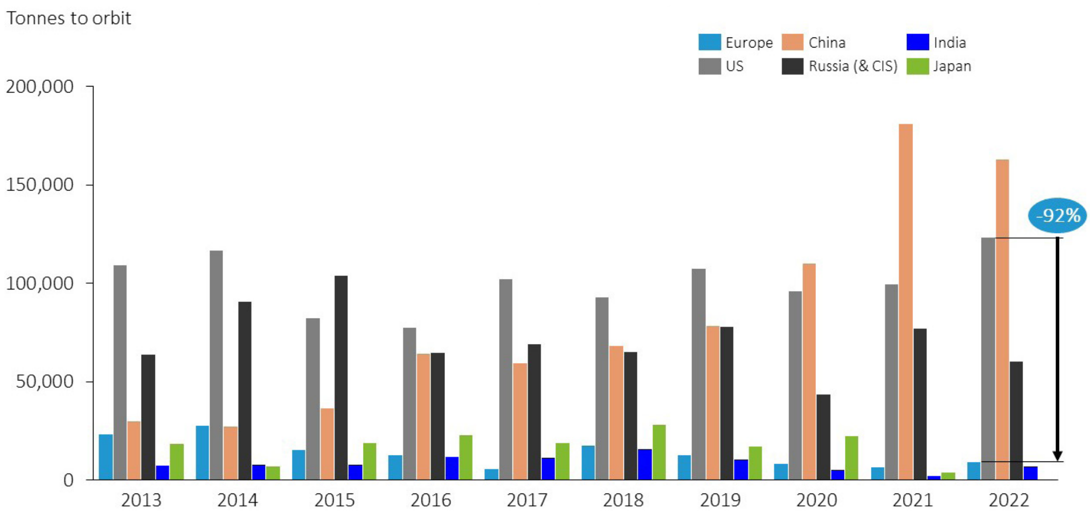
FIGURE 2
Government expenditure on space programmes



Source: Euroconsult, 2023.

The US and China's large civil and defence space programmes enable the growth and technological advancement of their domestic industrial bases. The US remains the uncontested leader in space, both for civilian programmes such as space exploration, Earth Observation and human spaceflight, but also in defence, with leading capabilities across the spectrum. In 2022, defence applications accounted for about 60% of space-related expenditure in the US (USD 37 billion). China's total space expenditure in 2023 is estimated to have been nearly USD 14 billion, with 62% represented by its civil space budget, and the remaining 38% by defence. China's civil space programme is vast and comprehensive, with significant industrial capacity and technological know-how across all the main areas of satellite application. Compared to the US and Europe, the Chinese space industry can count on lower costs for capital and labour inputs. Larger institutional space expenditure in the US and China generate a larger market for domestic companies, as they typically apply national-preference approaches when procuring and purchasing space services and solutions. Europe accounts for only 10% of all the approximately 6,500 institutional satellites (civil and defence) which are expected to be launched worldwide from 2023 to 2032.

FIGURE 3
Mass launched on behalf of institutional space programmes



Source: Eurospace, 2023.

→ Lacking coordination

The lack of coordination among EU Member States' investment in space hinders the aggregation of demand and 'anchor spending'. The notion of institutional space missions serving as an anchor for customers of domestic critical technologies is a strategy extensively employed by the US and China. They demand by regulation and mission requirements the use of domestic critical strategic technologies (from the system to component level) to ensure high demand volumes (driven by institutional missions) for their companies, and to contribute to their technological maturation. A similar approach has not been taken in the EU and its Member States where the selection of technologies is essentially driven by their performance, cost and lead time. Over time, however, this has led to the erosion of the EU's supply chains for solutions that were initially developed by EU R&D investment, due to insufficient volumes and demand. It has prevented EU space products from reaching the necessary market insertion and/or from maintaining a sufficient level of competitiveness by demonstrating similar or higher performance levels when competing with products from outside the EU. Indeed, much European investment made at the Member State level is not coordinated and does not contribute to demand aggregation and 'anchor spending' within the Single Market. As described above, the presence of multiple institutional space stakeholders implementing procurement and R&D projects based on a national logic adds complexity to the already fragmented nature of space supply chains.

→ Insufficient investment in R&D

Public investment in space R&D in the EU does not meet the required level of ambition. Europe is home to world-leading research institutions and universities, with a high impact on research and scientific progress in space. Altogether, investment in Europe by the EU, the ESA and major European countries in the field of space (Germany, Spain, France, Italy, and the UK) amounted on average to EUR 2.8 billion per year between 2020 and 2023. At the same time, investment in the US and China totalled EUR 7.3 billion and EUR 2.3 billion respectively. There is a pressing need to increase public investment supporting R&I in the field of space. Increased investment would not only enhance the competitiveness of the EU's space sector at large, but also foster the development of future strategic capacities, such as in-space operations and services (e.g. spacecraft servicing, assembly, manufacturing and transport in space) and quantum technologies. Besides increased investment, a comprehensive strategy on space R&I, aiming to establish a common vision and ensuring EU's technological leadership, is also lacking.

→ Limited access to finance

EU space companies' ability to scale up is hindered by limited access to finance and public contracts. The European space private ecosystem is characterised by numerous and dynamic start-ups that generate innovation. The space sector is high-tech and capital intensive with long investment cycles and, therefore, high risk. European companies are not able to scale up mainly due to limited access to finance. They are as a result forced to turn to non-EU markets for growth financing, often losing their EU ownership. They are also being bought by large non-EU companies, which acquire technology and know-how initially developed in the EU. A primary challenge is the difficulty for New Space start-ups to secure late-stage private equity funding (Series B, C and D) within the EU. Access to loans also proves challenging due to the risk aversion of key institutional players, such as the European Investment Bank (EIB) Group, and the still limited role of commercial banks in providing financing for space ventures. This scarcity of funding during critical growth phases hampers the ability of Europe's New Space sector to scale up and innovate effectively. Furthermore, limited access to public procurement contracts constrains New Space companies' ability to secure long-term revenue streams and establish credibility in the market. In 2023, US private investments in space totalled approximately EUR 4 billion, compared to EUR 1 billion in Europe. The private investment gap in Europe is estimated at EUR 10 billion during the next five years. Compared to previous years, as of 2023, private investment in the space economy have started to be more selective and targeted, decreasing access to finance for many emerging players.

→ A complex and fragmented governance model

The European governance of the sector is characterised by the co-existence of multiple institutional actors at the national and European levels, which amplifies the fragmentation of the EU's space industrial base. This governance is the result of historical and institutional developments during the past decades [see the dedicated

Box below]. In particular, the ESA – the leading European public institution in the field of space – operates based on the principle of 'geographical return', meaning that it invests in each of its member countries through industrial contracts for space programmes an amount which is more or less equivalent to the country's financial contribution to the agency. EU-funded programmes managed by the ESA are not covered by the geographical return principle. They follow EU procurement and financial rules, based on open competition and excellence. During the past decades, the principle of geographical return has enabled the commitment of significant national budgets to common space programmes. It has also allowed the increase of the capabilities of member countries in developing space technologies and enabled their industry to engage in different space technology fields and value chains. However, this policy is increasingly outdated.

The ESA's geographical return principle amplifies the fragmentation of the EU's space industrial base. In the context of increased global competition in space and a changing geopolitical environment, the geographical return principle has proved ineffective and even counterproductive (especially in key segments, such as launchers and space telecom). The policy is a source of economic inefficiency and harms the competitiveness of the European space industry due to a number of factors, including:

- The formation of complex industrial networks and the artificial fragmentation of supply chains induced by requirements to procure from specific member countries.
- The unnecessary duplication of capacities in relatively small markets.
- A mismatch between the most competitive industrial actors and the actual allocation of resources (driven by geographical repartition).
- Constraints on the choice of suppliers and on the inability to switch in case of underperformance, impacting project timelines and costs.

The geographical return principle becomes particularly inadequate in light of the fast growth and development of New Space actors, a fast global space race and the emergence of powerful global private players in the space domain, which do not follow any geographical non-commercial logic within a Single Market.

BOX 2

The governance and financing of EU space programmes

From a very simplified perspective, NASA in the US possesses the technical knowledge and facilities available to the US space industry. It develops and manages mostly civilian programmes, while the Space Force unifies the space activities of the armed forces. The Defence Advanced Research Projects Agency (DARPA) and other bodies have specific roles, but it is fair to say that NASA and the Space Force are the main two arms of the US government for space matters. They manage most of the approximately USD 50 billion a year spent on space, with the US Vice-President in charge of relevant policy in the White House's National Space Council.

The institutional set-up for space policy in Europe is more complex and fragmented compared to the US, mainly for historical reasons and to the specificities of the EU. The establishment of the European Space Agency (ESA), as an intergovernmental organisation, dates back to the 1970s. The EU gained competence in space policy much later, in particular, under the Lisbon Treaty, which established space as a shared competence of the EU and its Member States. These developments are reflected in current governance and funding structures at the European and national levels.

The European Commission is the overall programme manager for the EU Space Programme and IRIS2. It leads the design and evolution of space activities in the fields of Earth Observation, satellite navigation, connectivity, and space R&I. The EU Space Programme is continuously funded by the EU's Multiannual Financial Framework (MFF), which during the 2021-2027 period allocates a budget of EUR 14.9 billion to space policy.

The Commission implements the EU Space Programme also through its **EU Space Programme Agency (EUSPA)**. Established in 2021, EUSPA was initially conceived as the agency in charge of the operations of some of the EU's flagship space initiatives. Its main responsibilities have evolved and now include: i) the implementation and monitoring of the security of the EU Space Programme, acting as the security accreditation authority for all EU space assets; ii) promoting the exploitation of data and services offered by Galileo, EGNOS, Copernicus and GOVSATCOM across all domains; iii) providing front-desk services for the EU's Space Surveillance Tracking system; iv) offering positioning, navigation and timing and satellite communications services.

The ESA is an intergovernmental organisation (a non-EU institution) with 22 member countries, of which three are not EU Member States – the UK, Norway and Switzerland. The ESA's Governing Council is composed of the national bodies responsible for space in its member countries. The ESA runs space programmes funded by its member countries and is entrusted with the development, deployment and the technical evolution of a number of systems, including Galileo, Copernicus and EGNOS. It is the organisation at the European level with the highest technical capacities concerning space projects. Its budget for the 2022-2025 period amounts to EUR 16.9 billion and the agency is largely operated according to the principle of geographical return[03].

Finally, **EU Member States** themselves over the years have developed their own national space agencies, funded under national budgets. For example, the Centre National d'Etudes Spatiales (CNES), Deutsche Luft und Raumfahrt (DLR), and Agenzia Spaziale Italiana (ASI), all have significant centres, personnel and national space programmes. While ESA plays a coordination role and member countries place significant amounts of their space budget under the framework of the ESA, there is a lack of strategic and political cooperation between EU Member States regarding space policy-making.

Overall, the total European institutional funding of space programmes is not only a mere 20% of the US level, but it is also highly fragmented.

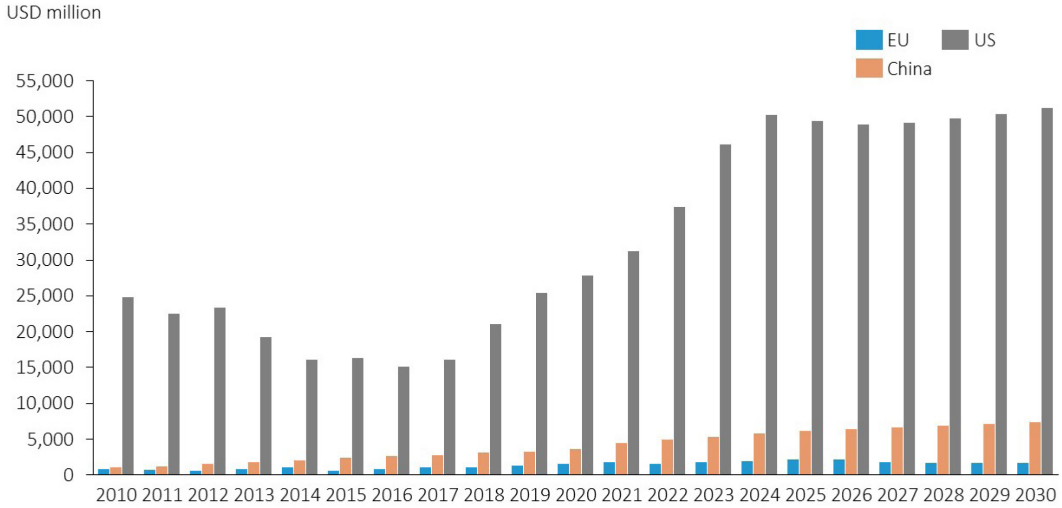
The EU lacks a unified legal framework for its space sector. At the moment, there is no single Space Law in the EU, but multiple and heterogeneous national space laws, which evolve at different speeds and prevent the EU from exploiting the benefits of a Single Market for commercial players. The Commission plans to propose an EU Space Law, which would establish a coherent legal framework, bring legal certainty for space market operators and create a level-playing field in the sector. Legislation would envisage common EU standards and rules for the safety, resilience and sustainability of space activities and operations.

→ Limited coordination between space and defence

Coordination and synergies between space and military activities are not fully exploited in the EU. Space assets are key for military operations (including for surveillance and intelligence), and for Europe's sovereignty. While all EU Member States recognise space as a strategic domain, their sense of urgency and strategies for protecting space assets vary. Only recently, with the adoption of the EU Space Strategy for Security and Defence (March 2023), has the EU started to develop synergies between space and defence to: (i) leverage the use of space in support of security and defence operations (including in the field of surveillance); and (ii) enhance the level of protection of space assets. The US established a Space Force in 2018, signalling a transformative view of space as a warfighting domain. This resulted in a shift from considering space as a support function, to recognising it as a distinct and leading dimension in future military operations. China's interest in space defence emerged from a doctrinal shift in 2015, acknowledging space as a key strategic arena. The creation of the People's Liberation Army Strategic Support Force in 2016 and China's possession of disruptive technologies underscore its capabilities in this domain.

03. In 2024, the ESA has a budget of EUR 7.8 billion, out of which EUR 5 billion come from member countries contribution to ESA programmes, EUR 1.8 billon from the European Union and EUR 1 billion from other cooperation agreements.

FIGURE 4
Space defence expenditure



Source: Euroconsult, 2023.

→ International dependency

European space activities and programmes face trade barriers and strategic dependency on foreign producers. European space programmes often heavily depend on critical technology and suppliers from outside the EU[04], which affects the economic security and sovereignty of the EU, as well as the competitive position of the European space manufacturing industry. Dependence on non-EU suppliers introduces potential geopolitical vulnerabilities, weakens the resilience of space supply chains, and undermines the continuity of space programmes in face of evolving global dynamics. This situation is aggravated by the imposition of stringent US export regulations, such as the International Traffic in Arms Regulations (ITAR), the Export Administration Regulation (EAR), and the recent Foreign Direct Product Rule. These regulatory frameworks, designed to safeguard US interests, inadvertently limit EU access to technology. They can lead to restrictions, procurement delays, administrative hurdles, uncertainty regarding the granting of licenses, and security concerns over the final use of components. Similar barriers are also in place for EU exports. The major market for the space industry, the US, imposes a number of import control measures and market access restrictions which protect US companies (through 'Buy American' measures), and limit the export of EU technologies. At the same time, the EU market remains open for foreign companies, both in terms of market access and foreign takeovers.

THE PERSPECTIVE MOVING FORWARD

Moving forward, a lack of adequate investment in European space assets and capabilities – supported by both public and private funding – would have severe implications for the European space industry. In particular, in the absence of necessary investment, the EU and its companies would:

- Miss future large commercial opportunities in fast-growing segments of the space market which will be unlocked by non-ISS stations and other space projects in the New Space economy.
- Face future entry barriers to the New Space economy, suffer from 'late-mover' disadvantages, and be unable to access critical technologies.

04. This is, for example, the case in the area of Electrical, Electronic and Electromechanical (EEE) components developed specifically for responding to space requirements, such as space-qualified microprocessors, field-programmable gate array (FPGA), application-specific integrated circuits (ASICs), radiofrequency (RF) components, memory, etc.

- Procure foreign (mostly US) solutions, deepening the existing strategic dependence on foreign suppliers in the absence of EU autonomy in this strategic sector (e.g. NASA has already awarded funding to four private US companies to develop private space stations after the ISS).

- Be unable to provide comprehensive and integrated solutions – because of lacking capabilities – which could leave European companies uncompetitive compared to other foreign suppliers.

- Face the progressive erosion of the EU's space industrial base and become more dependent on foreign players (mainly the US) in all the sectors linked to the space economy.

The Commission has launched a number of initiatives aiming to improving the conditions for New Space companies to scale up in Europe. The CASSINI Space Entrepreneurship Initiative, supported by the European Investment Fund (EIF), is one of them. The Cassini Investment Facility deploys EUR 1 billion in investment for venture capital funds interested in investing in EU-based companies in the space sector. To date, 13 European venture capital funds have received support from CASSINI[05]. Other initiatives involve the EIB Group for debt operations, the ESA and the EUSPA for matchmaking activities, and the European Innovation Council (EIC) for financial support to New Space companies. The Commission is also stepping up its role as an anchor customer, facilitating the access of New Space companies to public procurement contracts (e.g. with the award of contracts to act as data suppliers for Copernicus Contributing Missions). While current initiatives are welcome first steps, they would need to be substantially reinforced and scaled up to meet the needs of the European space sector.

05. The 'Matchmaking' arm of the initiative supports start-ups, scale-ups and SMEs by connecting them with potential investors and corporate partners to expand their financing opportunities, secure new customers and access new markets. The CASSINI Business Accelerator supports companies in accelerating their business development and sales. Over 200 European New Space start-ups have been supported by CASSINI, closing around 100 deals since 2022 (the majority of which in venture capital investment), raising a total of over EUR 1.3 billion in funding.

Objectives and proposals

Overall objectives for a reinforced space industrial strategy at the EU level would include:

- Guaranteeing European sovereignty in autonomous access to space, defence capabilities, and key space applications for society, such as telecommunication, Earth Observation, navigation, and security.
- Maintaining or achieving world-class industrial leadership in selected areas and emerging space-based industrial segments.
- Enabling innovation and the scaling up of successful European market participants.

Specific initiatives should establish effective governance of the sector, allocate and mobilise the required resources, and increase the effectiveness of the spending.

FIGURE 5

	SUMMARY TABLE SPACE SECTOR PROPOSALS	TIME HORIZON[06]
1	Reform the European space governance framework to reduce complexity, fragmentation and overlap.	MT
2	**Remove the European Space Agency's geographical return principle to reduce the fragmentation of the EU's industrial base and modernise EU procurement rules.**	**ST**
3	**Establish a functioning Single Market for space, through a common EU legislative framework.**	**ST**
4	**Establish a multi-purpose EU Space Fund at the EU level.**	**MT**
5	Improve access to finance for EU space SMEs, start-ups and scale-ups to ensure they can grow in the EU.	ST
6	Introduce targeted European preference rules for the space sector to support the scale up of European companies.	ST
7	Define joint strategic priorities for space research and innovation, to be supported by increased coordination, funding and the pooling of resources at the national and EU levels.	LT
8	Further exploit the synergies between space and defence industrial policies.	MT
9	Define an EU policy framework for launchers aiming to ensure autonomous access to space.	ST
10	Promote further access to international space markets.	MT

06. Time horizon is indicative of the required implementation time of the proposal. Short term (ST) refers to approximately 1-3 years, medium term (MT) 3-5 years, long term (LT) beyond 5 years.

1. **Reform the European space governance framework to reduce complexity, fragmentation and overlap.** In particular:

    - **Reinforce the role and political steer of the Competitiveness Council** (COMPET) in providing strategic direction for European space policy and the EU Space Programme, identifying and aligning priorities at the EU level and better coordinating national policy action between Member States, including on funding priorities.

    - **Establish a full membership role for the EU**, to be represented by the European Commission, **at the Governing Council of the ESA**.

    - **Further promote within ESA a deeper alignment of the ESA's governance frameworks with EU** procurement, financial and security rules.

    - **Accordingly, redefine the respective roles of the Commission, the ESA and EUSPA to ensure closer cooperation and coordination** also with national space agencies.

2. **Remove the European Space Agency's geographical return principle to reduce the fragmentation of the EU's industrial base and modernise EU procurement rules.** In particular:

    - **Gradually reform the ESA's procurement rules** and the design of space programmes to reflect the outcome of industrial competition, the choice of the best providers, departing from the constraints imposed by the relative financial contribution of each member country.

    - **Concentrate the ESA's and national resources** on projects that demonstrate the potential for significant scientific or technological advancement, regardless of the geographical location of the participating entities.

    - **Modernise relevant EU procurement rules** to make them fit for the characteristics of the current space market, allowing for more flexible and substantially faster procedures.

    - **Design procurement calls (at all levels) in a way that enables the opening of supply chains**, and the participation of SMEs and emerging players.

3. **Establish a functioning Single Market for space, through a common EU legislative framework.** Introduce common standards and harmonise licensing requirements in Member States, so that products and solutions comply with the same requirements (i.e. in line with the planned EU Space Law). Necessary EU legislation should ensure EU sovereignty concerning standards and norm-setting in this strategic policy field.

4. **Establish a multi-purpose EU Space Fund.** This would enable the Commission to act as an 'anchor customer' and jointly purchase space services and products on the EU market. Such joint and centralised procurement and purchasing would help Europe's industrial base to increase its capacities. Moreover, it would accelerate the growth of EU space companies.

    The fund would also have the objectives of:

    - Financing collaborative, multi-country projects. This would help to reduce fragmentation within the EU's space market and the risks of the 're-nationalisation' of space policy, especially in view of the developments of New Space actors.

    - Attracting private funding and accelerating innovation, the diversification and attractiveness of the European space industry beyond existing EU flagship programmes.

    - Funding critical technologies and manufacturing capabilities in strategic segments.

    - Acquiring strategic and critical companies on the European market which risk being acquired by non-EU entities to ensure the EU's economic security and strategic autonomy in key space technologies.

5. **Improve access to finance for the EU's space SMEs, start-ups and scale-ups to ensure they can innovate and grow.** In particular:
   - Enable a more risk-oriented lending policy for the EIB Group.
   - Improve access to capital, especially in the later phases of investment (beyond venture capital), to support European space companies in growing and scaling up.
   - Develop financial instruments tailored to the size of investment and the needs of space SMEs and mid-caps, together with improved access to traditional forms of lending (loans, debt-financing, and guarantees).
6. **Introduce targeted European preference rules for the space sector to support the necessary scale up of European space companies.** The relevant rules could be accompanied by incentive mechanisms of a financial nature and eligibility criteria that provide access to funding only to EU-based companies.
7. **Define joint strategic priorities for space research and innovation**, to be supported by increased coordination, funding and the pooling of resources at the national and EU levels. The definition of joint strategic R&I priorities at the EU level, as well as resource aggregation, should aim to limit small national research projects and promote EU-wide projects which can achieve scale. **New large space programmes could cover launchers and access to space, advanced Earth Observation, in-space operations and services**.
8. **Further exploit the synergies between space and defence industrial policies.** This should include space-based services and solutions being developed by new commercial entrants in the EU's space industry. Increased defence spending (already budgeted by Member States) can be directed towards expanding the size of European institutional space demand, which would allow the European industry to achieve the required critical mass. Space assets should be recognised as critical security infrastructure and be granted the relevant level of protection.
9. **Define an EU policy framework for launchers aiming to ensure autonomous access to space.** The framework should aggregate European institutional and commercial demand, support critical and disruptive innovation and infrastructure for the EU and Member States' sovereignty (testing, production and launch facilities).
10. **Promote further access to international space markets.** Increase efforts to remove trade barriers and ensure fair access to international procurement. Establish and operationalise 'EU Space Diplomacy' to promote the EU's strategic interests and help EU companies to export to new and emerging space markets.

ENDNOTES

i World Economic Forum, Space: The $1.8 Trillion Opportunity for Global Economic Growth, 2024.

ii European Space Policy Institute (ESPI), More than a Space Programme: The Value of Space Exploration to Empower the Future of Europe, 2023.

iii European Space Policy Institute (ESPI), Space Venture Europe 2023: Investment in the European and Global Space Sector, 2023.

iv ASD Eurospace, The European space industry in 2021. ASD Eurospace, Facts & Figures 2022, 2023, 2024 are used throughout this chapter.

v Euroconsult, Space Economy Report 2023, published in 2024. Data from the Report are used throughout this chapter.

9. Pharma

The starting point

The global pharmaceutical sector is the fourth largest market in the world measured in terms of net sales and the third largest measured by overall profit[i]. The global market for medicines (EUR 1.2 trillion in 2022 at ex-factory prices) is expected to grow to USD 1.9 trillion (EUR 1.76 trillion) by 2027[ii]. In the longer term, population ageing will continue to spur growth in demand.

The pharmaceutical sector is a significant contributor to the EU's economy. It accounts for 5% of value added to the economy from all manufacturing – representing over 20% for Belgium and Denmark in 2020[iii]. Pharmaceuticals represent almost 11%[iv] of EU exports.

Around 937,000 people are directly employed by the sector (as of Q4 2023), up from 680,000 (in Q1 2008)[v]. It is estimated[vi] that adding indirect employment generated by the sector would more than double its employment footprint. The sector offers highly skilled and well-remunerated jobs, with some 15% of staff involved in R&D[vii].

Pharmaceuticals is also a sector of geostrategic importance, as demonstrated by the COVID-19 pandemic. The capacity to swiftly develop, produce and administer vaccinations was crucial in allowing the EU's economic recovery.

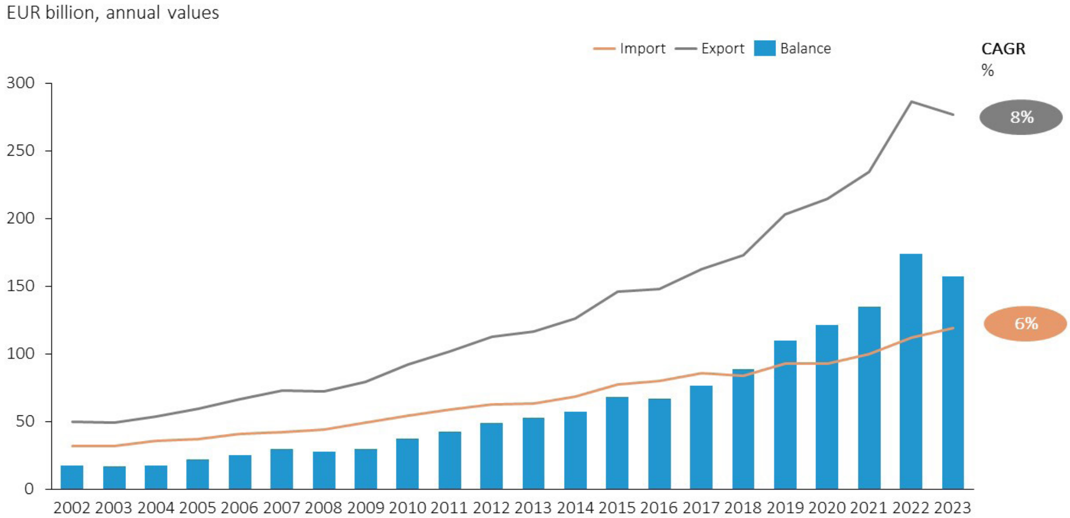
TABLE OF ABBREVIATIONS

1+MG	1+ Million Genomes
ACT EU	Accelerating Clinical Trials in the EU
AI	Artificial intelligence
API	Active pharmaceutical ingredient
ATMP	Advanced therapy medicinal product
B1MG	Beyond 1 Million Genomes
BARDA	Biomedical Advanced Research and Development Authority
CAGR	Compound annual growth rate
CIRM	California Institute for Regenerative Medicine
CTIS	Clinical Trials Information System
DARWIN EU®	Data Analysis and Real World Interrogation Network
ETCI	European Tech Champions Initiative
EHDEN	European Health Data Evidence Network
EHDS	European Health Data Space
EIB	European Investment Bank
EMA	European Medicines Agency
ERN	European Reference Network
FDA	Food and Drug Administration
GBARD	Government Budget Allocations for Research and Development
GDPR	General Data Protection Regulation
GMO	Genetically modified organism
HERA	Health Emergency Preparedness and Response Authority
HTA	Health Technology Assessment
INSERM	National Institute of Health and Medical Research
NCAPR	Network of Competent Authorities for Pricing and Reimbursement
NIH	National Institute of Health
P&R	Pricing and reimbursement
R&D	Research and development
RRF	Recovery and Resilience Facility
STEP	Strategic Technologies for Europe Platform
TFEU	Treaty on the Functioning of the European Union

The EU can leverage a strong historic footprint in the pharmaceutical sector:

- **A strong presence in trade**. The EU's pharmaceutical sector leads globally in trade measured by value. It accounts for sizeable and growing net exports, which peaked in 2022 – largely due to the export of COVID-19 vaccines [see Figure 1]. While there is wide variation between EU Member States, between 2002 and 2023 EU exports of medicinal and pharmaceutical products grew by almost 10% annually, while EU imports grew 8% year on year. During this entire period, the EU's trade balance for pharmaceuticals with the US was in favour of the EU, registering a surplus of EUR 45 billion in 2023 following a peak of EUR 53 billion in 2022.

FIGURE 1
EU trade in medicinal and pharmaceutical products



Source: Eurostat, 2024

- **A strong manufacturing base and scientific know-how in the on-patent space**. The EU's strong manufacturing base in the on-patent space (also demonstrated by its global trade presence) is further underscored by the fact that most active pharmaceutical ingredients (APsIs) for innovative medicine production in the EU are sourced from within the EU itself (77%)[viii]. In total, also including considering generics, EU imports and exports of APIs are roughly balanced in value and volume[ix].

- Concerning research, the EU remains on par with the US in terms of the number of scientific papers published. Recent trends show that the EU is actually overtaking the US in terms of the volume of scientific publications, especially in international journals. However, the US continues to have a more significant impact in citations [see Figure 2].

FIGURE 2
Strong fundamental in science

	Publications (world shares)			Top 10% publications (world shares)			Top 1% publications (world shares)		
Country	2000	2010	2020	2000	2010	2018	2000	2010	2018
EU-27	**29%**	**26%**	**21%**	**23%**	**24%**	**22%**	**20%**	**23%**	**20%**
United Kingdom	8%	6%	4%	10%	8%	7%	10%	8%	8%
China	3%	9%	16%	1%	5%	14%	1%	3%	9%
Japan	9%	6%	4%	5%	3%	3%	3%	3%	2%
US	31%	26%	21%	46%	40%	31%	53%	48%	40%

Source: European Commission, DG RTD. Based on data provided by Science-Metrix using Scopus database.

THE EU'S EMERGING COMPETITIVENESS GAP

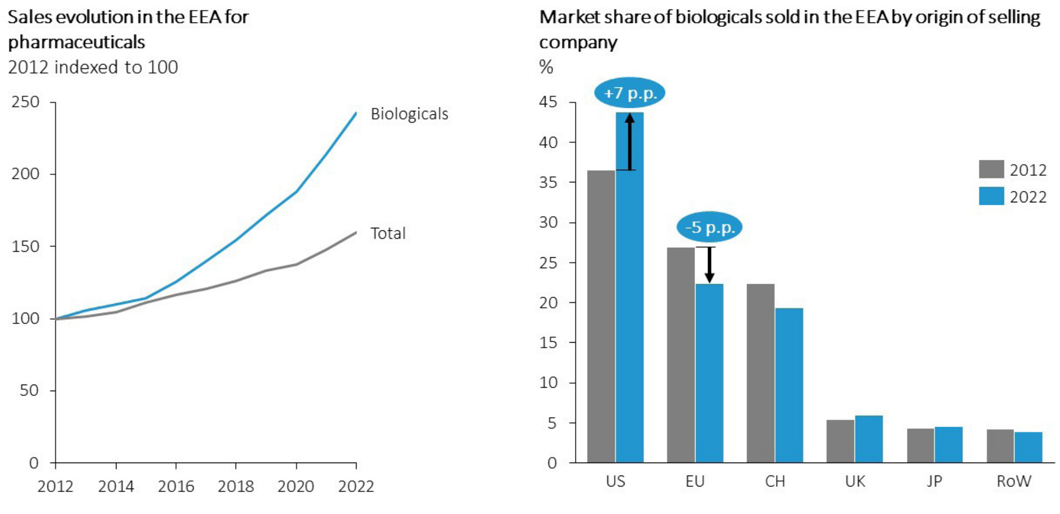
Nevertheless, over the past decade markets for pharmaceuticals have undergone transformative changes. This is demonstrated based on pharmaceuticals sales data for the EU (data for Malta and Cyprus missing) and Norway. The market for biologicals continues to grow dynamically [see Figure 3], along with exceptional growth in the market segment for orphan medicines [see Figure 4] and medicines based on genes, tissues or cells (advanced therapy medicinal products (ATMPs)) [see Figure 5]. These product categories largely overlap. Currently, 55% of orphan medicines sold in the EU are biologicals and many ATMPs are orphan medicines.

The EU is falling behind in these most dynamic market segments. Of the top ten best-selling biological medicines in Europe in 2022, two were marketed by EU companies, while six (including the top four) were marketed by US-based companies[x]. A clear drop in the market share held by EU companies is noted, whereas that held by US companies increased [see Figure 3].

Of the top ten best-selling products with market exclusivity as an orphan medicine in the EU/EEA in 2022, none were marketed by EU-based companies[xi]. By contrast, seven were marketed by US-based companies. Sales data for medicines with orphan medicine status in the EEA show a dramatic drop for EU-headquartered companies from over 40% of the market in 2012 (the United Kingdom alone accounted for more than 50%) to less than 5% in 2022, while the US today accounts for almost 70% of the market [see Figure 4].

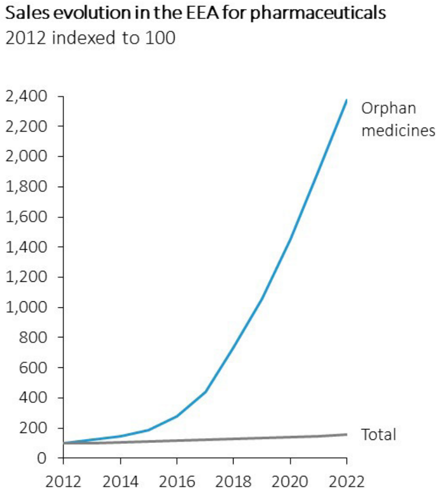
Currently, advanced therapy medicinal products (ATMPs) represent global market sales of some EUR 8 billion. Of this, EUR 1 billion is accounted for by the EU/EEA, mostly from products marketed by companies headquartered in the US and Switzerland [see Figure 5]. Spending on ATMPs worldwide grew with a compound annual growth rate (CAGR) of 60% between 2017 and 2022[xii].

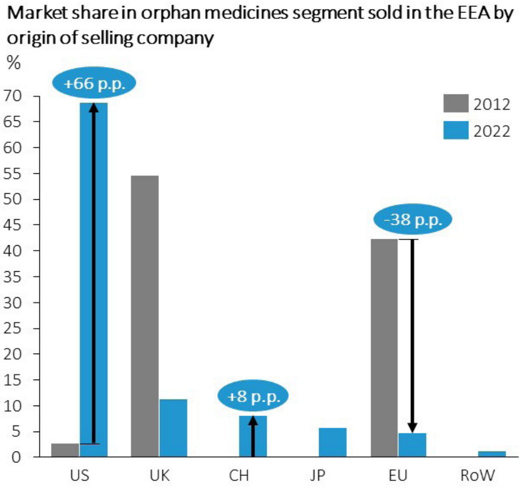
FIGURE 3
Market share erosion in the key segment of biologics



Source: European Commission. Based on IQVIA MIDAS® quarterly volume sales data for period 2012 – 2022 reflecting estimates of real-world activity. Copyright IQVIA. All rights reserved. Data for EEA markets (no data for CY, MT, IS and LI; retail data only for DK, EE, EL, LU, SI) and EC data (JRC R&D scoreboard) for regional allocation of companies.

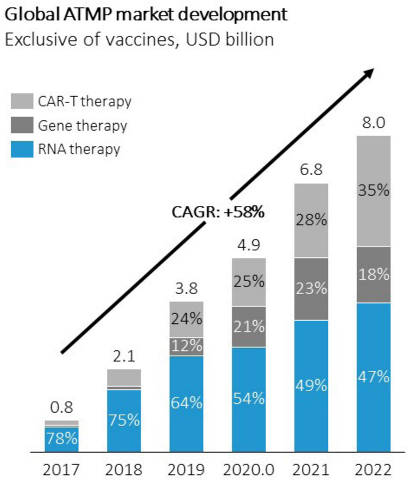
FIGURE 4
Market share erosion in the fast-growing segment of orphan medicines

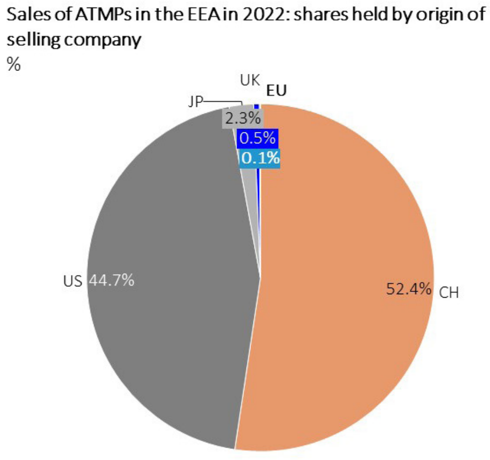




Source: European Commission, 2024. Based on IQVIA MIDAS® quarterly volume sales data for period 2012 – 2022 reflecting estimates of real-world activity. Copyright IQVIA. All rights reserved. Data for EEA markets (no data for CY, MT, IS and LI; retail data only for DK, EE, EL, LU, SI) and EC data (JRC R&D scoreboard) for regional allocation of companies and EMA data for identifying orphan medicines.

FIGURE 5
Low market presence in nascent market for ATMPs





Source: replicated from IQVIA 2023 (primary source: IQVIA EMEA Thought Leadership; IQVIA). MIDAS MAT Q4 2022 and Company Financial Statements). European Commission. Based on IQVIA MIDAS® quarterly volume sales data for period 2012 – 2022 reflecting estimates of real-world activity. Copyright IQVIA. All rights reserved.

THE ROOT CAUSES OF THE EU'S EMERGING COMPETITIVENESS GAP

Multiple causes underpin the EU's emerging competitive gap, including notably:

- Lesser and fragmented public R&D investment in the EU.
- Lesser private R&D investment in the EU and a weaker supporting environment.
- A slow and complex EU regulatory framework.
- The complex emergence of a European Health Data Space (EHDS).

1. **Lesser and fragmented public R&D investment in the EU.** For R&D investment, a wide funding gap with the US is observed against the backdrop of China's growing presence.

As for public investment in R&D, the US relies on a substantial budget, a diverse support base and centralised channels for funding. The National Institutes of Health (NIH) is the primary funder, with a budget exceeding USD 45 billion annually in 2023, with more than 80% of its budget spent on competitive grants. In addition, the Biomedical Advanced Research and Development Authority (BARDA) has a budget of USD 823 million to develop medical countermeasures for public health emergencies. US government funding also supports research in universities, research institutes and hospitals, covering a broad range of basic and applied research. All in all, in terms of direct public spending on scientific programmes and budgets in health, total US spending reached around EUR 47 billion in 2023 (EUR 44 billion in 2022, see also below)[xiii].

A general trend of increased public R&D funding can be observed in China. Data[xiv] indicates that in 2020 government funding of R&D in China accounted for 0.48% of GDP (0.69% in the EU and 0.74% in the US), up from 0.41% in 2010 (0.69% in the EU and 0.89% in the US). Concerning R&D for pharmaceuticals, by 2017 public spending in China was estimated[xv] to account for 0.02% of GDP, compared to 0.05% of GDP in direct public spending on R&D for health in the EU through scientific programmes and budgets[xvi].

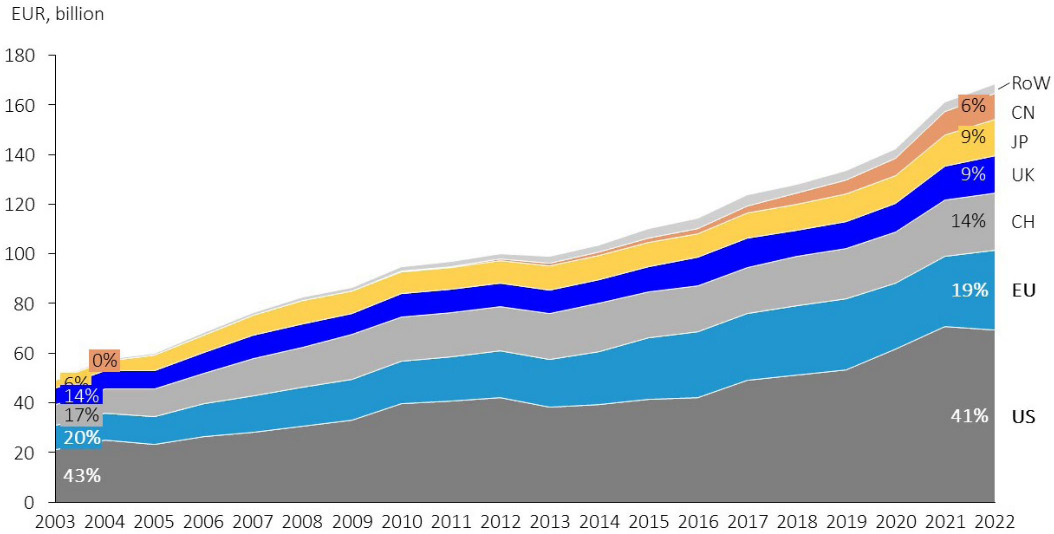
In contrast to the US, the EU relies on a lesser funding base which is fragmented and less focused. The Horizon Europe programme (2021-2027) allocates EUR 8.2 billion to health research, supporting fundamental and applied research, and to support for small companies and start-ups. Moreover, the European Commission's newly established Directorate-General for Health Emergency Preparedness and Response (HERA) has a budget of approximately EUR 5.4 billion (2022-2027) drawing on EU programs, including Horizon Europe and EU4Health. HERA focuses on enhancing preparedness for public health crises, among other by exploring solutions overcoming market failures in the development and marketing of antibiotics, vaccines and antivirals, developing the procurement of medical countermeasures, and enhancing health data and digital tools.

In addition, Member States contribute domestically by funding their universities and research institutions (e.g. Germany's Fraunhofer Society and the Max Planck Society, and France's National Institute of Health and Medical Research (INSERM)). EU Government Budget Allocations for Research and Development (GBARD) in health were around EUR 10 billion or 0.06% of GDP in 2022 or EUR 11.2 billion and 0.07% of GDP when including Horizon Europe (EUR 44 billion and 0.18% of GDP in the US for 2022)[xvii]. A country like Denmark spends 0.15% of GDP via GBARD for health. On the other hand, as many as nine EU Member States spend 0.1% of their GDP or less. The system's fragmentation risks duplication and potentially the emergence of less innovative projects.

2. **Lesser private R&D investment in the EU and a weaker supporting environment.**

Where private R&D investment by large multinational and mostly publicly listed companies is concerned, the US dominates the EU. Although the R&D intensity of US pharmaceutical companies relative to net sales (14.5%) is slightly higher than that of EU companies (13.2%), the United States' dominance in R&D investment is mostly due to the larger overall market presence of US companies (demonstrated by 86% higher global sales). Over the last two decades, the EU's share of global pharmaceutical R&D remained at around 20%, while that of the US stood at 40%. In particular the UK and Switzerland (CH) experienced a decline in position relative to China [see Figure 6]. The increase in R&D funding in China is also reflected in the stark growth in recent years of China-originated new medicines under development[xviii].

FIGURE 6
Company R&D outlays for pharmaceuticals



Source: Data annex to the 2023 EU Industrial R&D Investment Scoreboard panel 2003-2022 (for global top 2,500 companies, allocated to geography by location of company headquarters).

For private equity investment, the gap between the US and the EU is even greater. Overall, in 2021-2022 US biotech companies received USD 62.5 billion in venture finance, compared with the USD 11.2 billion received by European companies[xix]. This challenge is particularly acute for SMEs which play a crucial and ever-growing role in the pharmaceutical ecosystem. Emerging biopharma companies accounted for 59% of trial launches in 2021 (up from 29% in 2011), whereas large pharmaceutical companies accounted for 28% in 2021 (down from 59% in 2011)[xx].

As a result, total US business enterprise R&D expenditure on the manufacture of basic pharmaceutical products and pharmaceutical preparations is about four times that in the EU, at 0.45% of GDP for the US compared to 0.11% for the EU, as estimated based on OECD data reported for 2021[xxi]. Data reported by the industry[xxii] point to a similar, though less pronounced difference – EUR 69.7 billion for the US and EUR 26.5 billion for EU Member States in 2021.

This said, at the EU level there are noteworthy initiatives catalysing private funding. For instance, to foster response capacity for future health emergencies HERA Invest frees up credits of up to EUR 100 million to provide dedicated to support innovative SMEs in the early and late phases of clinical trials. HERA Invest is part of the InvestEU Fund run in partnership with the European Investment Bank (EIB) Group. Overall, the EIB is the largest venture debt provider to the life sciences sector in Europe with a portfolio of over EUR 2.7 billion at the end of 2023 supporting more than 100 innovative companies, almost half of which are in the biotechnology field[xxiii].

Innovation hubs uniting industry, academia and investors fail to reach critical mass in the EU. EU clusters, such as the tri-national BioValley in France, Germany and Switzerland, Medicon Valley across Denmark and Sweden, BioM in Germany and FlandersBio in Belgium have not yet reached the critical mass to rival the size, appeal and global impact of major US hubs (in the Boston area or San Francisco Bay area). This is partly due to EU's fragmented approach. Typically, Member States' national interests lead to support for local champions resulting in a dispersed landscape, rather than focusing on developing a few dedicated, targeted hubs.

By contrast, the US focuses its support on hubs. Massachusetts receives 11.4% of NIH funding despite representing only 2.1% of the US population to boost the Boston area hub[xxiv]. China is also implementing policies to create hubs. Biotechnology is listed as one of ten key sectors for development under China's 'Made in China 2025' industrial strategy. State policy for biotechnology industry development relies on a cluster model, prioritising three regions – the Beijing-Tianjin-Hebei area in northeastern China, the Yangtze River Delta centred on Shanghai and the Pearl River Delta focused on Guangzhou and Shenzhen close to Hong Kong. With the advent of more personalised therapies and especially ATMPs, the integration of innovation hubs with the rest of the value chain is set to grow.

BOX 1

Allocating companies to countries in a globalised industry – caveat

Assigning a company's activities exclusively to the country where it has its headquarters does not necessarily paint an accurate picture of the actual location of R&D and industrial activities.

As an illustration, Belgium has a high level of activities based on its territory by foreign-headquartered companies, such as Johnson and Johnson, Pfizer, Novartis and GSK. Local company R&D investment in pharmaceuticals accounted for EUR 5.7 billion in 2022, the second highest in the EU after Germany (EUR 9.4 billion)[xxv]. However, when assigning company R&D investment according to country headquarters, Belgium ranks only fifth (with EUR 1.7 billion in 2022) after Germany, France and Denmark and Ireland[xxvi].

Economic literature shows that R&D and production tend to co-locate, whereas headquarter locations exert no co-location effects on the rest of the value chain[xxvii]. However, for the pharmaceutical sector, data suggests that corporate headquarter location does play a role. Accordingly, all of the top 20 global pharmaceutical companies have an active R&D centre in their home country[xxviii].

More uniform taxation policies benefit R&D activities in the US. Tax systems significantly influence biopharmaceutical companies' decisions regarding the location of their headquarters and R&D centres. In the EU, the absence of harmonised tax policy results in varying incentives across Member States. For example, Belgium offers an 80% deduction on withholding tax for R&D employees and a deduction of up to 85% on innovation income tax. Ireland on the other hand offers a 12.5% corporate tax rate on trading income and a 25% R&D tax credit.

These country-specific incentives contrast with the United States' more uniform approach, where federal incentives like the R&D Tax Credit and the Orphan Drug Tax Credit apply nationwide. Furthermore, the US system includes Bonus Depreciation and Section 179 Expensing, which allow immediate deductions for a significant portion of the purchase price of eligible business property, including R&D equipment. This said, at the level of individual US states additional incentives do exist. Notable state-specific tax credits include the California Competes Tax Credit and the Life Sciences Tax Incentive Program in Massachusetts, the latter benefiting companies located in the Boston area.

3. A slow and complex regulatory medicines framework in the EU.

Approval times for new medicines in the EU/EEA under procedures performed by the European Medicines Agency (EMA) are longer than those of regulatory agencies in other regions. The reported[xxix] median approval time for regulatory agencies in 2022 was 322 days in Japan, 334 days in the US, 347 days in Australia, 351 days in Canada and 418 days in Switzerland – compared to 430 days in the EU/EEA.

In addition, industry stakeholders report that compared to the US Food and Drug Administration (FDA), the EMA offers less opportunities for direct, structured interaction on scientific advice. Moreover, the need to interact with multiple EMA committees renders the EU framework complex. Complexities also arise from the links between general pharmaceutical legislation and other pieces of EU legislation[xxx].

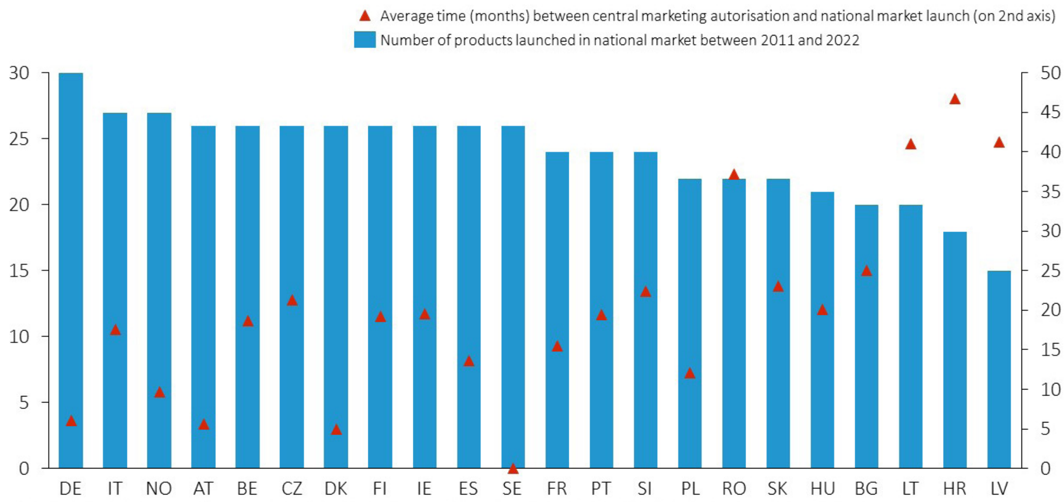
Once a new medicine has been approved by the EMA, there are 27 different procedures to decide on national pricing and reimbursement. Wide differences are observed across the EU and a considerable share of products is eventually only launched in a limited number of markets [see Figure 7]. Internationally, Japan and Germany are the first countries to launch after the US, with an average lag of approximately one year[xxxi].

One critical element of these decisions is the national Health Technology Assessment (HTA), which commonly informs reimbursement decisions at the national level. Often, additional data is required to demonstrate a product's effectiveness relative to the current treatment reimbursed domestically. This process is fragmented and time-consuming, in particular compared to the current set-up in the US, where by and large Medicare (the largest public payer for medicines) covers FDA-approved medicines.

FIGURE 7

Wide differences in national market launches

Medicines for human use (excluding generics and biosimilars) with central marketing authorisation granted in 2011



Source: European Commission. Based on IQVIA MIDAS® quarterly volume sales data for period 2012 – 2022 reflecting estimates of real-world activity.

BOX 2

EU Member State national pricing and reimbursement frameworks

Decisions on the pricing and reimbursement (P&R) of pharmaceutical care fall under the remit of national authorities in the EU in respect of article 168 (7) of the TFEU (the 'Lisbon Treaty'). Pharmaceutical companies can of course make unilateral decisions influencing the accessibility of their technologies. The inclusion of new products in the basket of covered services usually requires both parties to negotiate on the conditions for a product to enter a market.

In addition, national P&R decisions are subject to the rules of the Treaty on the Free Movement of Goods and to the procedural requirements defined in the 'Transparency Directive' (89/105/EEC). The directive mainly defines procedural obligations for Member States to ensure pharmaceutical companies benefit from timely, motivated and appealable decisions regarding the P&R of their products. Notably, it requires Member States issue a pricing decision within 90 days (if Member States decide on price only), set a 90-day limit on reimbursement decisions (if Member States decide on reimbursement only), and set a 180-day limit for joint P&R decisions. However, 'clock stops' may apply, extending eventual timelines.

The P&R landscape in the EU is fragmented resulting in an uneven uptake of novel medicines across Member States. Medicines in the EU first come to market in Member States, such as Sweden, Denmark, Austria and Germany. Germany's P&R framework foresees an initial six-month period of 'free pricing', after which the government will take a P&R decision based on a cost-benefit assessment of the novel medicine[xxxii]. The German approach is resource-intensive as it requires capacity for the government to conduct Health Technology Assessments (HTAs) comparing costs and clinical effects across therapies to assess the value for money of novel medicines. The discretion of companies to price products ad libitum during the initial start-up period needs to be nuanced as prescribing doctors are subject to restrictions ensuring a rational use of resources. Another fast adopter, Sweden, applies an approach more commonly seen across EU Member States. The Swedish reimbursement committee decides on the inclusion of novel products in the basket of insured services based on clinical evidence and health economic documentation provided by pharmaceutical companies[xxxiii]. In general, time to market is strongly (inversely) correlated to the size of Member States' healthcare budget per resident.

4. **The complex emergence of a European Health Data Space (EHDS).** There is significant untapped potential to leverage health data in the EU, as demonstrated by the considerable possibilities to access and link datasets in healthcare relative to the US[xxxiv].

Currently, the GDPR allows the processing of health data for the provision of health or social care, public health and scientific purposes based on EU or national law. Data can be processed without explicit consent provided that suitable and specific measures are put in place to safeguard the rights and freedoms of data subjects. Some Member States already benefit from these possibilities under their own national law.

However, the uptake of these options by Member States has been uneven and has resulted in the ineffective secondary use of health data. To overcome this challenge, the Commission has proposed a regulation to enable a European Health Data Space (EHDS) by building on possibilities offered by the GDPR for a specific EU law with particular safeguards. In spring 2024, the European Parliament and the Council reached a political agreement on the proposed regulation. The proposal aims to develop a European framework inspired by the actions taken by several Member States that have adopted similar national legislation for the secondary use of health data.

RECENT REFORMS AND PROPOSALS

Recent EU-level reforms, actions and proposals to further reform the regulatory landscape aim to spur innovation and streamline rules, but greater efforts are needed.

After the establishment of the European Medicines Agency (EMA) in 1995, to be marketed in the EU most novel, innovative medicines now pass through the centralised authorisation procedure overseen by the EMA. Recent proposals aim to modernise and simplify the regulatory framework for the authorisation of new medicines.

BOX 3

The European Medicines Agency (EMA) and the Central Marketing Authorisation procedure

The EMA was set up in 1995 to harmonise the work of existing national medicine regulatory bodies. The EMA oversees marketing authorisations granted under the 'centralised procedure' by decision adopted by the European Commission. The centralised procedure allows the marketing authorisation holder to market the medicine and to make it available to patients and healthcare professionals throughout the EU/EEA on the basis of a single marketing authorisation.

The centralised procedure is compulsory for products derived from biotechnology (e.g. biologicals), orphan medicinal products, medicinal products for human use which contain an active substance authorised in the EU after 20 May 2004 and which are intended for the treatment of AIDS, cancer, neurodegenerative disorders or diabetes.

On 26 April 2023, the European Commission adopted a proposal for a new directive and a regulation, which revise and replace existing general pharmaceutical legislation. Notably, the proposal envisages a modern and simplified regulatory framework with faster authorisation of new medicines. Under the proposal, the EMA would have 180 instead of 210 days to conduct its assessment. For authorisation, the Commission would have 46 instead of 67 days. The simplified framework would help to reduce the current average of around 400 days between submission and market authorisation. For the assessment of medicines that are of major public health interest, the EMA would have 150 days.

Further measures put forward in the proposal include regulatory sandboxes supporting the development of innovative medicines and medicines developed by SMEs (by allowing for more timely scientific advice), electronic submissions and e-leaflets[xxxv]. The proposal also seeks to streamline rules for the clinical trial of medicines consisting of or containing genetically modified organisms (GMOs), likely to facilitate R&D in ATMPs in the EU.

In January 2022, the Clinical Trials Regulation entered into force, which aims to create a more favourable environment in the EU for carrying out clinical research on a large scale. Under the regulation, the Clinical Trials Information System (CTIS) platform was launched in January 2022 to enable clinical trial sponsors to submit streamlined, single applications for clinical trials whether national or conducted in multiple countries. Building on the regulation, the Commission with the Heads of Medicines Agencies and the EMA, launched the initiative Accelerating Clinical Trials in the EU (ACT EU) to better integrate clinical research in the European health system through ten priority actions (running until 2026). In addition, the COMBINE project[xxxvi], launched in 2023, aims to analyse the root causes of the growing number of challenges encountered when conducting clinical trials that involve the combination of medicines and medical devices or in vitro diagnostics.

As of January 2025, the EU Health Technology Assessment (HTA) Regulation (adopted in 2021) is expected to deliver efficiency gains in the lead-up to national decisions on pricing and reimbursement and facilitate faster access to medicines. This will be achieved by pooling the clinical assessment of products for use in national HTAs. By December 2024, a number of implementing acts are set to be adopted for the HTA Regulation dealing with key aspects, such as the scope of data considered for the input parameters of the Joint Clinical Assessments of medicinal products.

The EHDS Regulation aims to help unlock health data for research and innovation (secondary use). EHDS will give researchers and innovators access to anonymised and pseudonymised health records from across the EU. Access to health data is a precondition for the further development of AI. Importantly, the proposed action to improve the sharing of electronic health records aims to address fragmentation between EU Member States.

The use of 'real-world evidence' may help streamline the process of patient recruitment and data collection for pricing and reimbursement. An example of how real-world data can be applied at the EU level is the Data Analysis and Real World Interrogation Network (DARWIN EU®). DARWIN EU® was established in 2022 by the EMA and the European Medicines Regulatory Network as a coordination centre to provide timely and reliable evidence from real-world healthcare databases across the EU on the use, safety and effectiveness of medicines. By the end of 2023, sixteen studies[xxxvii] had been completed under DARWIN.

Another initiative aligned with the EHDS is the 1+ Million Genomes[xxxviii] (1+MG) and its long-term follow-up initiative Beyond 1 Million Genomes (B1MG). Both initiatives aim to enable secure access to genomic data for better research, personalised healthcare and to improve health policy-making. B1MG will strive do so by establishing European Genomic Data Infrastructure by the end of 2026. The infrastructure would allow national data sharing networks (with partners from academia and industry) to connect an international network where data remains locally stored, but accessible across Europe. Using this tool, scientists and clinicians will be able to access the huge amounts of linked genotypic and phenotypic data across the 25 European countries (including Norway) participating in the project.

BOX 4

AI use cases in the healthcare and pharmaceutical sectors

Artificial Intelligence (AI) will revolutionise and disrupt the healthcare sector in a radical way. In particular, use cases in so-called 'combination products' (therapeutic and diagnostic products combining drugs, devices and biological components) integrating medicine delivery systems with AI algorithms (processing feedback data in real time) hold promise to deliver more precise and personalised therapies to patients in Europe and beyond.

The EU's annual spending on AI in healthcare and pharmaceuticals was estimated at USD 2.6 billion in 2022, less than North America (USD 4.7 billion) and the Asia-Pacific (USD 2.3 billion). Global spending is set to grow at an annual rate above 40% in coming years[xxxix]. While the promise of AI in this field is just starting to be realised, the impact on patients' lives is already visible, as are the tangible signs of its huge potential. This extends well beyond increasing the productivity of researchers and medical liaisons (e.g. by automating repetitive and time-consuming tasks, like document creation and record keeping).AI stands to dramatically boost healthcare professionals' capability to deliver quality and precision, accomplishing tasks and achieving results that people alone simply could not achieve [see the Box on AI vertical use cases in the chapter on digital and advanced technologies: *A design for the development of EU-wide vertical AI use cases*]. For example:

- **AI is already making incredible inroads in medical diagnosis**. The use of AI and machine learning has already become accepted medical practice in the interpretation of some types of medical images[xl]. The potential for further uptake is high. For example, a trained neural network (a complex form of machine learning) can classify hip fractures 19% more accurately than any experienced human observer in a clinical setting. As classification is highly determinative of treatment, higher accuracy leads to better treatment, improved patient outcomes and lower costs[xli].
- **AI can be applied across the lifecycle of medicines**. This leads to faster discovery of novel compounds with potential medicinal applications[xlii], faster development of medicines through human clinical trials and better disease understanding (for instance, applying whole-genome sequencing for patient group segmentation in cancer to target the development of novel therapies). Deploying AI to help cure more diseases more quickly could free up additional resources in currently underserved areas. Business ventures aim to reduce discovery times, which as well as bringing treatments to patients faster have potential to expand the value of the pharmaceutical market by increasing effective patent protection for novel medicines. Cost savings made by AI applications from the discovery to preclinical stages are estimated at 25-50%[xliii]. Notably, efficiency gains in phase III clinical trials (the costliest R&D stage) may drive R&D cost reductions. All in all, gains of USD 60-110 billion a year are estimated from the use cases of AI in the pharma and medical device industries[xliv].
- **Generative AI may help to personalise therapies**. This can be achieved, for instance, by analysing patient data and clinical outcomes to optimise treatment plans. The ability to generate insights and patterns from vast quantities of patient data will spark more personalised treatments and improved patient outcomes. Generative AI tools could also make patient care more consistent by reducing deviations in the manufacturing and delivery of therapeutics.

At the same time, improved healthcare quality will need to be reconciled with patient equity and sustainable health budgets[xlv]. Moreover, several key elements will be needed to foster AI vertical use cases in the EU's healthcare and pharmaceutical sectors. Executives will have to grapple with tricky strategic decisions and operational challenges in an uncharted landscape marked by fast-changing technology and emerging risks. Examples include:

- **Access to quality data to train algorithms**. Generative AI cannot deliver results unless a proper data architecture is in place. Companies will need to build an intelligence layer that can understand issues, such as molecular structures, clinical operations and patient data. A multipronged approach will be necessary to create a data infrastructure to run internal and external datasets. This is more than a technical matter. Data scientists will need to collaborate closely with leaders on business strategy, medical affairs and legal and risk aspects to set priorities and execute strategies. Regarding the need for patient data, the digitisation of health systems is also a key enabler to fully leverage the EHDS. Health systems in the EU are gradually being digitised, but there is still great potential for full health system digitisation by 2030. As an example, the share of individuals accessing health records online increased from around 10% in 2020 to 24% in 2022. However, there is wide divergence across Member States, with Finland approaching 80% in contrast to only 2% in Germany in 2022.

- **Supportive regulatory frameworks**. This includes frameworks for the training and validation of AI algorithms, ensuring the safety of patients, and upholding the confidentiality and security of data. In fact, generative AI models account for only around 15% of a typical project effort. Most of the work involves adapting models to a company's internal knowledge base and use cases. This is particularly true in the pharmaceutical industry given the complexity of its data and the uniqueness of its regulations and technology.
- **A skilled workforce**. The availability in sufficient numbers of data scientists, AI specialists, bioinformatics experts and professionals well-versed in both pharmaceuticals and AI is a major factor. Moreover, to succeed in deploying generative AI, companies must have the necessary skillset to integrate it across complex workflows to promote its adoption and impact. For instance, 70% of digital transformations may fail not because of technical issues, but because healthcare leaders ignored the importance of managing change.
- **Market-oriented R&D**. Cooperative efforts among start-ups, larger companies, research teams and healthcare providers could nurture disruptive innovation and expedite AI uptake. In the future, financial support for start-ups and research teams active in disruptive RD&I or in developing specific new hardware applications in the field of health could be tendered as competitive calls for projects ('challenges') in the context of private-public partnerships bringing together public actors and companies active in pharmaceuticals and companies active in the field of AI.

Objectives and proposals

The overall objective is to maintain and expand the capacity of the EU to conduct R&D. In doing so, location decisions concerning manufacturing may be positively influenced, for example in the space for on-patent pharmaceuticals. Specific focus is placed on biologicals, orphan products and advanced therapy medicinal products (ATMPs). Concerning the latter – the nascent market for ATMPs – global leadership for the EU in R&D is pursued.

Proposals aim to address the key root causes driving the EU's emerging competitiveness gap for pharmaceuticals. The following actions are recommended to address this gap, also building on recent reforms and proposals. Moreover, proposals 1 and 2, as well as 4, will in particular draw novel R&D activities to the EU. Proposals 3-5 will help expedite the access to markets for products. Proposals 7 and 8 directly address options for increased and more focused R&D funding. Finally, proposals 6 and 9 aim at fostering business predictability in the longer run.

These proposals are complemented with proposals from various other chapters, notably the Innovation, Sustaining Investment and Governance chapters.

FIGURE 8

	SUMMARY TABLE PHARMA PROPOSALS	TIME HORIZON[01]
1	**Maximise the impact of the EU Health Data Space**, e.g. by facilitating access to and the sharing of electronic health records, leveraging the DARWIN EU® network and scaling up genome sequencing capacities.	ST/MT
2	**Streamline the set-up and management of multi-country trials in the EU** to advance the EU as an attractive place for conducting clinical R&D.	MT
3	**Expedite access to markets** through coordinated action by medicines agencies, HTA authorities and public payers on guidance to industry, pricing and reimbursement as well as procurement.	MT
4	Provide clear and timely guidance on the use of AI in the lifecycle of medicines.	MT
5	Rapidly and fully implement the HTA regulation and ensure the required resources are allocated to ensure the delivery of joint clinical assessments as of 2025, with the aim of establishing an EU agency in the long term.	ST/LT
6	Improve business predictability through a continuous evidence-based dialogue with stakeholders to underpin EU policy-making on protection mechanisms for novel medicines.	MT/LT
7	Increase and focus public R&D investment in the EU, e.g. supporting a number of world-class innovation hubs in life sciences for advanced therapy medicinal products (ATMPs).	MT
8	Mobilise private R&D investment in the EU and bolster the supporting environment.	MT
9	Develop strategic international partnerships to solidify and bolster the EU's international trade position in pharmaceuticals.	MT/LT

01. Time horizon is indicative of the required implementation time of the proposal. Short term (ST) refers to approximately 1-3 years, medium term (MT) 3-5 years, long term (LT) beyond 5 years.

1. Maximise the impact of the European Health Data Space (EHDS).

Ensure the optimal implementation of the EHDS Regulation by supporting the accessing and sharing of electronic health records and capacity building for national health data access bodies. The regulation is expected to start to apply two years after its entry into force with a staggered application thereafter and a first partial evaluation after eight years. To optimise its implementation, it is key to make short-term resources available for the introduction of EU requirements and standards in electronic health records at the national level. This is important notably to enable the cross-border provision of healthcare and patient rights to access their health data in a structured interoperable format. Investment under the EU's Cohesion Fund can be deployed, complementing sizeable investment in health system digitalisation under the Recovery and Resilience Facility (RRF) and the EU4Health programme. National health data access bodies have a pivotal role as they are tasked to decide on data access applications. Their proper functioning will be crucial for the overall implementation of the EHDS Regulation. The clarification and cross-country coordination of opt-out mechanisms will need to be ensured.

Leverage existing health data for regulatory, policy and clinical decision-making by stepping up the standardisation of pre-existing 'legacy' health data. In the run-up to the full application of the EHDS Regulation, it will be necessary to continue and increase efforts to standardise existing data sources to a common data model building on the work initiated by the European Health Data Evidence Network (EHDEN), set to end by October 2024. The initiative can be set up as a new public-private partnership, aiming to work in full alignment (forward compatibility) with the EHDS. Through this work, standardised health data will be leveraged to generate evidence for regulatory, policy and clinical decision-making.

Leverage the DARWIN EU® network to generate evidence for innovation in medicine development and for policy and clinical decision-making supported by the use of AI. Existing expertise and experience need to be geared towards generating 'real-world' evidence by running non-interventional studies drawing on the existing data source catalogue to expand activities building on additional data sources in Member States made available by the EHDS. AI has huge potential to accelerate the management and analysis of health data for this purpose.

Further scale up genome sequencing capacities in the EU and present a strategic blueprint beyond 2026. Building on the European 1+ Million Genomes (1+MG) initiative and complementing Beyond 1 Million Genomes (B1MG), there is a continued need to strengthen the infrastructure for whole-genome sequencing, including to enhance data sharing across borders under the EHDS. This action, to be set up under a private-public partnership, should build on the European Genomic Data Infrastructure, delivered by a project that will conclude by 2026.

2. Streamline the set-up and management of multi-country trials in the EU.

Establish rules to address challenges for studies which combine medicines with medical devices and the application of AI. This could follow the recent example of proposals made for reviewed rules on the use of genetically modified organisms (GMOs) in human clinical trials.

Introduce reinforced coordination mechanisms between national ethics committees and a binding EU-level decision-making committee for the authorisation of multinational clinical trials. This would facilitate the starting phase of new clinical studies.

Introduce model templates in use for trials, notably for the interaction between trial sponsors and trial participating institutes (sites), such as suitability forms. **Incentivize the implementation of templates** (including already existing ones) as a condition for clinical trials to receive public funding. In addition, providing EU-level support to multi-country, non-commercial clinical trials may help not only to address market failures (e.g. lack of economic incentives for the repurposing of off-patent medicines), but can also support solidifying expertise and capacity within the EU with potential spillover effects for EU competitiveness.

3. Expedite access to markets through coordinated action by medicines agencies, HTA authorities and public payers to issue guidance on clinical evidence required from industry and to co-operate on pricing and reimbursement as well as procurement.

Streamline guidance to industry on unmet medical needs, the design of clinical trials and the use of real-world evidence across national medicine agencies, national bodies for HTAs as well as pricing and reimbursement authorities. In general, interaction between national medicine agencies and other relevant national actors should be stepped up in a structured way. This matters all the more, as decisions on the location of R&D activities, such as phase III clinical trials with chronic (repeat use) treatments, may in part be governed by the likelihood of the subsequent coverage of medicines by local public payers. Overall, there is a trend towards growing integration of the entire value chain, starting with R&D.

Overcome cross-country coordination problems in the area of pricing and reimbursement. Member States should adhere more closely to pricing principles as previously established under the EURIPID collaboration[xlvi] and step up cross-country initiatives for joint pricing (and reimbursement) negotiations for specific medicines. Further actions, include the need to assess the prospect for expanding the scope of EU joint procurement to encompass treatments beyond those in response to cross-border health threats. Given the high degree of public payer cost-sharing for pharmaceuticals in the EU, there are trade-offs at play between stimulating innovation, fiscal sustainability and affordable access for patients. Actions can build on experience and expertise gained in the Network of Competent Authorities for Pricing and Reimbursement (NCAPR), as well as cross-country collaborative approaches (such as Beneluxa).

Use award criteria in public tenders such as security of supply and production in the EU/EEA or in countries with which the EU has concluded an agreement on government procurement to foster EU competitiveness in the area of pharmaceuticals. This action can build on tools which can already be used in relation to the availability of critical medicines, namely the use of award criteria in public tenders such as security of supply and production in the EU/EEA or in countries with which the EU has concluded an agreement on government procurement[xlvii].

4. Provide clear and timely guidance on the use of AI in the lifecycle of medicines.

Guidance is gradually disseminated until 2027 by the EMA and national medicine agencies, under their AI work programme. Importantly, it will need to maximise the possibilities offered by the forthcoming EHDS Regulation and the recent AI Act. This should cover the analysis of 'raw' clinical data transmitted to the EMA by the industry as planned under current proposals, as well as data collected for pharmacovigilance purposes. Opening up the secondary use of health data for research purposes has particular potential to anchor R&D activities within the EU. Guidance can also build on the experience gained through the DARWIN EU® network (see proposal 1).

5. Rapidly and fully implement the HTA regulation and ensure the required resources are allocated to ensure the delivery of joint clinical assessments as of 2025, with the aim of establishing an EU agency in the long term.

The HTA Regulation has potential to improve efficiency in the uptake of pharmaceuticals by health systems following their marketing authorisation. Considerable resources will need to be made available to achieve this objective. In particular sufficient expert staff from national HTA bodies and Commission services as well as commensurate funding at EU level for HTA bodies should be freed up to ensure the successful implementation of Joint Clinical Assessments. These assessments will start as of January 2025 for medicinal products with new active substances for the treatment of cancer and for advanced therapy medicinal products. Consideration could be given to models that allow for the cost recovery of EU-level HTA activities through industry fees. This could include establishing a dedicated structure, following the example of HTA agencies at national level that are fee-charging.

6. Improve business predictability through a continuous evidence-based dialogue with stakeholders to underpin EU policy-making on protection mechanisms for novel medicines.

The EU boasts a solid and transparent framework for the protection of intellectual property, including through regulatory protection schemes. Intellectual property is the key driver of medical innovation at the global level. Given the long development times of medicines, stability in the incentives offered by this framework is needed. At the same time, pharmaceutical markets are dynamic, driven by scientific developments. Their competitive functioning evolves in parallel, implying that future changes to this framework are likely.

To enhance transparency in the long-term rationale for EU policy action, the EU should develop, publicise and update on a continuous basis a standard model capturing the key impacts of EU regulatory action in terms of innovation and patient access. Inspiration can draw on the US experience and the recent Congressional Budget Office Model of New Drug Development. In doing so, combined with stakeholder involvement on a continuous basis, future developments of the EU acquis for pharmaceuticals are put on a firm basis.

7. Increase and focus public R&D investment in the EU.

Focus EU funding on the development of a limited number of world-class innovation hubs in life sciences for advanced therapy medicinal products (ATMPs). Lessons can be drawn from the example of the California Institute for Regenerative Medicine (CIRM) as a blueprint for the establishment of a leading EU institute dedicated to advancing stem cell therapy. Founded in 2004, running on an annual budget of USD 423 million (2022-2023 fiscal year), CIRM funds clinical trials, provides training and hosts panels to advise researchers on how to accelerate the development of therapies. To date, more than 50 start-ups have roots in CIRM-funded research projects. Unique features of CIRM, beyond its singular focus on the development of stem cell therapies, include the explicit mandate to fund infrastructure (the Alpha Clinics Network), as well as the involvement of regulators and payers in its activities. In the EU, promising initiatives have emerged, such as the Centre of Gene and Cell Therapy established at Charité hospital in Berlin. More centres of excellence and innovation in life sciences should be identified throughout the EU and consolidated with EU public support in keeping with the Strategic Technologies for Europe Platform (STEP) for biotechnologies [see the chapter of this report on innovation].

Expand, consolidate and integrate disease registries established under European Reference Networks (ERNs). ERNs were first established in 2017 as virtual networks involving healthcare providers across Europe. They aim to facilitate discussions on complex or rare diseases and conditions that require highly specialised treatment, concentrated knowledge and resources. ERNs are involved in running large multi-centre clinical trials, with a focus on rare diseases and areas of niche scientific know-how. One relevant example is the Stem Cell and Gene Therapy Working Group established under RITA – the ERN focusing on patients with rare immunological disorders. Core funding for ERNs draws on the EU4Health programme (grants totalled EUR 7.8, EUR 11.2 and EUR 77.2 million under the work programme in 2021, 2022 and 2023 respectively). Action to strengthen the usability of patient data collected under ERNs, as well as integration with the EHDS is likely to bolster EU-based R&D for orphan medicinal products.

8. Mobilise private R&D investment in the EU and bolster the supporting environment.

In line with the proposal in the Innovation chapter, it is recommended to increase the budget of the European Investment Fund (EIF) to enhance the EU venture capital ecosystem. For pharmaceuticals in particular, this could be done by capitalizing on experience gained with the existing venture debt programme for SMEs and mid-caps with a specific focus on life sciences.

Moreover, in line with the proposal in Sustaining Investment chapter, higher risk and more scale-up investment could be financed through the InvestEU programme. This is aligned with the possibility for late-stage growth capital to be tapped in by the EIB under the European Tech Champions Initiative (ETCI) launched in February 2023. This would address the fact that, next to overall lower private equity funding for biotech in the EU compared to the US, average deal sizes are reported to be significantly smaller.

9. Develop strategic international partnerships to solidify and bolster the EU's international trade position in pharmaceuticals.

Measures taken to bolster the resilience of EU pharmaceutical supply chains in the EU focus on mitigating shortages of critical medicines, most of which are off-patent. However, such measures also hold potential to boost the overall competitiveness of the industry. This relates in particular to the EU-based manufacturing of biologicals as companies that launch on-patent biologicals also increasingly launch biosimilars. Possible indirect negative effects from such measures on the EU's trade position can be minimised by complementing them with trade diversification. This could encompass international co-operation in view of strengthening supply resilience autonomy, notably through supply chains diversification and the development of new productions sites in strategic regions outside the EU, the strengthening of existing supply sources, and the development of strategic partnerships with international partners as well as the optimisation of trade agreements. The Critical Medicines Alliance is bringing together EU and non-EU members to address these challenges and find solutions to reinforce global supply chains of medicines. Work is also ongoing in other fora.

ENDNOTES

i European Commission (JRC), The 2023 EU Industrial R&D Investment Scoreboard, data annex, 2023.

ii IQVIA, The Global Use of Medicines 2023, 2023.

iii European Commission, Eurostat, National accounts aggregates by industry (up to NACE A*64) (online data code: nama_10_a64), accessed on 19 July 2024.

iv European Commission, Eurostat, International trade in medicinal and pharmaceutical products, accessed on 31 May 2024.

v European Commission, Eurostat, Employment by sex, age and detailed economic activity (from 2008 onwards, NACE Rev. 2 two digit level) - 1 000 (Online data code: lfsq_egan22d), accessed on 31 May 2024.

vi PWC and the European Federation of Pharmaceutical Industries and Associations (EFPIA), Economic and societal footprint of the pharmaceutical industry in Europe, 2019, p.6 (figure 2).

vii EFPIA, The Pharmaceutical Industry in Figures, 2024, p. 7.

viii EFPIA, EU strategic resilience in pharmaceuticals: global value chains and innovation, 2020.

ix European Centre for International Political Economy (ECIPE), Key Trade Data Points on the EU27 Pharmaceutical Supply Chain, 2020.

x IQVIA, IQVIA Midas® quarterly volume sales data for period 2012-2022 (proprietary data procured by European Commission).

xi Idem.

xii IQVIA, Piping Hot: A look at the state of cell, gene and RNA therapies in early 2023, 2023.

xiii European Commission, Eurostat, GBARD by socioeconomic objectives (NABS 2007), (Online data code:gba_nabsfin07), accessed on 31 May 2024.

xiv European Commission, Eurostat, GERD by sector of performance and source of funds´ (online data code: rd_e_gerdfund), accessed on 31 May 2024.

xv Diao, Y. et al., `Unlocking Access To Novel Medicines In China-A Review From A Health System Perspective´, Risk Management and Healthcare Policy, (12), 2019.

xvi European Commission, Eurostat, GBARD by socioeconomic objectives (NABS 2007) (online data code: gba_nabsfin07), accessed on 31 May 2024.

xvii Idem.

xviii Ge, Q. et al., `Development of Chinese innovative drugs in the USA´, nature reviews drug discovery biobusiness briefs, 8 May 2024.

xix Gong, J. et al., `Bridging the gap between innovation and later-stage financing for biotech in Europe´, nature reviews drug discovery biobusiness briefs, 5 September 2023.

xx IQVIA, Emerging Biopharma's Contribution to Innovation, 2022.

xxi OECD, BERD by industry, accessed on 31 May 2024.

xxii EFPIA, op. cit., 2024.

xxiii Piovesan, L. et al., `Challenges and Opportunities in Biotherapies and Bioproduction - an EIB Investment Perspective´, Réalités Industrielles, November 2023.

xxiv Charles Rivers Associates, Factors affecting the location of biopharmaceutical investments and implications for European policy priorities, 2022, p. 58.

xxv EFPIA, op cit., 2024.

xxvi European Commission, Joint Research Centre, The 2023 EU Industrial R&D Investment Scoreboard, data annex, 2023.

xxvii Defever, F., `Functional fragmentation and the location of multinational firms in the enlarged Europe´, Regional Science and Urban Economics, Volume 36, Issue 5, September 2006.

xxviii Piovesan, L. et al., op. cit., 2023.

xxix Centre for Innovation in Regulatory Science (CIRS), New drug approvals in six major authorities 2013-2022: Focus on orphan designation and facilitated regulatory pathways, 2023, p. 1.

xxx European Commission, Impact Assessment Pharma Review Proposal, annex 5, 2023, p. 54.

xxxi US Department of Health and Human Services (HHS), Comparing New Prescription Drug Availability and Launch Timing in the United States and Other OECD Countries, 2024 p. 5.

xxxii Institut für Qualität und Wirtschaftlichkeit im Gesundheitswesen (IQWIQ), The AMNOG procedure: more than just cost control, 2024.

xxxiii Pharmaceutical pricing and Reimbursement Information (PPRI), PPRI Pharma profile Sweden, 2023.

xxxiv OECD, Health at a Glance, 2023, figure 2.3 on p. 41.

xxxv European Commission, Q&A on the revision of the pharmaceutical legislation, 2023.

xxxvi European Commission, The Combine Project, 2024.

xxxvii Data Analysis and Real World Interrogation Network (DARWIN EU®), listed studies, accessed on 31 May 2024.

xxxviii European Commission, European '1+ Million Genomes' Initiative, 2024.

xxxix Gloriumtech, The potential for AI in healthcare, 2024.

xl Haug, C. J. et al. 2023, `Artificial Intelligence and Machine Learning in Clinical Medicine, 2023´, N Engl J Med 2023; 388.

xli Murphy, E.A. et al., `Machine learning outperforms clinical experts in classification of hip fractures´, Nature Scientific Reports volume 12, Article number: 2058, 2022.

xlii Boston Consulting Group, Unlocking the potential of AI in Drug Discovery, 2023, p. 6.

xliii Data Analysis and Real World Interrogation Network (DARWIN EU®), op. cit., 2024.

xliv McKinsey, Generative AI in the pharmaceutical industry: Moving from hype to reality, 2024.

xlv WHO, Benefits and risks of using artificial intelligence for pharmaceutical development and deliver, 2024, p.19.

xlvi European medicine price database (EURIPID), Best practice report on External Reference Pricing (ERP), 2017.

xlvii European Commission, Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions – Addressing medicine shortages in the EU (COM(2023) 672 final), 2023.

10. Transport

The starting point

Well-functioning transport networks and services and a prosperous transport industry are crucial to the competitiveness of the entire EU economy. Transport systems ensure access to goods, services and resources (including knowledge and innovation), in the process driving economic development, territorial and social cohesion. Historically, cities emerged around transport hubs in well-connected locations, which continue to be favoured by businesses and consumers alike. In the EU, transport is considered a 'service of general interest', whose role in promoting social and territorial cohesion is acknowledged in the Treaties.

Transport is also a priority sector for the EU's transition to a net-zero economy. Transport accounts for one-quarter of all greenhouse gas emissions overall depending on the mode [Figure 1] with some segments considered particularly hard to abate[01]. Unlike other sectors, CO_2 emissions from transport are still higher than in 1990[i] [Figure 2], and - in the absence of mitigation measures - could further increase.

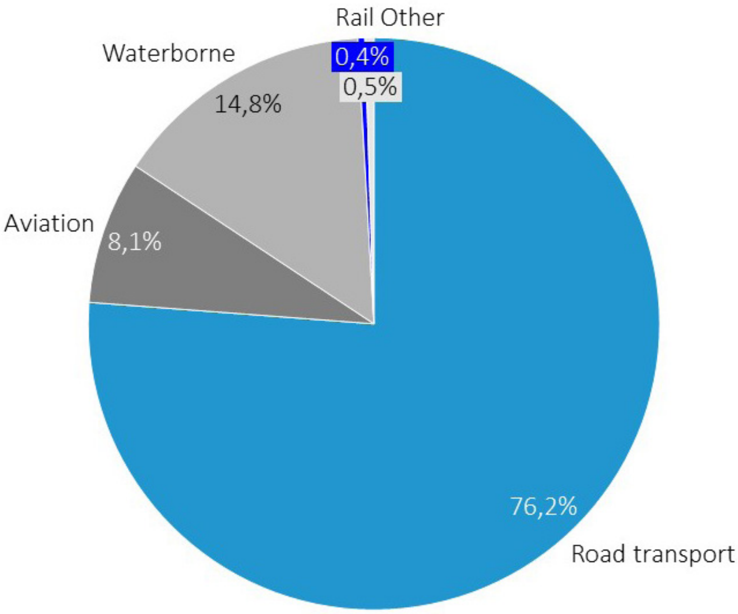
01. Heavy-duty trucking, shipping and aviation.

TABLE OF ABBREVIATIONS

AFIF	Alternative Fuels Infrastructure Facility
AI	Artificial intelligence
DAC	Digital Automatic Coupling
DCM	Digital Capacity Management
DDoS	Distributed denial-of-service
EIB	European Investment Bank
ERTMS	European Rail Traffic Management System
EV	Electric vehicle
FRMCS	Future Railway Mobile Communication System
FTA	Free trade agreement
GDP	Gross domestic product
ICAO	International Civil Aviation Organization
IMO	International Maritime Organization
IPCEI	Important Project of Common European Interest
MASS	Maritime Autonomous Surface Ships
OECD	Organisation for Economic Co-operation and Development
RAB	Regulatory Asset Base
RFNBO	Renewable Fuels of Non-Biological Origin
SAF	Sustainable aviation fuel
SESAR	Single European Sky ATM Research
TEN-T	Trans-European Transport Network
TFEU	Treaty on the Functioning of the European Union
UNCTAD	United Nations Conference on Trade and Development

FIGURE 1

Share of transport emissions by mode in the EU (% 2021)

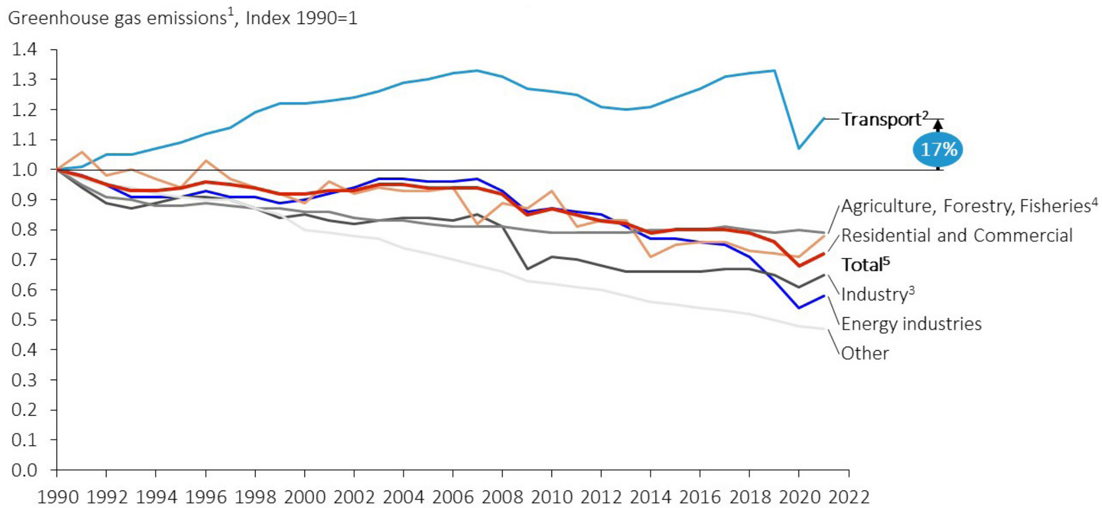


NOTE: International bunkers are included in aviation and maritime emission data; Railways emissions exclude indirect emissions from electricity consumption. OTHER includes combustion emissions from remaining transport activities including pipeline transportation, ground activities in airports and harbours, and off-road activities.

Source: European Commission, 2023.

FIGURE 2

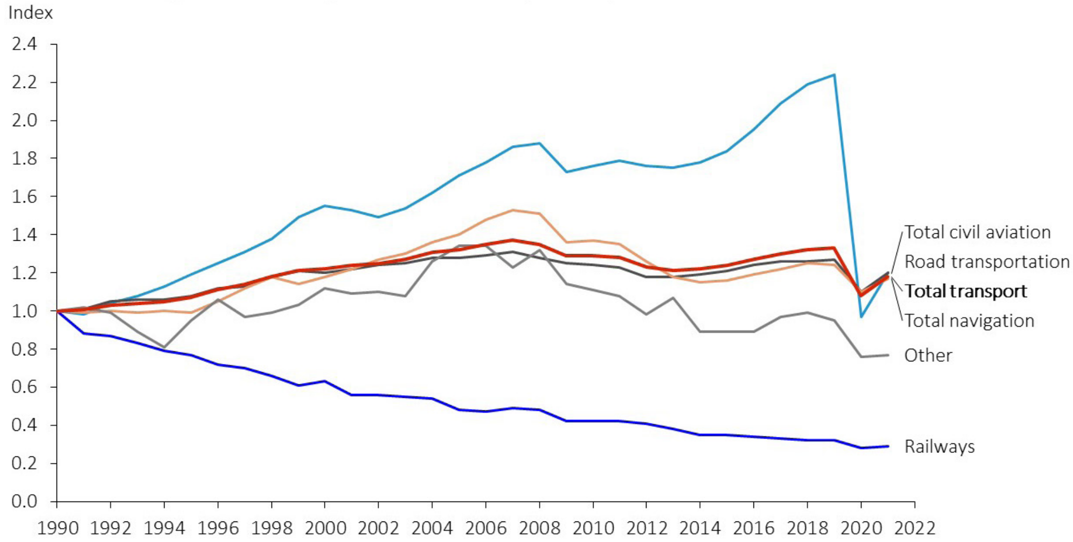
Evolution of greenhouse gas emissions by sector in the EU



1 Excluding LULUCF emissions and international maritime, including international aviation and indirect CO_2; 2 Excluding international maritime (international traffic departing from the EU), including international aviation.3 Emissions from Manufacturing and Construction, Industrial Processes and Product Use; 4 Emissions from Fuel Combustion and other Emissions from Agriculture; 5 Emissions from Fuel Combustion in Other (Not elsewhere specified), Fugitive Emissions from Fuels, Waste, Indirect CO_2 and Other.

Source: European Commission, 2023.

FIGURE 3
Evolution of greenhouse gas emissions by transport mode in the EU



Source: European Commission, 2023.

Driven by fast growing demand, transport is an increasingly attractive industry. With 74% of the world's population living within 100 km of an airport[ii], the airline industry reached estimated revenues of USD 723 billion in 2022[iii]. Moreover, with global trade reaching record values (increasing by 26% in 2022 compared with 2019[iv]), air cargo accounts for 35% of world trade by value[v]. Similarly, maritime container carriers saw annual profits soar to EUR 240 billion in 2021[02] and the market value of rail supply is valued at EUR 176 billion a year.

Global, regional and local transport demand is set to expand, requiring unprecedented robustness of the transport sector. By 2050, global passenger demand is projected to increase by 79% compared to 2019 levels and freight demand will be approximately double. Moreover, urban mobility and logistics are set to play an increasingly important role, with nearly 70% of the global population (and 80% of Europeans) living in cities by 2050[vi]. To serve this increasing demand, transport infrastructure will need to expand. According to some estimates, this might require at least USD 50 trillion in investment globally by 2040[vii].

Transport enables the prosperity of other branches of the economy. The industry underpins an increasingly global logistics network, whose growth is driven by e-commerce (30% of the world's GDP in 2019[viii]) and international tourism (over 1.2 billion arrivals worldwide in 2023[ix]).

In the future, transport is set to experience major green and digital transformations. The transport fleet will increasingly rely on new technology, including autonomous functions exploiting artificial intelligence (AI) and big data, as well as emerging innovation (e.g. hyperloop trains) to deliver greater speed, efficiency and cost savings. Freight and passenger services will, in turn, be underpinned by technologies optimising real-time monitoring (e.g. for traffic management), customer data analytics, and predictive maintenance fostering disruptive business models, including for shared mobility, last-mile deliveries and intermodal services. Depending on the segment, transport operators will handle alternative, more sustainable fuels in a transition phase, and fleets that are electrified and automated and use space and capacity more effectively, thanks to ultra light materials and structural improvements. Logistics services will increasingly specialise in reverse distribution, while transport industries will leverage existing supply chains and processes for recycling and waste recovery.

Transport is key to security and defence. In the EU, it is estimated that up to 90% of the transport infrastructure needed for large military operations is dual use[x]. Transport infrastructure and national logistics systems are, therefore, a strategic consideration to allowing (or potentially hindering) Member States' armed forces to respond quickly and at scale to crises within and beyond the EU's borders.

02. It is to be noted that the year 2021 has particularities as a result of the COVID-19 pandemic. See: United Nations Trade and Development (UNCTAD), Review of Maritime Transport 2022, 2023.

Transport is a critical infrastructure exposed to terrorist and hybrid threats (including cyber attacks)[03]. It has, therefore, been covered by the very first EU-wide measures protecting critical infrastructure[xi]. Transport hubs, including ports and airports, are also critical points of potential vulnerability with ever-greater interdependency between transport and other economic sectors (e.g. electrification, digital infrastructure, and space systems).

Ongoing conflicts have demonstrated the need for robust and cost-efficient global transport routes. Transport operators from all over the world suffer, together with the industries they support, from the fragility of connectivity from the global West to the East. In the case of the Red Sea for shipping (which until recently carried one-third of the world's container traffic), there are few viable alternatives. Similarly, the use of northern Eurasian transport corridors to bring overland freight from China to Europe has decreased by an estimated 50% since the start of Russia's invasion of Ukraine in February 2022. In addition, security risks now affect shipping via the Black Sea (which until 2022 carried 90% of Ukraine's agricultural exports, representing 10% of the global market, metallurgical products and iron ore).

Temporary alternatives have proven costly, adding to transport times (e.g. to travel via the Cape of Good Hope) and insurance costs (e.g. premiums attached to transporting via the Black Sea corridor). In the last week of December 2023, average container spot freight rates increased by USD 500, the highest ever weekly increase according to the United Nations Conference on Trade and Development (UNCTAD)[xii]. Moreover, alternative routes may have insufficient capacity and entail complex cross-border procedures (e.g. road routes in the framework of the Gulf Cooperation Council, the Trans-Caspian Middle Corridor[xiii], and the Southern Corridor). At the same time, the need for alternatives also brings opportunities, as shown by improved cross-border road, inland waterways, port infrastructure and procedures as part of the EU-Ukraine Solidarity Lanes.

Ensuring the resilience of transport increasingly counts on global efforts to tackle climate risks. Extreme weather events are currently considered the second largest global threat[xiv], with transport (and in particular inland waterways) expected to be heavily affected. For example, droughts and low water levels regularly impact navigation in the Panama Canal (through which 3% of global maritime trade passes) and on the Rhine (cutting production in key industries[xv] with recorded impacts of almost EUR 5 billion only in 2018 and triggering the need to adapt the fleet to shallow water). The landslide that forced the Frejus tunnel between France and Italy to close in 2023 blocked road and rail transport routes (some of them still inaccessible as of 2024) in the absence of an effective alternative. Worldwide, damage to rail infrastructure is expected to increase in the future due to rising temperatures[xvi].

THE EU'S CONNECTIVITY AND TRANSPORT SECTOR AS A COMPETITIVE STRENGTH

Transport is an important pillar of the EU's economy. In the EU, the transport sector contributes 5% of GDP, to 5% of all direct jobs (every direct job in transport is linked to four jobs in other sectors of the economy), and to 10% of cross-border employment. The EU's transport network underpins operations handled by an important logistics sector, which is home to the world's largest companies and represents 26% of all transport-related jobs. Transport is an essential service as underlined in the European Pillar of Social Rights, yet at 12% it represents (after housing and food) the third highest category of household expenditure in the EU (mainly incurred through vehicle ownership).

The EU is one of the most connected regions globally and the world's largest trader of domestically manufactured goods and services[xvii]. The EU's connectivity infrastructure is among the best in the world. For example, it features some of the world's largest mega container ports (which are greater in size only in China) with significant higher handling capacity than US ports. EU ports are increasingly specialised and for four out of five of the largest maritime liner companies are EU companies. The EU hosts four of the world's ten largest airports in terms of international passenger volumes[xviii], and its aircraft operators rank high worldwide in terms of the number of daily departures[xix]. The EU also has an extensive rail network, 5% of which is very high speed, currently concentrated in less than half of the EU's Member States, with 80% of traffic running on electrified tracks. By comparison, the US has the largest rail network in the world, but with a very small share of high-speed or electrified lines[04]. Spain alone has the

03. Transport represented 17% of all distributed denial-of-service (DDoS) attacks in the EU in 2023. See: European Union Agency for Cybersecurity, ENISA threat landscape 2023, 2023.

04. The US currently has one high-speed service along the Northeast Corridor. In 2023, US President Joe Biden announced USD 8 billion in support for ten major passenger rail projects across the US, including the first world-class US high-speed rail projects.

second longest high-speed rail network in the world (after China) and the third most dense high-speed rail network globally. The EU also has an extended network of navigable inland waterways (running through 25 Member States and connecting 13 of them), slightly above the capacity in the US.

The EU's transport industry benefits from a large Single Market providing opportunities for scale and open competition. Concerning air services, the first transport sector to be liberalised in the EU, the total number of flights increased by 80% and the number of routes by 138% between 1990 and 2013[xx]. Competition has resulted in continued growth in traffic thanks to a reduction of relative prices due to higher occupancy rates and technical advances. In Member States with an open rail passenger transport market, services are more frequent, of higher quality and offered at lower prices[xxi]. Considering the long-distance bus and coach market, the entry of large players operating across borders has enhanced the long-distance connectivity of areas which are less well served by rail and air transport services.

The EU's ambitious plans to decarbonise the transport sector provide unique opportunities for the EU to be at the forefront of decarbonisation solutions. Sustainable mobility has been the headline objective of the EU's transport policy since 1992. Today, with an EU-wide target to reduce transport emissions by 90% by 2050 compared to 1990 levels, decarbonisation is one of the main pre-conditions for the industry's growth. EU companies are 'first-movers' in sustainable transport with container ships running entirely on methanol and electric aircraft powered by liquid hydrogen in development. Furthermore, EU ports are contributing to greening transcontinental transport corridors and to supplying electricity to neighbouring cities. Airports in the EU are home to green hydrogen demonstrators and are developing proof of concept for modular sustainable aviation fuel (SAF) blending installations.

The EU is the world leader in the mass manufacturing of cutting-edge transport technologies, deployed in its extensive market and exported globally. As multiple forms of transport were invented or brought to technological maturity in Europe, the EU maintains extensive know-how, as exemplified in a number of segments [see the Box below].

BOX 1

The strengths of the EU's transport manufacturing sector

The EU holds over half of the world's market share for civilian aircraft (EUR 23 billion annual trade surplus, with China as its main export destination[xxii]).

For complex ships and marine equipment, EU companies have a world-leading civil and naval orderbook, in terms of value. For marine equipment only, the largest trade segment in marine equipment, the EU posted net exports of USD 12.9 billion between 2019 and 2020, making it the world's largest exporter[xxiii].

For rail supplies, EU companies receive one-third of global orders of a value of some EUR 50 billion. They have been the world's largest net exporters since 2000, with a steady EUR 4.5 billion annual trade surplus in 2012-2021[xxiv].

The EU counts companies specialised in both civilian and defence applications developing the world's first unmanned submarines and automated driverless trains.

Moreover, the EU is the world leader in the development of urban air mobility, representing 31% of the global market by 2030.

However, the potential of the EU's transport sector has not yet been fully leveraged. Improved infrastructure and services can unlock further growth, help to tackle congestion and accommodate increasing demand. Completing the Trans-European Transport Network (TEN-T) envisaged in the EU Treaties[05] is projected to bring an

05. Article 170 of the Treaty on the Functioning of the European Union (TFEU) provides that the Union shall contribute to the establishment and development of trans-European networks in the areas of transport, [telecommunications and energy] so that EU citizens, economic operators and regional and local communities can derive the full benefit from an area without internal frontiers.

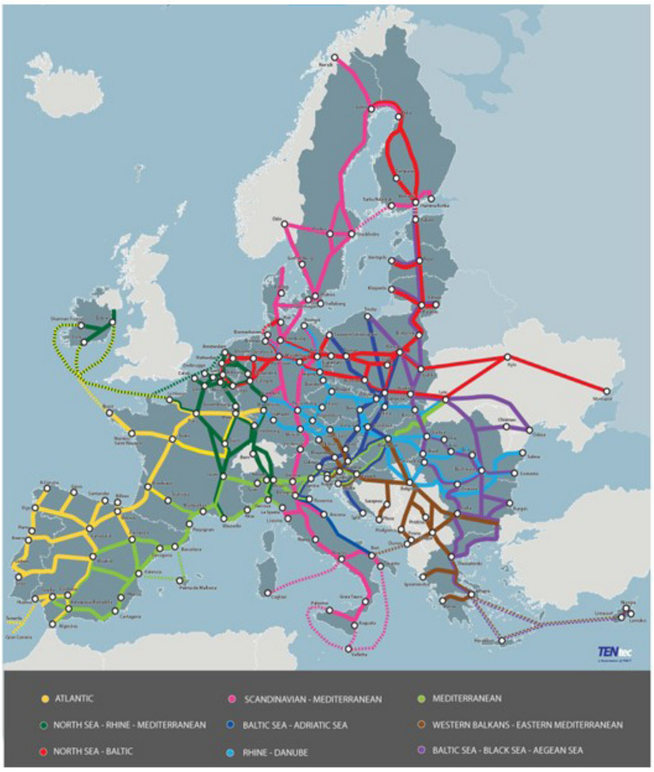
annual GDP increase of EUR 467 billion in 2050, relative to the baseline for that year[xxv]. TEN-T aims to connect the whole of the EU using all transport modes and by deploying long-term projects such as the Brenner Tunnel and Rail Baltica [see Figure 4]. Moreover, more effective railway and inland waterway management could further contribute to reducing freight transport congestion on roads. Road congestion is estimated to cost the EU some EUR 230 billion a year[xxvi]. Intermodal transport could help to reduce freight transport door-to-door costs by 10% and bring external cost savings of almost EUR 20 billion in the next 25 years[xxvii].

THE EU'S TRANSPORT INDUSTRY FACES MULTIPLE CHALLENGES

A complex and varied industry, the EU's transport operators nonetheless face common challenges. Many of these challenges are not new and revolve around the need for deeper EU integration and the establishment of a holistic vision that considers all transport modes and sectors.

Massive strategic investment is needed to complete missing links and to modernise transport infrastructure, where major gaps exist in public and private financing. The TEN-T, which requires an estimated EUR 845 billion in investment by 2040 (of which EUR 210 billion for main cross-border links), is not accompanied by a comprehensive ex-ante plan to secure the necessary financing and investment. EU public funding is expected to cover a minor share of investment (some EUR 87 billion by 2027). Projects submitted under the dedicated EU funding programme for the 2021-2027 period, the Connecting Europe Facility, represented on average three to four times the available budget. Moreover, private financing remains hard to obtain, despite a mature pipeline of TEN-T projects. This is due to their important level of risk, high upfront costs, or lacking short-term profitability[xxviii]. The EU is nearly halfway through completing the major cross-border projects, with the planned road network being by far the most advanced compared to other modes. It is now crucial to assure the remaining investments within the next decade. Beyond what is planned under TEN-T, the realisation of a high-speed rail network connecting all EU capitals and major cities[06] would enhance rail attractiveness and further increase investment needs.

FIGURE 4
EU-level corridors covered by TEN-T by 2050



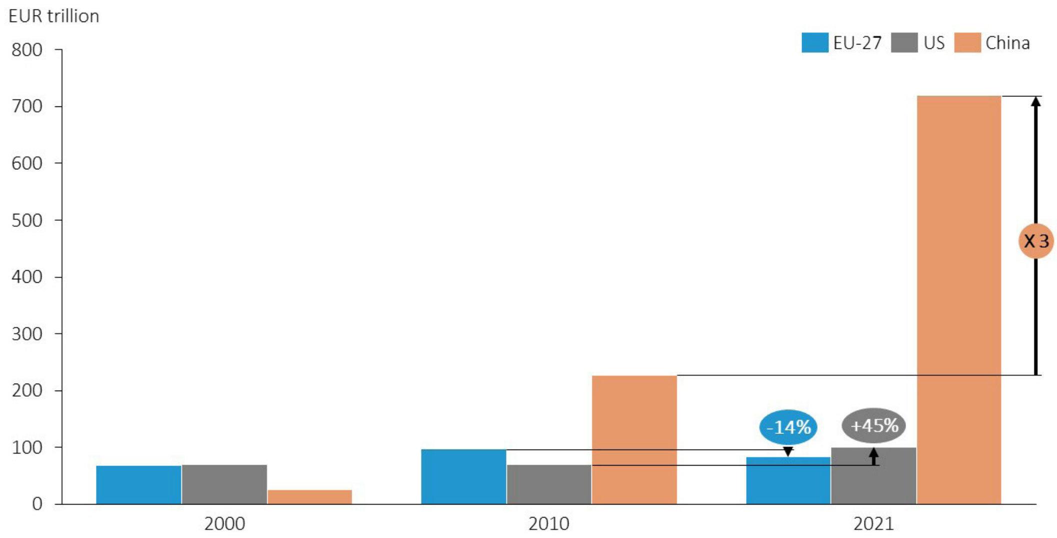
Source: European Commission, 2021.

06. Letta, E., Much more than a market, 2024.

Beyond the links that secure EU-level integration, ensuring investment in transport has proven challenging. Investment in major infrastructure (ports, railways and airports) has high societal value, but also brings high risks, is characterised by lengthy project lead times, and a long wait for return on investment. Major transport infrastructure projects therefore rely largely on public funding. Private financing has only proved feasible when risks were demonstrated to be manageable for investors. While higher than in any other sector in the EU, the value of public-private partnership transactions (EUR 5 billion in 2022[xxix]) in transport remains marginal compared to Europe's investment needs.

Other world regions are significantly increasing their investment. Concerning land transport infrastructure, EU investment has decreased slightly during recent years. In the US and China, on the contrary, it has increased [see Figure 5].

FIGURE 5
Annual investment in land transport infrastructure in selected regions



Source: OECD, Accessed in March 2024.

Maintenance will require significant investment. While Member States have considerable know-how in building and deploying new infrastructure, network maintenance for land transport has significant costs[xxx] (e.g. for rail alone, it represents around one-quarter of all network expenditure) and remains low[xxxi]. During the coming decade, the costs of maintaining the TEN-T are expected to increase drastically in view of the ageing of its infrastructure[xxxii].

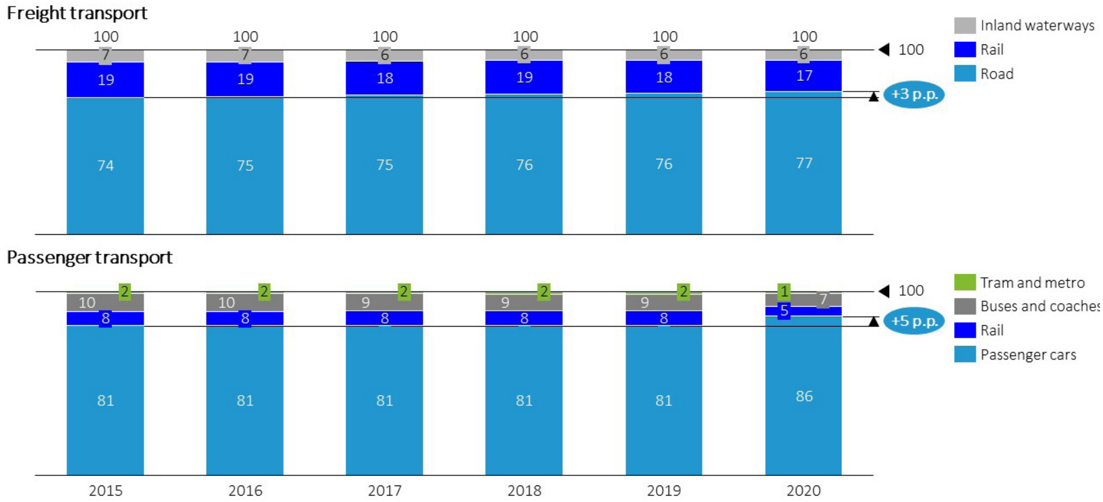
Administrative obstacles hinder projects. Complex and diverging administrative and environmental rules, namely those that apply to grant permits, constitute a barrier to the realisation of transport infrastructure projects[xxxiii]. Challenges are amplified for transnational projects, such as those for inland waterways, 75% of which are cross-border in the EU[xxxiv].

The EU's milestones towards shifting more activity to more sustainable modes of transport are still far from being achieved [see Figure 6]. Despite EU policies seeking to accommodate growing traffic and to decarbonise the sector, transport by rail and inland waterways is not yet competitive compared to road transport, due to lower reliability and higher transport costs[07]. Given the great volumes carried by road and the need to maintain the related infrastructure, Member States tend to prioritise investment in road infrastructure.

In addition, bottlenecks persist in securing necessary equipment. For example, rail rolling stock has proven scarce when demand has soared and investment in modern vessels able to operable on different inland waterway infrastructure, is considered highly risky.

07. Intermodal transport is not competitive with road transport when it comes to shorter distances. For example, the price gap with road transport at a distance of 500 km is around 19%. See: European Commission, Staff Working Document – Impact Assessment accompanying the Proposal for a Directive of the European Parliament and of the Council amending Council Directive 92/106/EEC as regards a support framework for intermodal transport of goods and Regulation (EU) 2020/1056 of the European Parliament and the Council as regards calculation of external costs savings and generation of aggregated data (SWD(2023) 351), 2023.

FIGURE 6
EU land transport by mode (%)



Source: European Commission, 2023.

Challenges pertaining to investment and its realisation is underpinned by overall sub-optimal planning. The long-standing TEN-T plan primarily follows a cohesion logic, although it also considers competitiveness factors.

Furthermore, EU-level planning does not fully consider the interconnections between network industries—transport, energy and telecommunications. It overlooks the fact that energy and telecommunications, including secure satellite and navigation technologies, critical among other things to support the shift towards autonomous transportation and remote piloted aircraft systems, must adapt to the evolving needs of transport infrastructure and services. For instance, although transport is part of the Commission's 2040 Climate Target Plan, it is excluded from the mandatory National Energy and Climate Plans (NECPs) where Member States outline their strategies to address various aspects of the Energy Union, including decarbonisation. Additionally, at the national level, as detailed in the chapter on the automotive industry, grid availability is often not planned for use in recharging infrastructure for road vehicles.

National planning continues to lack in a further set of areas, including alternative fuels in the transport sector and the deployment of relevant infrastructure[xxxv], as well as the uptake of intermodal and combined transport[xxxvi]. Requirements set out in EU law and in Commission proposals aim to address such shortcomings.

Where national planning for transport projects and investment does exist, it primarily focuses on individual modes, is not uniform across the EU nor fully aligned with EU planning. The recently adopted review of the TEN-T Regulation[xxxvii] requires Member States to ensure that national plans contributing to the development of TEN-T are coherent with EU transport policy and the TEN-T plan.

At the national level, there also seems to be a lack of prioritisation, as inefficiencies exist (e.g. underutilised connections with high-cost infrastructure could be replaced by on-demand flexible services.)

While some progress has been made, the persistent lack of EU integration and low competition continue to impact capacity and connectivity. While significant progress has been made towards realising an integrated EU transport market, unnecessary barriers persist. Member States tend to unevenly interpret EU rules and are reluctant to update outdated legislation in some sectors, or to propose and agree compromises to addressing outstanding problems. Some legislative proposals have been pending for years (e.g. on the allocation of slots at EU airports[xxxviii], and on common rules for access to the international market for coach and bus services[xxxix]), or withdrawn and resubmitted to co-legislators (e.g. the pending proposal on combined transport[xl]). At times, national governments take purely national initiatives which fragment the Single Market or outright favour national operators and services at the expense of EU integration. All such elements represent a barrier to integration and intermodality. They also prevent the emergence or growth of EU players in transport, travel and logistics.

Regarding air transport, the use of airspace and airport capacity is not optimised. Despite air services benefiting the most from an integrated Single Market relative to other transport sectors, the lack of rationalised cross-border air traffic management cost an estimated EUR 6 billion and led to 11.6 million tonnes of excess CO_2 in 2019 alone. This fragmentation happens in a context of national airspaces being managed by quasi monopolistic, most often State-owned, air navigation service providers. In addition, Member States take unilateral decisions that impact air traffic (e.g. not protecting overflights during air traffic control strikes). In EU airports, steadily increasing demand, congestion and the ineffective use of existing airport capacity have led to major bottlenecks[xli].

Rail markets remain fragmented. Passenger and freight capacity handling is not planned and coordinated across borders. Some 800 national rules still exist for rail across the EU. Moreover, operational requirements diverge (e.g. concerning the number of staff in driving cabins). Market barriers remain for new entrants who in some cases face high track access charges and difficulties in accessing equipment[xlii] and ticketing systems. This weakens the ability of providers to scale up and operate across borders. Operators active in more than one national market remain the exception in the EU. Consequently, the number of long-distance cross-border rail services in Europe has hardly increased during the last two decades[xliii]. Consumers experience a lack of fast connections, complexity in booking multiple legs of journeys and weaker consumer passenger rights. In addition, rail freight suffers a relative de-prioritisation compared to rail passenger services. This leads to issues with the speed and reliability of rail freight transport.

There is scope to further develop intermodal transport for freight. In addition to infrastructure that remains inadequate, EU rules incentivising intermodal transport (the 1992 Combined Transport Directive) are broadly defined, and long outdated. While intermodal transport has expanded (it quadrupled between 1996 and 2016)[xliv], more than half of intermodal operations in the EU today are excluded from the support framework provided by the Directive[xlv].

Road transport suffers from fragmentation. Across the EU, traffic rules and basic vehicle standards diverge widely[xlvi], and so does the regulatory framework for innovative mobility. This limits the capacity to roll out new mobility solutions, such as automated vehicles, and new mobility services (with some Member States unilaterally applying outright bans). Moreover, while the EU is moving towards distance-based pricing, dynamic pricing (based on the time of day) is only applied occasionally. In the long-distance coach and bus services sector, despite common rules on access to the international market for coach and bus services, there are restrictions on access to some national markets, preventing companies from operating in other Member States.

Fragmentation and a lack of coordination also affects inland waterborne transport, in particular along the Danube. Despite increased EU harmonisation, diverging rules and practices remain for crews (e.g. concerning working hours), creating administrative barriers, notably in the Danube basin. Moreover, cooperation between inland waterway ports is in many cases sub-optimal, reducing efficiency and generating bottlenecks in the system.

Interoperability and the (harmonised) deployment of innovative (digital) solutions is limited. The ongoing integration of national transport systems prevents the full interoperability of infrastructure and of technical requirements for the deployment of fleets and equipment. This has serious implications on the (cost-)efficiency of transport services, and on their reliability and ability to transition to innovative clean and digital technologies. By comparison, the US does not have the same interoperability challenges as the EU and technologies can be deployed and scaled up more quicky. In the US, this process has also been spurred by the practice whereby innovative transport technologies have been acquired and deployed via central procurement in the defence sector – and later deployed also for civilian applications. Moreover, in some cases Member States maintain outdated rules on the handling of transport documents. This creates a fragmented regulatory environment when EU rules on digitalisation are implemented, leading to a complex and inefficient system of overlapping regulations.

Regarding rail, there is the need to connect digital solutions with legacy systems, which differ in each Member State's railway system. Due to an unharmonised network, the EU still lacks interoperable rail command, control and signalling, despite several EU bodies working towards this objective. The European Rail Traffic Management System (ERTMS) that the EU has successfully exported to various world regions counterintuitively remains scarcely deployed in the EU after decades of efforts. The ERTMS represents an important market: by 2050, its estimated deployment investment could reach EUR 190 billion. By contrast, also due to a strongly centralised EU-level governance, Galileo technologies have been successfully deployed across the Union. Urgent investment is needed to roll out digital solutions projected to boost rail capacity, such as the Future Railway Mobile Communication System (FRMCS), Digital Capacity Management (DCM), and Digital Automatic Coupling (DAC). In the future, besides the evolutions of these solutions, the EU will have to prepare for the coordinated development and deployment of Automated Train Operations. Another example where rail infrastructure and practices are not up-to-date is capacity planning and allocation, which is currently still done at the national level without the use of modern IT tools.

Concerning air services, technological solutions are not being deployed in a synchronised manner. Of the existing technologies developed which could be used to optimise air traffic control, only a limited number have been rolled out due to technical, coordination and regulatory challenges. The implementation of the technology pillar of the EU's Single European Sky (SESAR solutions) is forecast to bring a EUR 419 billion boost to GDP during the 2013-2030 period[xlvii]. Yet, these benefits will be lost if efforts are not stepped up to bring the air transport network up to date. Tellingly, in air freight management, communication using digital tools is still accompanied by paper-based means, with electronic data sharing lacking along the value chain.

Only 1% of cross-border operations in the EU can be carried out in a completely digital manner, i.e. not requiring a physical document at some stage of the transport process[08]. Procedures for ships in EU ports (two million ports call a year) and for land freight are cumbersome. They are either paper-based or based on several proprietary and not always interoperable IT systems and solutions, hampering collaboration with authorities and among firms. The newly adopted rules to digitalise information exchange in freight transport[xlviii] (by road, rail, inland waterways, and air) is estimated to bring EUR 27 billion savings over 20 years. The new Maritime Single Window Environment[xlix] will enable ships to (re-)use the same interface and data definitions in any EU port.

Multimodal digital solutions are largely unavailable and dissuade logistics operators from blending different means of transport. A multimodal travel market for passengers virtually does not exist. This is due to complexity for operators in obtaining licences and concluding network distribution and revenue sharing agreements[l].

Across the industry, the value of data is not exploited. There is scope to drastically improve access to and the (re-)use of data. To name just one example, the deployment of real-time road traffic avoidance technology is estimated to save EUR 20 billion for road users.

AI will enable increasingly automated functions to deliver safety and quality, navigation and route optimisation, predictive maintenance and fuel or power reduction. For maritime transport, AI can deliver interconnected fleets and shore facilities, provide remote surveillance, the monitoring of shipping lanes, and speed optimisation. For air transport, it enables the better use of scarce resources (e.g. airspace and runways), supports air traffic controllers and is used to detect foreign objects on runways, as well as enabling security screenings in airports. Finally, for rail, AI can support shift planning, boost energy efficiency, and improve service scheduling and real-time disruption management.

Other world regions are progressing faster in digitalising transport and adopting AI, in part thanks to the provision of public support. Global competition in automated vehicles and vessels is fierce. For example, in the US and China, large investments are already leading to the introduction of 'robot-taxis' in urban and peri-urban areas. Furthermore, both China and South Korea aim to secure global leadership in digital solutions for the maritime sector and have envisaged State subsidies to this end[li].

The EU's decarbonisation targets put pressure on transport sectors, in particular those that are hard to abate. The European Commission recently concluded that transport decarbonisation measures could reduce transport emissions by close to 80% by 2040 (compared to 2015 levels)[lii]. However, the implementation of such measures can be particularly costly and technologically challenging in some cases. Despite this, the right incentives and the selection of the most appropriate investments can make it possible to lower decarbonisation costs. Transport decarbonisation investment needs for the entire EU lie in the region of EUR 150 billion a year from 2025 to 2030 and of EUR 869 billion a year from 2031 to 2050[liii]. These estimates refer to the decarbonisation of all modes (although rail and road infrastructure are excluded), capturing needs discussed in the chapters on energy and on the automotive industry. This chapter focuses, in particular, on the decarbonisation of a set of hard-to-abate segments (aviation, maritime, and heavy-duty vehicles).

08. Differences exist across single modes, with 40% of information exchange taking place electronically in aviation, 5% in rail and less than 1% in road and maritime. See: European Environment Agency, Transport and environment report 2022, Digitalization in the mobility system: challenges and opportunities, 2022.

The investment needs to decarbonise the most internationally exposed transport sectors (aviation and maritime) lie in the region of EUR 61 billion a year (for the aviation sector) and EUR 39 billion each year (for the international maritime sector) from 2031 to 2050. The EU level provides 20 million ETS allowances for the decarbonisation of the maritime and aviation transport sectors respectively, until 2030, in addition to other forms of support[09]. Extra-EU flights and sea journeys are partly excluded from the ETS. As a result, the prices of these journeys do not yet reflect their climate impact[liv]. Consequently, there is a risk of business diversion from transport hubs in the EU to those in the EU's neighbourhood, unless effective solutions for ensuring a level playing field are found at the international level (in the context of the International Maritime Organization (IMO) and in the International Civil Aviation Organization (ICAO)).

As discussed in the chapter on the automotive industry, the decarbonisation of light-duty vehicles faces challenges (a slowing market for EVs, the availability of the electricity grid and financing for develop charging infrastructure). **In addition, the EU is working to develop relevant recharging, refuelling and electricity supply infrastructure for maritime, aviation and heavy-duty vehicles**. However, when it comes to heavy-duty vehicles, only a marginal share is electrified due to high costs which are hard to sustain for an industry relying largely on SMEs. In parallel, there is currently almost no dedicated heavy-duty vehicle charging infrastructure, with very few operators investing in this area. The market will have only six years to shift from the state of play to meet EU legal deadlines for emissions reduction and the roll-out of charging infrastructure. In this segment, alternatives to electrification are available and will be assessed, such as the role of sustainable renewable and low-carbon fuels[10]. **Sustainable renewable and low-carbon fuels are essential for the decarbonisation of aviation and maritime transport in the medium term and may be required for heavy-duty vehicles**. However, several challenges need to be overcome to ramp up today's marginal production capacity [see the Box below].

BOX 2

Sustainable renewable and low-carbon fuels for the decarbonisation of hard-to-abate transport segments

EU legislation outlines an emissions reduction pathway for 2050 with progressively stricter emissions reduction targets and leeway for operators to choose and combine technologies and fuels. For example, by 2030:

- Aviation operators must use at least 6% sustainable aviation fuels (SAF) in their total fuel mix.
- Maritime operators must reduce their GHG intensity of onboard energy by at least 6% (compared to 2020 levels).
- Emissions from large trucks and buses, will have to be reduced by 45% and for new urban buses by 90%.
- Member States must ensure that the transport sector as a whole uses at least 5.5% advanced biofuels (of which 1% Renewable fuels of non-biological origin (RFNBOs)) by 2030.

The EU has a leading position in technology development. The Union holds 60% of global high-value patents and tops global rankings for the most innovative companies. Moreover, it invests (under IPCEIs and research funding) in eMethanol and eKerosene projects. In May 2024, the Commission approved the fourth IPCEI focused on the hydrogen value chain for transport and mobility applications.

09. Other forms of support include the zero rating under the ETS of the emissions related to the combustion of sustainable alternative fuels.

10. The revised CO_2 emissions standards for heavy-duty vehicles indicate that the Commission shall assess the role of sustainable renewable and low-carbon fuels in the transition towards climate neutrality and shall by 31 December 2025 present a report to the European Parliament and to the Council with a comprehensive analysis of the need to further incentivise the uptake of advanced biofuels and biogas and renewable fuels of non-biological origin and the appropriate framework of measures, including financial incentives, to achieve that deployment. See: Regulation (EU) 2024/1610 of the European Parliament and of the Council of 14 May 2024 amending Regulation (EU) 2019/1242 as regards strengthening the CO2 emission performance standards for new heavy-duty vehicles and integrating reporting obligations, amending Regulation (EU) 2018/858 and repealing Regulation (EU) 2018/956, 2024.

Nevertheless, implementation will be challenging without appropriate action. Most EU Member States did not meet the 2020 targets for the use of renewable energy in transport and none declared the use of sustainable biofuels in aviation or maritime transport in 2021[lv].

To date, the EU has limited installed capacity and planned production. The EU is the world leader for commercial advanced biofuels plants as the home to 19 of 24 of the world's operational plants. However, it has a growing trade deficit (EUR 3.6 billion in 2022) and rising feedstock dependencies on third countries[lvi]. There are barriers in high capital costs (e.g. up to EUR 500 million to build a plant) and high operational costs (up to 50% higher than producing conventional fuels, mostly dependent on the cost of feedstock). R&D and public support can help to reduce related market and technology risks. Regarding aviation fuels, the US Inflation Reduction Act has driven projects in the US (40% of global projected investment in new SAF plants are in North America). On the other hand, eKerosene and SAF projects in EU could only theoretically enable meeting the EU's demand by 2030, with final investment decisions currently pending. Bio-SAF from biomass will need to be complemented by e-SAF from renewable electricity, water and biogenic or atmospheric carbon. For maritime transport, biofuels will suffice until 2030 or 2035, but green or low-carbon synthetic fuels are needed in the long-term. First offtake agreements are signed, notably for green e-Methanol, but rapid upscaling is needed. **The price gap between alternative and conventional fuels is significant. Advanced biofuels are currently not price-competitive** (costing one-and-a-half to three times as much as conventional biofuels).

The EU needs to start building a supply chain for alternative fuels, or the costs of meeting its targets will be significant.

EU manufacturing of transport equipment is not on a level playing field with production in other world regions, impacting some segments in particular.

Around the world, there are different degrees of subsidisation for the transport industry.

Other regions of the world provide targeted public subsidies, notably to vertically integrated and State-owned companies. The impact of this seems reflected in the pricing offered by foreign competitors benefiting from such support. In the shipbuilding sector, the distortive impact has been particularly acute. Asian competitors can offer prices up to 30%-40% lower than the EU. In the rail equipment and supply sector, Chinese companies offer drastically lower prices than their EU competitors in EU Member States' public procurement procedures. At the same time, the EU makes limited use of defensive instruments[11] and Member States seldom promote factors other than costs in public procurement procedures.

As a result, in combination with price gaps, the EU is losing out or is increasingly challenged by global competitors. For merchant shipbuilding, the EU has (similar to the US) over the years become fully dependent on Asia for merchant shipbuilding, 94% of which is now supplied by Asia. Moreover, 96% of shipping containers are currently produced in China. Beyond commercial shipbuilding, this situation could also impact naval (military) shipbuilding given the high interlinkages between these two segments.

The EU faces external pressure concerning infrastructure ownership and management, with risks for its autonomy. China is gaining a foothold in the EU's transport and logistics infrastructure and fleets. Chinese investment in EU ports is on the rise, and Chinese carriers are controlling a significant share of railway lines arriving in Europe. Moreover, China has invested in a land-sea route through the Balkans to increase their share of EU-China

11. While the EU International Public Procurement Instrument has to date not been applied to the transport industry, an in-depth investigation into a rail public procurement procedure under the EU Foreign Subsidy Regulation has led to the withdrawal of a non-EU operator. See: Regulation (EU) 2022/1031 of the European Parliament and of the Council of 23 June 2022 on the access of third-country economic operators, goods and services to the Union's public procurement and concession markets and procedures supporting negotiations on access of Union economic operators, goods and services to the public procurement and concession markets of third countries, 2022. Regulation (EU) 2022/2560 of the European Parliament and of the Council of 14 December 2022 on foreign subsidies distorting the internal market, 2022. See also: European Commission, Statement by Commissioner Breton on withdrawal by CRRC Qingdao Sifang Locomotive Co., Ltd. from public procurement following the Commission's opening of an investigation under the Foreign Subsidies Regulation – Press release, 2024.

freight. While this transit corridor represents opportunities for EU logistics companies, the EU is becoming ever more dependent on infrastructure investment from China. EU foreign direct investment screening[lvii] focuses on individual investments at the national level, but does not examine the systemic implications of investment at the sector or EU-wide level.

The EU's ownership share of the global maritime fleet is declining. The share of the global fleet owned by EU companies is shrinking[12], though the support via the Guidelines on State aid to maritime transport has been key for the industry to become world leader[lviii]. The shipping industry is highly mobile and the related assets, considered both taxable entities and as companies, can move out from one country to another over the course of weeks. A number of third countries (e.g. UK, in Asia, in the Middle East, and in North America) offer a generous business environment. For example, China offers attractive leasing for shipowners, while EU commercial banks have slowed their support due to strict prudential requirements.

Despite the EU's strength in global logistics, only one European player is in the top five global companies managing port terminals. Today, Asian and Middle Eastern players dominate the business and win concessions around the world.

The EU's transport sector suffers a shortage of trained professionals. Some parts of the sector suffer from severe shortages (e.g. 400,000 professionals needed in the heavy-duty vehicle sector alone in 2024), including in manufacturing. Relatively less attractive working conditions play a role, especially in specific transport segments (some transport segments are among the sectors where workers report the highest levels of job strain and difficulties[lix]). Moreover, the share of older workers in the transport industry is higher than in the rest of the economy. 41.9% of staff employed by rail undertakings are older than 50 and the average age of truck drivers in the EU is the highest in the world. A lack of diversity compounds this trend, with women representing only 22% of employees in the industry (this figure is as low as 1.2% for seafarers, and 2% for professional heavy-duty vehicle drivers).

Reskilling is becoming a pressing need. Moreover, a large shift is expected in skills needs both in technical and administrative roles, driven by digitalisation (and the closely connected importance of cybersecurity) and by decarbonisation. For example, in the maritime sector, reskilling needs could affect some 250,000 seafarers in EU[lx] during the coming years. New skills needs will arise related to the handling and bunkering of alternative fuels and their safety, alongside the ability to maintain optimal operating speeds, and, later, the management of automated vessel operations. Across the transport sector, demand for low-skilled workers is likely to decrease as complex human-machine interactions become more widespread in the medium term. Despite this, training currently focuses on present and immediate skills needs. Certification and driver licencing (and their recognition) for rail, maritime, coach transport and logistics professionals are not yet fully harmonised across the EU, which represents a significant obstacle.

12. Between 2020 and 2024, Asia-based competitors gained ground to the detriment of the EU-controlled fleet, which has proportionally declined from 39.5% down to 35.4% of the global fleet. This is not an absolute decline as the European fleet grew during this period.

Objectives and proposals

Transport is a clear example of a European public good providing essential services to EU citizens and businesses fostering the EU's global economic competitiveness and productivity.

To retain a leading position in face of growing global competition, EU policies must:

- Ensure infrastructure development and the harmonisation of rules to achieve an integrated and intermodal market across the EU.
- Secure the resilience of infrastructure and routes, services and the industry.
- Lead decarbonisation and the adoption of digital and automated solutions.
- Secure a leading manufacturing industry and a level playing internationally for the EU's industrial operators.

The EU already has an extensive body of regulation in this sector. Implementing what is in place remains a priority. The EU should provide the right incentives for Member States and the industry to work together in the full spirit of collaboration. This framework needs to accompany the deployment of advanced digital and clean technology solutions with the provision of efficient, affordable and competitive transport services, and secure and resilient networks, services and industries.

This should contribute to enhancing the competitiveness of the EU's transport sector and the EU economy as a whole.

FIGURE 7

	SUMMARY TABLE TRANSPORT PROPOSALS	TIME HORIZON[13]
1	**Improve infrastructure planning with a primary focus on competitiveness as a complement to cohesion and an evolution towards fully multimodal transport**	**ST**
2	**Mobilise public and private financing: i) increase EU and Member State resources for cross border connectivity, military mobility, climate resilience; ii) introduce or reinforce schemes to attract and de-risk private financing.**	**MT**
3	**Remove barriers to integration and interoperability in all segments.**	**MT**
4	Accelerate digitalisation to enhance efficiency, through the development and enforcement of incentives and standards.	ST/MT
5	Launch dedicated EU innovation projects leveraging public-private partnerships and cross-border cooperation for decarbonisation and automatisation challenges in different segments.	ST/MT
6	Introduce schemes to de-risk and finance decarbonisation solutions in hard-to-abate segments	ST/MT
7	Level the playing field for EU industries leveraging among others public procurement, foreign direct investment screening and an EU export credit facility.	MT
8	Establish international partnerships and develop strategic infrastructure to increase global integration including in climate policy and resilience.	MT
9	Align job profiles to the green and digital transition for diverse and flexible employment opportunities and provide enhanced professional mobility.	MT

13. Time horizon is indicative of the required implementation time of the proposal. Short term (ST) refers to approximately 1-3 years, medium term (MT) 3-5 years, long term (LT) beyond 5 years. In the transport sector, the timelines for seeing results from the proposed actions may vary depending on the specific segments.

1. **Improve infrastructure planning with a focus on competitiveness as a complement to cohesion and an evolution towards fully multimodal transport.**

   The EU should **design adequate planning that prioritises competitiveness (increasing the level of integration of transport modes also considering the potential of adjacencies such as logistics, tourism, manufacturing), transport efficiency, and resilience to climate risks**. This should build on the TEN-T process and cohesion policy, which mainly focus on securing minimum connectivity everywhere in the EU.

   Projects identified based on this enhanced planning should be subject to accelerated project permitting procedures (e.g. legal deadlines for critical projects).

   Alongside this, better coordination between converging network industries should ensure that **energy and telecommunications networks** can better serve the needs of an ever greener and smarter transport sector. For example, transport should be included in the scope of National Energy and Climate Plans (NECPs). Moreover, grid and telecom networks availability should be secured to deliver a modern and extended charging infrastructure for road vehicles [see the chapter on the automotive industry] as well as for other transport modes. In addition, navigation and satellite services should be better integrated in transport, including in the efforts to attain the 2030 EU targets outlined in the Digital Decade policy programme [see also the chapter on digitalisation and advanced technologies].

   National planning should follow similar principles as at the EU level and be aligned to EU-wide planning (also in terms of programming cycles, e.g. by having a duration similar to that of the Multiannual Financial Framework) and consider interactions across transport modes, aiming for overall integration.

2. **Mobilise public and private financing: i) increase EU and Member State resources for cross border connectivity, military mobility, climate resilience; ii) introduce or reinforce schemes to attract and de-risk private financing.**

   Proposal 2a

   The EU should reinforce EU funding, prioritising cross-border connections and national links with cross-border impact, together with military mobility, efficiency and climate risk resilience. The 'use-it-or-lose-it' principle should be maintained to ensure that only mature projects are co-funded by the EU, so that EU grants are used for the above priorities.

   At the national level, Member States should direct more public investments in transport by increasing the use of cross-financing and the earmarking of transport revenues for transport investment. They should also reward projects that contribute to emission reduction by earmarking ETS revenues.

   Proposal 2b

   The EU should rely on a basket of options to unlock private investment:

   - The EU should adopt a conducive framework for the public sector to share risk with the private sector, namely through public-private partnerships backed by solid guarantees and Regulatory Asset Base (RAB) models (e.g. for railway infrastructure), with benchmarking and price reviews by regulators.
   - The EU should also define dedicated models for de-risking private finance, notably of mobile assets including ships (for example, specialised lending instruments and securitisation products with ships as collateral assets, and the aggregation of inland waterway vessel modernisation projects to facilitate loans or guarantees).
   - The EU should also assess how to best leverage foreign capital while maintaining control of selected critical transport infrastructure.
   - The EIB should expand its support to transport projects aligned with EU strategic priorities (e.g. EU Competitiveness Missions).

3. Remove national barriers to EU integration and interoperability.

The EU should put in place and Member States should implement specific measures for each mode of transport [as detailed below], to lift national barriers, achieve interoperability and make best use of the available connectivity infrastructure. When necessary, Member States should engage into regulatory reforms to align their national policies with EU transport policies. Dedicated reforms that go beyond the application of EU law could be incentivised through performance-based mechanisms in the EU budget.

The objectives to be achieved by the Member States vary depending on the segment. The EU should provide tailored forms of support to Member States in this process.

For rail, Member States should, as an example, remove unnecessary national operational rules and standards (the EU should continue providing support to this end, namely via the European Railway Agency), better coordinate rail capacity management both in freight and passenger transport (based on the Commission proposal on the use of railway infrastructure capacity[14]), and implement the fourth Railway package, to ensure open, competitive markets at the national level.

For air services, Member States should, for example, ensure the timely implementation of the recently agreed Single European Sky 2 Plus package, in particular concerning reliance on pan-European providers of data services for air traffic control and stronger collaboration with the European air traffic Network Manager. The EU could create conditions for better cross-border collaboration (e.g. using performance schemes).

For waterborne transport, operators should benefit from similar operational rules across borders, such as EU harmonised rules for inland waterway crews and rules or policies fostering coordination in port operations (also within the same basins, when there is a cross-border dimension).

For road transport, operators should benefit from open markets to deliver services across borders and the most innovative services should benefit from a common baseline of rules and principles at the EU level. For example, to this end, the co-legislator should agree the pending proposal on international markets for bus and coach services[15] and the Commission should propose a set of key principles to be set out in legislation, for the deployment of cooperative, connected and automated mobility (see also the chapter on the automotive industry).

4. Accelerate digitalisation to enhance efficiency, through the development and enforcement of incentives and standards.

Proposal 4a

Member States and the transport sector should adopt digitalisation measures to increase efficiencies in the respective transport segments.

From the EU's side, this translates into the continuous development of technical specifications and standards, if appropriate also based on stronger governance. For **Member States, as part of the planning defined in proposal 1, digitalisation must be included as a performance element, with related targets**. It should include AI, cybersecurity measures, and the contribution of transport to a common EU space for data (data from travel, ticketing, traffic and freight transport) also by means of paperless procedures.

The sector could be incentivised to develop digitalisation measures through different instruments at the national level (e.g. tax reductions and standard enforcement).

14. European Commission, Proposal for a Regulation on the use of railway infrastructure capacity in the single European railway area, amending Directive 2012/34/EU and repealing Regulation (EU) No 913/2010 (COM(2023) 443), 2023.

15. European Commission, Proposal for a Regulation amending Regulation (EC) No 1073/2009 on common rules for access to the international market for coach and bus services (COM(2017) 647), 2017.

Examples of key digitalisation solutions by transport segment (on which relevant EU bodies should continue developing technical specifications) which the industry should be required and incentivised to take up, are:

- For **rail** transport: the European Rail Traffic Management System (ERTMS), the Future Railway Mobile Communication System (FRMCS), Digital Capacity Management (DCM), and Digital Automated Coupling (DAC), along with future Automated Train Operations solutions. To support this, the EU could ensure the coordination of projects and investment and of the deployment of innovative solutions. This could be done, for example, by expanding the role of the existing EU coordinator for the ERTMS or of the European Railway Agency.

- For **air** transport: solutions part of the digital pillar of the Single European Sky (SESAR) and air traffic management technologies defined in the EU Master Plan of the SESAR Joint undertaking, along with the better integration of air traffic management with airline and airport operations for efficient gate-to-gate operations.

- For **waterborne** transport: a European Maritime Single Window Environment, improved information flows for port call optimisation, and the coordination of supply chain operations.

- For **road** transport: cooperative intelligent transport systems and centralised coordination of the deployment of cooperative, connected and automated vehicles, technologies for the smart enforcement of road traffic rules, and dynamic road tolling using real-time monitoring and satellite positioning technologies.

5. Launch dedicated EU innovation projects leveraging public-private partnerships and cross-border cooperation for decarbonisation and automatisation challenges in different segments.

In light of different priorities for each transport segment, the EU should provide a range of support tools to foster innovation until market deployment.

Examples of key targets and priorities by segment are:

- **Rail**: Automated Rail Operations, alongside the evolution of ERTMS, FRMCS, DCM and DAC.

- **Air**: Fuel efficient and zero emission aircraft.

- **Waterborne**: Maritime Autonomous Surface Ships (MASS), Modern inland waterway vessels adapted to new river conditions, and offshore wind platform technologies.

- **Road**: cooperative, connected and automated mobility.

- Piloting and new generation of **sustainable renewable and low-carbon fuels**, including eSAF produced from renewables.

The EU should offer a wide range of instruments, which all transport segments could leverage, to be activated at different technology readiness levels, such as:

- An EU industrial demonstrator (e.g. as part of a new Competitiveness Joint Undertaking, replacing current public-private partnerships [see innovation and governance chapters]).

- New competitiveness IPCEIs, extended beyond the first market deployment for State aid cross-border projects (see also the IPCEI proposed in the chapter on the automotive industry).

- A reinforced 10th Framework Programme for research and innovation, which should extend to the phase of deployment to market, with AI and automation, cybersecurity and emissions reduction among overarching R&I priorities across all transport segments. It should also leverage the dual use nature of certain technologies and synergies with adjacent industries (e.g. offshore, green steel).

6. Introduce schemes to de-risk and finance decarbonisation solutions in hard-to-abate segments

The EU should mobilise a set of tools to support hard-to-abate industries in meeting EU decarbonisation targets and reap opportunities of being a 'first mover' in emissions reduction solutions.

To support investment to reduce emissions in the aviation, maritime and heavy-duty vehicle transport sectors, the EU should:

- De-risk investment in sustainable renewable and low carbon fuels, via schemes based on Contracts for Difference and auctions as a service similar to those designed for the Hydrogen Bank.
- Ensure continuity and expand existing funding mechanisms (the current Transport Alternative Fuels Infrastructure Facility (AFIF) under the Connecting Europe Facility programme, blending EU grants with support by EIB and National Promotional Banks) for refuelling and recharging infrastructure, in particular for heavy-duty vehicles.
- Launch dedicated sectoral calls under the Innovation Fund for the first deployment of decarbonisation solutions, possibly even per technology (e.g. eSAF).

7. Level the playing field for EU industries leveraging among other means public procurement, foreign direct investment screening, and an EU export credit facility.

As indicated in other chapters (notably in the chapter on energy-intensive industries), and in addition to the specific objectives and levers presented in the chapter on the automotive industry, the EU should react where appropriate to global asymmetries in regulation and subsidies, by using a set of levers.

Whilst global leadership objectives differ depending on the industry [see the Box below], the EU should support all its industries with trade measures, in line with the key principles for trade policy discussed in Part A. Specific actions with reference to the transport sectors include:

- Public procurement procedures rewarding innovative and sustainable solutions.
- Comprehensive investigations into the business practices of foreign companies in the EU and the assessment of foreign investment exposure in transport segments.
- An EU export credit facility.

In addition, the EU should equip its industries with the tools most suited to the specificities of each transport segment.

For example, in **shipbuilding**, the EU could leverage synergies with industrial defence production and public support provided for dual use technologies, consider conditionalities in EU financial instruments or tax incentives for shipowners to buy ships made in EU, and extend EU financial and policy instruments dedicated to renewable energy projects to specialised vessels.

To ensure autonomy in **sustainable renewable and low-carbon fuels**, the EU should secure necessary feedstock, including through international partnerships; support investment in production plants for example by extending the scope of eligible support schemes under section 2.8 of the Temporary Crisis and Transition Framework to include these fuels in addition to other clean technologies [see clean technologies chapter]; coordinate demand aggregation and joint purchases. Furthermore, strategically using public procurement, for instance in the defence sector, can help to de-risk the emerging SAF production industry.

BOX 3

Possible industrial objectives by transport segment

Rail: maintain the current industrial base, exploit an integrated EU market to deploy existing technologies and boost exports (e.g. locomotives, signalling). Launch and maintain large-scale automated train production.

Shipbuilding: maintain the current industrial base (more complex and value added). Regain leadership in ferries, energy transport and research vessels. Gain global leadership in the production of floating technologies and in the supply of vessels for the installation and maintenance of offshore wind.

Aviation: maintain and boost current leadership. Achieve full EU autonomy along the supply chain (e.g. 100% EU-made engines). Boost EU-made dual use vehicles and systems.

Sustainable renewable and low-carbon fuels for hard-to-abate transport segments: secure a certain degree of EU autonomy in the supply chain for sustainable renewable and low-carbon fuels.

8. Establish international partnerships and develop strategic infrastructure to increase global integration, including in climate policy and resilience.

Proposal 8a

The EU should prepare its future enlargement by further strengthening the Solidarity Lanes with Ukraine and Moldova through investment in land and river infrastructure and ensuring procedures at its borders; by embedding Ukraine, Moldova and the six Western Balkan partners in TEN-T; and by aligning standards and the acquis together, supporting enlargement countries to further extend the EU's reach to the rest of the world. Such engagement with enlargement countries should promote transport as a vector of integration.

Proposal 8b

The EU should adopt an international connectivity strategy, that would:

- Intensify work with partners (including in the EU neighbourhood, such as with the EU Eastern Partnership and the Union for the Mediterranean) and investors to build connectivity infrastructure and create regulatory conditions for attractive and effective alternative transport connections – namely, a multimodal Trans-Caspian Transport Corridor connecting Europe and Central Asia.
- Leverage the Global Gateway via strategic planning to support infrastructure investment worldwide (e.g. Middle and Lobito Corridors, Nordic routes), and to promote EU standards (e.g. for rail) around the world.
- Develop an EU-wide system to anticipate and handle crises, prioritising in the short term the continued contribution to securing trade routes under EU-led operations, such as ASPIDES in the Red Sea.
- Lead international cooperation (including climate diplomacy) efforts to align international standards to those of the EU. Alongside a permanent evaluation of business leakage risks, the EU should advocate for a global emissions pricing mechanism and fuel and energy efficiency standards in the International Civil Aviation Organization (ICAO) and in the International Maritime Organization (IMO).

9. Align job profiles with the green and digital transition for diverse and flexible employment opportunities and provide enhanced professional mobility.

In addition to the proposals set out in the chapter on skills, the EU transport sector would benefit from action in two key areas:

Proposal 9a

The EU should map the skillset needed in the future to guide education programmes, while the industry should create diverse job profiles, in line with the needs of a transforming sector, that would also help to attract a more diverse range of employees.

Proposal 9b

The EU should facilitate smoother circulation of professionals through a comprehensive and up-to-date framework for the mutual recognition of certifications.

ENDNOTES

i European Commission, Climate Action Progress Report, 2023.

ii International Civil Aviation Organization (ICAO), Future of Aviation.

iii International Air Transport Association (IATA), Brief: Aviation value chain - An analysis of investor returns in 2022 within the aviation value chain, 2024.

iv United Nations Conference on Trade and Development (UNCTAD), Key statistics and trends in international trade 2022, 2023.

v IATA, Value of Air Cargo.

vi International Transport Forum (ITF), ITF Transport Outlook 2023, OECD Publishing, 2023.

vii Global Infrastructure Outlook, Forecasting infrastructure investment needs and gaps.

viii UNCTAD, Estimates Of Global e-Commerce 2019 and Preliminary Assessment of COVID-19 Impact on Online Retail 2020, Technical Notes on ICT for Development, no 18.

ix United Nations World Tourism Organization (UNWTO), World Tourism Barometer and Statistical Annex, 2024.

x NATO, Resilience, preparedness and Article 3, last updated 8 July 2024.

xi Council Directive 2008/114/EC of 8 December 2008 on the identification and designation of European critical infrastructures and the assessment of the need to improve their protection, 2008. Directive (EU) 2022/2557 of the European Parliament and of the Council of 14 December 2022 on the resilience of critical entities and repealing Council Directive 2008/114/EC, 2022.

xii UNCTAD, Unprecedented shipping disruptions raise risk to global trade, UNCTAD warns, 2024.

xiii OECD, Realising the Potential of the Middle Corridor, 2023.

xiv World Economic Forum, Global Risk Report 2024, 2024.

xv Platina 3, IWC Policy Platform, Options for shallow-water / climate resilient vessels, 2022.

xvi Intergovernmental Panel on Climate Change (IPCC), Climate Change and Land: an IPCC special report on climate change, desertification, land degradation, sustainable land management, food security, and greenhouse gas fluxes in terrestrial ecosystems, 2019.

xvii European Commission, EU position in world trade.

xviii Airport Industry News, ACI World Reveals Top 10 Busiest Airports in 2023, 2024.

xix EUROCONTROL, EUROCONTROL European Aviation Overview – 20-26 May 2024, 2024.

xx ITF, EU Air Transport Liberalisation Process, Impacts and Future Considerations, Discussion Paper No. 2015-04, 2015.

xxi European Court of Auditors, Special Report 19/2018: A European high-speed rail network: not a reality but an ineffective patchwork, 2018.

xxii Eurostat, International trade in aircraft, 2022.

xxiii OECD, Council Working Party on Shipbuilding, Analysis of the marine equipment industry and its challenges (C/WP6(2022)15/FINAL), 2022.

xxiv Gardner, H., Brambilla, M., and Matheus, D. Research for TRAN Committee – Perspectives for the rolling stock supply in the EU, European Parliament, Policy Department for Structural and Cohesion Policies, 2023.

xxv European Commission, Staff Working Document, Impact Assessment Report Accompanying the document Proposal for a Regulation of the European Parliament and of the Council on Union guidelines for the development of the trans-European transport network, amending Regulation (EU) 2021/1153 and Regulation (EU) No 913/2010 and repealing Regulation (EU) 1315/2013, SWD(2021), 2021.

xxvi European Commission, Staff Working Document Accompanying the Document Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions – Sustainable and Smart Mobility Strategy – putting European transport on track for the future (SWD(2020) 331), 2020.

xxvii European Commission, Staff Working Document – Impact Assessment: Report Accompanying the Document Proposal for a Directive of the European Parliament and of the Council amending Council Directive 92/106/EEC as regards a support framework for intermodal transport of goods and Regulation (EU) 2020/1056 of the European Parliament and the Council as regards calculation of external costs savings and generation of aggregated data (SWD(2023) 351), 2023.

xxviii TEN-T Coordinators' Position Paper, Connecting Europe – A transport funding and financing that is adapted to the challenges ahead, 2024.

xxix European Investment Bank, European PPP Expertise Centre, Market update – Review of the European public-private partnership market in 2022, 2023.

xxx For example, maintenance represented 25% of the EUR 41 billion annual operating expenditures of the EU's rail network. See: European Commission, Report from the Commission to the European Parliament and the Council Eighth Monitoring Report on the development of the rail market under Article 15(4) of Directive 2012/34/EU of the European Parliament and of the Council, 2023.

xxxi European Court of Auditors, Landscape review: Towards a successful transport sector in the EU: challenges to be addressed, 2018.

xxxii TEN-T Coordinators' Position Paper, Connecting Europe – A transport funding and financing that is adapted to the challenges ahead, 2024.

xxxiii European Court of Auditors, Special Report 10/2020: EU transport infrastructures: more speed needed in megaproject implementation to deliver network effects on time, 2020.

xxxiv Platina 3m IWC Policy Platform, Report on barriers towards the implementation of waterway and port infrastructure investments and proposed solutions, 2023.

xxxv Regulation (EU) 2023/1804 of the European Parliament and of the Council of 13 September 2023 on the deployment of alternative fuels infrastructure, and repealing Directive 2014/94/EU, 2023.

xxxvi European Commission, Proposal for a Directive of the European Parliament and of the Council amending Council Directive 92/106/EEC as regards a support framework for intermodal transport of goods and Regulation (EU) 2020/1056 of the European Parliament and the Council as regards calculation of external costs savings and generation of aggregated data (COM(2023) 702), 2023.

ENDNOTES

xxxvii Regulation (EU) 2024/1679 of the European Parliament and of the Council of 13 June 2024 on Union guidelines for the development of the trans-European transport network, amending Regulations (EU) 2021/1153 and (EU) No 913/2010 and repealing Regulation (EU) No 1315/2013, 2024.

xxxviii European Commission, Proposal for a Regulation of the European Parliament and of the Council on common rules for the allocation of slots at European Union airports (Recast) (COM(2011) 827), 2012.

xxxix European Commission, Proposal for a Regulation of the European Parliament and of the Council amending Regulation (EC) No 1073/2009 on common rules for access to the international market for coach and bus services (COM(2017) 647), 2017.

xl European Commission, Proposal for a Directive of the European Parliament and of the Council amending Council Directive 92/106/EEC as regards a support framework for intermodal transport of goods and Regulation (EU) 2020/1056 of the European Parliament and the Council as regards calculation of external costs savings and generation of aggregated data (COM(2023) 702), 2023.

xli European Commission, Call for evidence, allocation of EU airport slots – review of rules, 2022.

xlii See also, for example: Authorité de la Concurrence, Avis 23-A-18 du 29 novembre 2023 relatif au secteur des transports terrestres de personnes, 2023.

xliii European Court of Auditors, Special Report 19/2018: A European high-speed rail network: not a reality but an ineffective patchwork, 2018.

xliv European Commission, Staff Working Document – REFIT Ex-Post evaluation of Combined Transport Directive 92/106/EEC Final Report (SWD(2016)141), 2016.

xlv European Commission, Updating EU combined transport data – Final report, 2017.

xlvi European Court of Auditors, Special report 04/2024: Reaching EU road safety objectives, 2024.

xlvii SESAR Joint Undertaking, Assessing the macroeconomic impact of SESAR – Final report, June 2011.

xlviii Regulation (EU) 2020/1056 of the European Parliament and of the Council of 15 July 2020 on electronic freight transport information, 2020.

xlix Regulation (EU) 2019/1239 of the European Parliament and of the Council of 20 June 2019 establishing a European Maritime Single Window environment and repealing Directive 2010/65/EU, 2019.

l European Commission, Inception Impact Assessment – Multimodal Digital Mobility Services, 2021.

li European Commission, The Transition pathway for the EU Mobility Industrial Ecosystem, 2024.

lii European Commission, Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions – Securing our future Europe's 2040 climate target and path to climate neutrality by 2050 building a sustainable, just and prosperous society (COM(2024) 63), 2024.

liii Ibid.

liv ITF, 'The Potential of E-fuels to Decarbonise Ships and Aircraft', International Transport Forum Policy Papers, No. 111, OECD Publishing, 2023.

lv European Court of Auditors, Special report 29/2023: The EU's support for sustainable biofuels in transport – An unclear route ahead, 2023.

lvi Motola, V., Hurtig, O., Scarlat, N., Buffi, M., Georgakaki, A., Letout, S., and Mountraki, A., Clean Energy Technology Observatory: Advanced biofuels in the European Union - 2023 Status Report on Technology Development, Trends, Value Chains and Markets, Publications Office of the European Union, 2023.

lvii Regulation (EU) 2019/452 of the European Parliament and of the Council of 19 March 2019 establishing a framework for the screening of foreign direct investments into the Union.

lviii European Commission, Commission communication C(2004) 43 — Community guidelines on State aid to maritime transport, 2004.

lix European Commission, Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions – Labour and skills shortages in the EU: an action plan (COM(2024)131), 2024.

lx Based on estimates for reskilling needs at global level in the 'Zero Carbon by 2050 scenario', modelled by Lloyds Register and University Maritime Advisory Services, whereby some additional training would be required for 450,000 seafarers by 2030 and 800,000 seafarers by the mid-2030s. See: DNV AS, Insights into seafarer training and skills needed to support a decarbonized shipping industry, 2022.

PART B | SECTION 2

Horizontal **policies**

1. Accelerating innovation

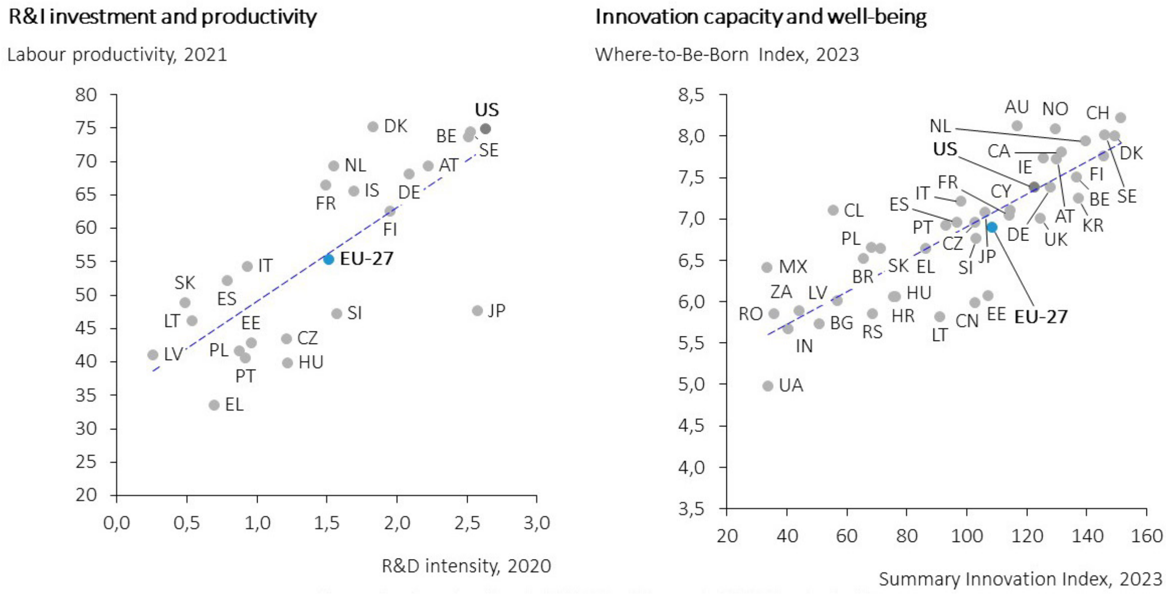
The starting point

Research and innovation (R&I) are the main drivers of productivity and people's well-being [see Figure 1]. Innovation generates positive externalities, with new technologies serving as stepping stones for further innovation. This creates cumulative positive spillovers that justify a role for government intervention to promote research and innovation. R&I will be critical for financing Europe's welfare system as the EU population ages and its labour force shrinks. The importance of R&I for productivity growth will increase in the future as a result of the accelerating pace of global innovation during the past decades.

TABLE OF ABBREVIATIONS

AI	Artificial intelligence
CERN	European Organization for Nuclear Research
DARPA	Defense Advanced Research Projects Agency
EIB	European Investment Bank
EIC	European Innovation Council
EIF	European Investment Fund
EPO	European Patent Office
ERA	European Research Area
ERC	European Research Council
ERC-I	European Research Council for Institutions
ESFRI	European Strategy Forum on Research Infrastructures
EuroHPC JU	European High-Performance Computing Joint Undertaking
FCC	Future Circular Collider
FP10	10th EU Framework Programme for Research and Innovation
IEC	Innovative European Company
IoT	Internet of Things
IPO	Initial public offering
IPR	Intellectual Property Rights
JEDI	Joint European Disruptive Initiative
NPB	National Promotional Bank
PPA	Published patent applications
RD&I	Research, development and innovation
RTO	Research and technology organisation
S&T	Science and technology
SME	Small and medium-sized enterprises
SPRIN-D	Federal Agency for Disruptive Innovation
STEM	Science, technology, engineering and mathematics
TRL	Technology Readiness Level
TTO	Technology Transfer Office
VC	Venture capital

FIGURE 1
The impact of research and innovation



Note: Left: business expenditure in R&D (BERD) measured in percentage of gross domestic product (GDP) 2020 and labour productivity 2021 based on Eurostat. Right: Where-to-Be-Born Index by Country 2023, Economist Intelligence, and Summary Innovation Index 2023, European Innovation Scoreboard.

Source: European Commission, DG RTD, 2024.

Innovation is also key to pursue the green and digital transitions, necessary to reinforce Europe's resilience, and to strengthen its position in global supply chains. Achieving the EU's climate objectives hinges on Europe's ability to rapidly deploy robust investments in clean technologies [for more detail, see the chapter on clean technologies]. Almost one-third of the required CO_2 emissions reductions by 2050 rely on clean technologies currently in the demonstration or prototype phase[i]. Since around 2010, patenting in low-carbon innovation has slowed down and the current level of green innovation will not be sufficient to meet the EU's 2050 net-zero emissions objectives[ii]. Relevant decarbonisation solutions (e.g. green hydrogen, carbon capture and alternative fuels for aviation and maritime transport) are still very expensive, making them unaffordable for widescale deployment. Technological development can help reduce and even eliminate the existing premia in green technologies, as has already happened in the case of solar or wind energy generation. Therefore, innovation will be a main driver of the green transformation of Europe's energy sector [see the chapter on energy]. Similarly, innovation in transport manufacturing and services is fundamental to reduce their climate and environmental footprint while staying globally competitive [see the chapter on transport].

THE EU'S INNOVATION PERFORMANCE

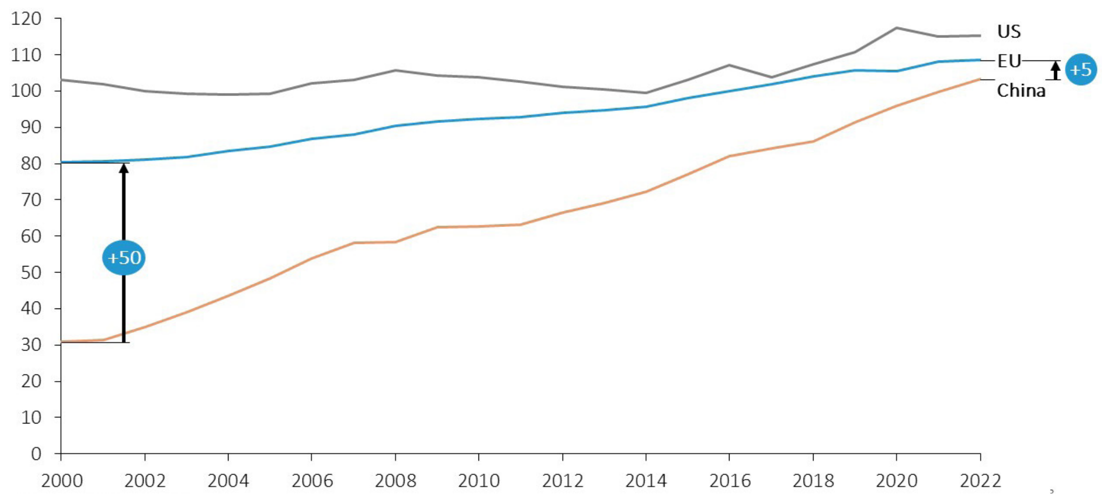
The innovation capacity of the EU as a whole continues to lag behind that of the US. EU convergence with the US in terms of innovation capacity has slowed during the last decade, with the US remaining ahead by almost seven percentage points according to the Summary Innovation Index of the European Innovation Scoreboard[01]. By contrast, China's performance has more than tripled over the past two decades and is rapidly approaching the EU's level [see Figure 2]. Until 15 years ago, competition for world leadership in innovation was primarily between the US and Europe. Today, it involves three players, with China showing a much faster increase compared to both the US and the EU.

01. The Summary Innovation Index is part of the European Innovation Scoreboard, which provides an annual indicator-based comparative assessment of the research and innovation performance of EU Member States, as well as many regional and global partners. It covers the main dimensions of innovation performance under four groups: framework conditions, investment, innovation activities, and impact. Overall, it builds on 32 indicators (for international comparison, only 21 indicators are used due to a lack of data availability).

FIGURE 2

Evolution of the innovation performance of the EU and its main competitors

European Innovation Scoreboard



Source: European Commission, 2004.

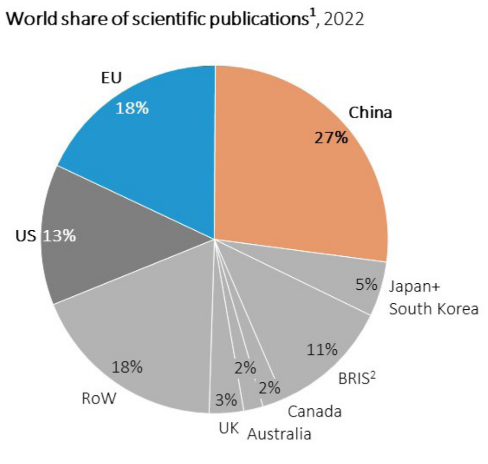
The EU shows weaknesses throughout the entire lifecycle of innovation, as well as in its pattern of sectoral specialisation.

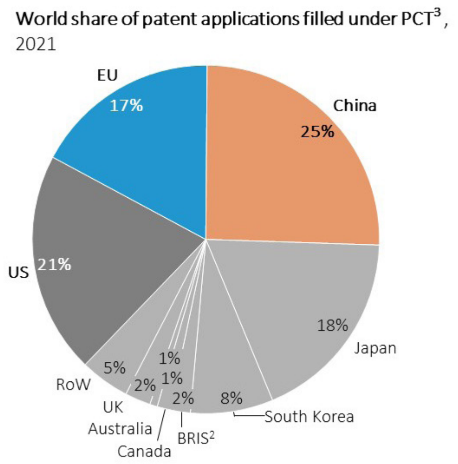
1. Weaknesses throughout the lifecycle of innovation

The EU produces almost one-fifth of the world's scientific publications, ranking ahead of the US and second only to China [see Figure 3]. In terms of high-quality publications (the 10% most cited), the EU is on par with the US, but lags behind China. The EU also has a strong (yet eroding) position in patenting. In 2021, it accounted for 17% of the world's patent applications, compared with a share of 21% for the US and 25% for China [see Box 1].

FIGURE 3

The EU's position in producing scientific and technological outputs





Note: (1) Fractional counting used. (2) BRIS: Brazil, Russia, India and South Africa. (3) Patent Cooperation Treaty (PCT) patents. Fractional counting method, inventor's country of residence and priority date used. 2-3 weeks of data from 2021 are missing due to the timing of the snapshot by the EPO.

Source: European Commission, DG RTD, 2024. Based on Science-Metrix using the Scopus database.

BOX 1

The emergence of China as an innovation superpower

China's contribution to scientific publications and patents has grown remarkably during the last two decades. This has been the main factor behind the declining world shares of both the EU and the US. During the past 20 years, China has successfully propelled some of its universities and research institutions to the forefront of world research. This is the result of a well-thought-out and persistent strategy based on: exposing its students to the best global universities, primarily in the US, but also in Europe; providing incentives to bring the best scholars back home; and creating a scientific environment at home as attractive as the best labs worldwide. The strategy has focused on STEM, with the objective of concentrating resources on fields with the greatest returns for innovation.

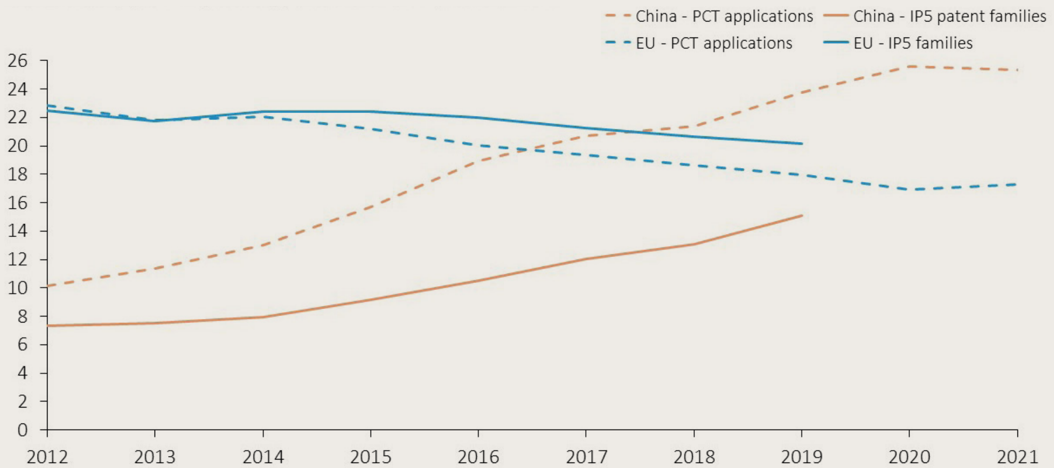
The Chinese experience shows that rapid progress is attainable. The ingredients behind China's success are threefold: i) the allocation of generous resources; ii) a rich pool of highly skilled scientists (often trained in the US or elsewhere outside of China), and iii) intensive collaboration, including with partners in third countries.

In some frontier technologies, such as additive manufacturing, blockchain, computer vision, genome editing, hydrogen storage and self-driving vehicles, the quality of Chinese patents is pushing the global frontier[iii]. However, there are also indications that the quality of publications, trademarks[iv], and more importantly patents has not risen proportionally across the board[v], [vi]. For instance, while there has been a strong increase in the number of patents registered in at least two of the five major patent offices (known as IP5 patent families), which typically indicates high-quality patents, this growth has been less impressive than the increase in total patent applications [see Figure 4]. This might be the result of the Chinese government's attempt to prioritise quantity over quality in patents to increase China's geopolitical visibility[vii].

FIGURE 4

Patenting in the EU compared with China

World share (%) of PCT patent applications and IP5 patent families



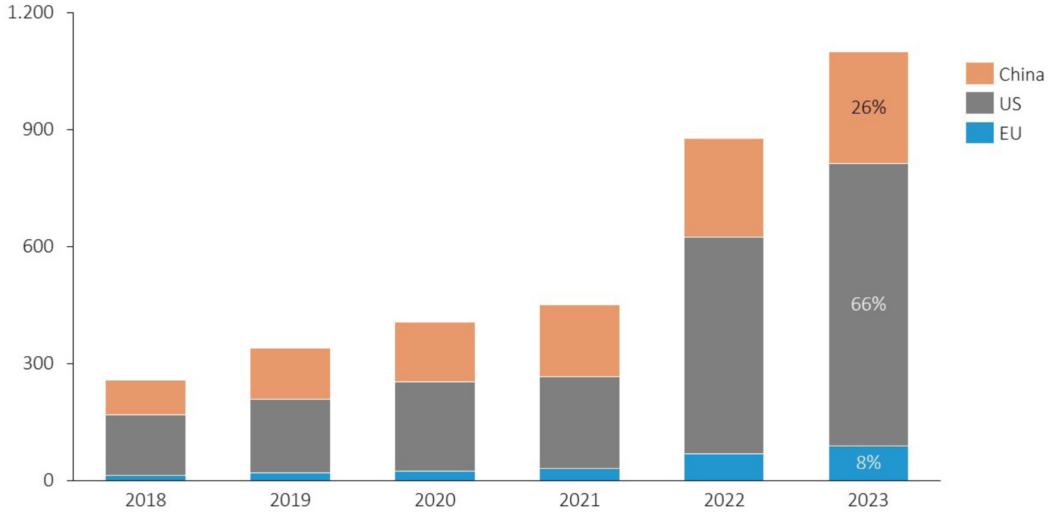
Note: Patent Cooperation Treaty (PCT) patents. Fractional counting method, inventor's country of residence and priority date used. IP5 patent families refer to patents that have been filed in at least two IP offices worldwide, one of which among the five IP offices (namely the European Patent Office, the Japan Patent Office, the Korean Intellectual Property Office, the US Patent and Trademark Office, and the State Intellectual Property Office of the People's Republic of China). Fractional counting method, inventor's country of residence and priority date used.

Source: European Commission, DG RTD, 2024. Using PATSTAT.

However, the EU's robust scientific position is not fully reflected in its presence in innovative markets. The EU's pool of innovative companies is significantly smaller than that of the US. Only around 40% of European companies report that they invest in R&I, compared to 56% in the US[viii]. This difference is mostly due to a lower intensity of investment in 'new to the company' innovation indicating a slower pace of technology adoption.

Importantly, new European tech start-ups face issues in scaling up. Europe is now creating a significant number of start-ups, comparable to that in the US[ix]. However, European companies often fail to successfully pass the growth stage. As a result, the EU has a lower number of unicorns (i.e. start-ups with a valuation exceeding USD 1 billion) [see Figure 5]. Many upcoming European start-ups relocate, mostly to the US[x]. Similarly, the EU has fallen behind in nurturing companies specialised in 'high-tech' R&D. Currently, there are only 12 European companies among the world's 50 companies with the highest R&D budgets, compared to 22 in the US[xi].

FIGURE 5
Active unicorns



Source: Pitchbook. Accessed 2024.

2. A sectoral gap in digital and advanced technologies

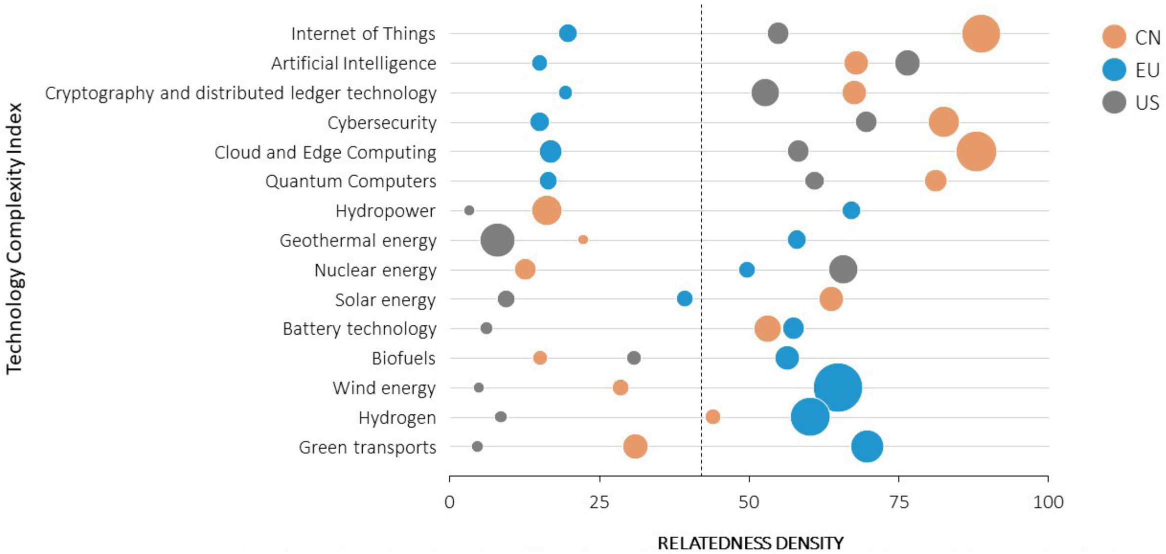
The EU has a broad and diversified industrial innovation base, but is lagging behind in the field of digital technologies[xii]. The EU has important capabilities, in particular, in green technologies, advanced manufacturing and advanced materials, the automotive industry and biotechnology. However, it is weak in digital technologies, such as artificial intelligence (AI), cybersecurity, the internet of things (IoT), blockchain and quantum computers [see Figure 6][xiii].

Given the importance of digitalisation for the economy as a whole, the EU's gap in digital and advanced technologies may affect the performance of many other sectors. Digital technologies are highly complex, and building up expertise and capabilities in them is difficult, time-consuming and requires coordination of different business actors. The EU's existing digital gap with respect to both the US and China will be difficult to overcome without significant targeted policy actions.

FIGURE 6

The EU's position in complex (digital and green) technologies

2019-2022



Note: The results are based on an analysis of patent data to understand the complexity and potential for specialization in different technology areas. On the y-axis, technologies are ranked according to how advanced or complex they are, with scores ranging between 0 (less complex) and 100 (more complex). The x-axis (showing the relatedness density) represents how easily a country can build comparative advantage in a particular technology, depending on how closely related it is to other technologies the country is already strong in. The size of the bubbles shows how much each country has already specialized in a technology, using a measure of "revealed comparative advantage" (RCA), which reflects their competitive strength in that field.

Source: European Commission, DG RTD.

The EU's comparative advantage in green technologies is increasingly challenged. From 2016 to 2021, Europe produced 30% of all green inventions worldwide, compared with 19% and 13% by the US and China, respectively. The EU is strong in domains such as green transport, biofuels and wind energy. In many of these technologies, the EU outperforms both China and the US. The EU also has strong potential to innovate in nuclear energy, solar energy, hydropower, geothermal energy and battery technologies. Nevertheless, China is catching up quickly, with its number of patents increasing rapidly. The EU will need to make a sustained effort to retain its comparative advantage in green technologies, which represents both an opportunity for commercial exploitation and a driver of the green transition.

EU innovation activities are primarily concentrated in sectors with medium-to-low R&D intensity. This might push the EU into a 'middle technology trap' [xiv]. Figure 7 compares the top-three companies for R&D spending in the EU and the US, respectively. Over the past two decades, the top-three EU companies have consistently been from the automobile sector, showing minimal changes in their ranking. In stark contrast, R&D leaders have changed in the US over time. In the early 2000s, the top three US companies spanned the automobile and pharmaceutical industries. By the 2010s, they had shifted to the software and hardware sectors; and in the 2020s, the top-three companies included Alphabet and Meta, global leaders in the digital sector. This dynamic business evolution has been notably absent in the EU.

FIGURE 7
Top-three R&D spenders and their industries in the EU and the US

Top 3 R&D spenders and their industries in the EU and the US			
	2003	2012	2022
US	Ford (auto) Pfizer (pharma) GM (auto)	Microsoft (software) Intel (hardware) Merck (pharma)	Alphabet (software) Meta (software) Microsoft (software)
EU	Mercedes-Benz (auto) Siemens (electronics) VW (auto)	VW (auto) Mercedes-Benz (auto) Bosch (auto)	VW (auto) Mercedes-Benz (auto) Bosch (auto)

Source: Fuest et al. (2024). Based on the EU Industrial R&D Investment Scoreboard.

THE ROOT CAUSES OF EU'S WEAK INNOVATION PERFORMANCE

We identify eight root causes for the EU's weak innovation performance.

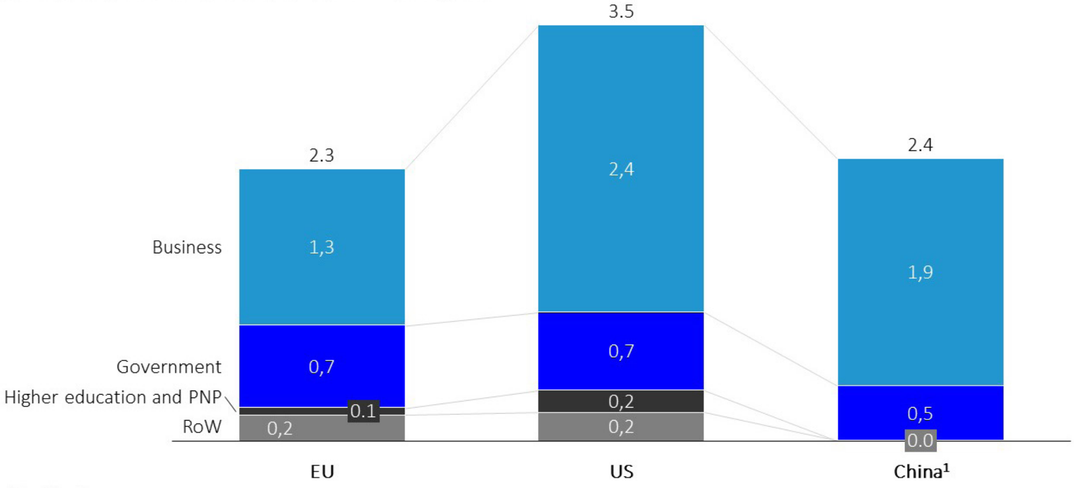
1. Lower private R&D spending

The EU's competitive weakness in innovation is partly due to an R&D investment gap. The EU is investing less in R&D compared to the US, Japan and also China, which is making impressive progress. In 2022, the EU spent 2.24% of its GDP on R&D resulting in an investment deficit of around EUR 123 billion, relative to its target of achieving 3% R&D spending as a percentage of GDP[02]. As a comparison, the US spends 3.5% of its GDP on R&D, Japan 3.3%, and China 2.4% – all higher than the EU. The gap with the US is even more striking when stated in absolute monetary amounts. The US outperforms all other major economies in total annual R&D expenditure, investing EUR 877 billion in 2022, compared to EUR 355 billion by the EU in the same year.

There are big differences in R&D spending across EU Member States. Only five Member States exceed the EU's 3% R&D spending target (Belgium, Sweden, Austria, Germany and Finland). The R&D investment of nine Member States is below 1% (Lithuania, Luxembourg, Slovakia, Ireland, Bulgaria, Cyprus, Latvia, Malta, and Romania).

02. The target to increase the EU's R&D spending to 3% of GDP was set in 2002 during the Barcelona European Council and was also part of the Lisbon strategy.

FIGURE 8
R&D intensity
R&D intensity, GERD as % of GDP, by source of funding, 2021



1 Except Hong Kong.

Note: PNP refers to private non-profit sector; RoW refers to rest of the world.

Source: European Commission, 2024. Based on Eurostat and OECD.

Lower private R&D spending is the main reason for the EU's R&D spending gap. European underspending is mostly attributable to the business sector, whose R&D expenditures account for about 1.3% of GDP – well below the level of 2.4% in the US and of 1.9% in China. Private sector investments in R&D account only for 67% of total R&D spending in the EU, compared to 81% in the US and 76% in China.

The relatively high share of medium and low R&D-intensive sectors in the EU accounts for most of the gap in private R&D spending[xv]. Fuest et al.[xvi] estimate that the sectoral composition of the economy accounts for about 60% of the difference between private R&D spending in the US and the EU. If the EU had the same structural composition as the US, its private spending on R&D would be 2.2% of GDP and total spending would be almost 2.9%[03]. Even with the same sectoral composition, the EU would have lower R&D spending, as the EU also has a smaller private R&D spending in high-tech sectors. As a result, only 10 EU companies are among the top 50 companies investing in R&D worldwide, and only one EU company is among the top ten globally, which collectively account for almost one-fifth of global private R&D spending.

2. Less effective public R&D spending

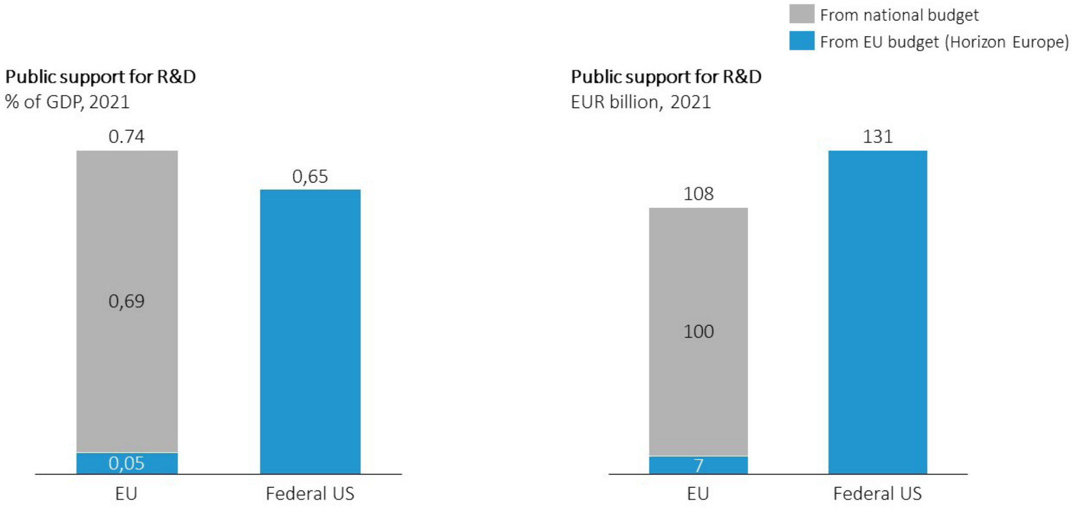
Public R&D spending in the EU is comparatively high. Public spending on R&D stands at 0.74% of GDP in the EU Member States compared with 0.69% in the US, and 0.5% in both Japan and China[04]. There is significant heterogeneity among EU Member States. Public spending on R&D ranges from 0.94% in Germany to a mere 0.15% in Romania, and many other Member States suffer from low and highly volatile R&D investment expenditures.

Public R&D spending in the EU is highly fragmented across Member States, not consistently directed towards EU-wide priorities, and often difficult to access. In the US, the vast majority of public R&D spending comes from the federal budget. In the EU, it largely comes from the budgets of the 27 Member States, complemented by a smaller amount of EU-level resources. R&D spending at the EU level mostly comes from Horizon Europe, the EU's Framework Programme for R&I. Other EU-level resources come from the structural and cohesion funds and the European Defence Fund. All the EU-level funding of public R&D accounts for around one-tenth of the overall public spending on R&D in the Union [see Figure 9].

03. This is a demonstrative, very approximate calculation. Fuest et al.'s (2024) calculations are based on a sample of the best-performing countries in R&D, accounting for some 90% of private R&D spending. We assume that the full distribution has the same properties.

04. It is notable that around half of public spending on R&D takes place in the defence sector in the US.

FIGURE 9
State versus federal source of R&D funding in the EU and US



Source: European Commission, 2024. Based on Eurostat and OECD.

Most importantly, Member States do not coordinate their national public spending on R&D to align it to EU-wide priorities. This lack of coordination between the EU-level and national funding allocations has several implications. First, some large-scale innovation projects can only take place at the EU level, due to their remarkable size and risk profile, which makes the projects unviable for individual Member States to fund in isolation. The success story of CERN [see Box 2] exemplifies both the exceptional opportunities that could be missed without proper EU-level coordination and the potential for effective coordination among Member States. Second, the lack of coordination among Member States leads to potential duplication and reduces competition for funding based on excellence, which is a key driver of breakthrough innovation. Third, the lack of coordination among Member States limits the capacity of public entities to promote EU-wide excellence and to collaborate with the private sector on breakthrough innovation projects. Lastly, fragmentation diminishes the bargaining power of individual Member States when negotiating procurement contracts for innovative projects, such as research infrastructure.

BOX 2

The CERN success story

A notable example of the remarkable returns from the joint collaboration of European countries is the creation of the European Organization for Nuclear Research (CERN) in 1954. CERN started with an initial coalition of 12 European countries. Today, it comprises 23 European Member States, along with 11 non-European Associate Member States and 4 Observers (the EU, UNESCO, Japan, and the US). CERN made it possible to set up and sustain investment in high-energy physics research that any single European country would have regarded as unsustainable over such a prolonged period of time. The pooling of country-specific resources allowed single countries to share the considerable risks and uncertainty inherent to fundamental innovative research. Its collaborative effort has yielded remarkable successes, including two most notable discoveries: the invention of the World Wide Web, invented at CERN 35 years after its inception, and the discovery of the Higgs Boson particle, announced on 4 July 2012. CERN scientific leadership spans various domains, including superconductivity, magnets, vacuum, radio frequency, precision mechanics, electronics, instrumentation, software, computing and Artificial Intelligence. CERN's technologies have generated significant societal benefits, including advancements in cancer therapy, medical imaging, autonomous driving with artificial intelligence, and environmental applications of superconducting cables.

The Large Hadron Collider has propelled CERN to global leadership in particle physics – a mantle that has shifted from the US to Europe – and it stands as CERN's flagship facility. One of CERN's most promising current projects, with significant scientific potential, is the construction of the Future Circular Collider (FCC): a 90-km ring designed initially for an electron collider and later for a hadron collider. Chinese authorities are also considering constructing a similar accelerator in China, recognising its scientific potential and its role in advancing cutting-edge technologies. If China were to win this race and its circular collider were to start working before CERN's, Europe would risk losing its leadership in particle physics, potentially jeopardising CERN's future.

The Horizon Europe programme has multiple weaknesses. For the 2021-2027 period, it has a budget close to EUR 100 billion. Horizon Europe is an important tool to support research and innovation in the EU. It is a unique instrument in the global context, covering a wide range of Technology Readiness Levels (TRLs) and thematic areas, and relying on diverse tools. It builds on the successes of its predecessors, but:

- **Its resources are split across too many fields and priorities**. As a result, the programme lacks focus and some EU-wide top priorities are covered only thinly.
- **Access to the programme tends to be excessively difficult**. Newcomers experience difficulties in accessing the programme, resulting in Horizon Europe funding being concentrated among too few existing beneficiaries. Moreover, the programme has historically experienced a very high level of oversubscription, with around 70% of high-quality proposals not receiving funding[05]. There is a general perception among beneficiaries and stakeholders that the programme's rules (both for submitting proposals and for managing projects once successful) are excessively complex, and should be simplified.
- **The determination processes for priorities and budget allocation are overly complex**. The programme involves a wide range of Commission departments, Member States and the European Parliament through complex governance arrangements. Additionally, there is no explicit mechanism to align the R&I spending priorities set under the programme with the national priorities set independently by Member States.
- **The potential of public-private partnerships is not fully seized**. The structure and governance of its partnerships with the private sector are inefficiently designed, leading some partnerships to fall short of their initial objectives.
- **Support for breakthrough disruptive innovation remains limited**. Even though Horizon Europe's mission is to promote disruptive research and innovation, the programme is neither sufficiently funded nor well-structured for the purpose. For example, the European Innovation Council's (EIC) Pathfinder instrument, which should support bold ideas for radically new technologies at low Technology Readiness Levels (TRL), has a budget of only EUR 250 million for 2024. In comparison, the US ARPA agencies have significantly higher budgets (DARPA: USD 4.1 billion for 2023; ARPA-H: USD 1.5 billion; ARPA-E: USD 0.5 billion). Similarly, the UK's ARIA has a budget of GBP 800 million over several years and the German Federal Agency for Disruptive Innovation (SPRIN-D) has a budget of EUR 220 million for 2024. Moreover, governance issues undermine the success of the EIC: it is mostly led by EU officials rather than top scientists and innovation experts; there are few project managers; selection procedures are highly bureaucratic; collaborations are mandated through a top-down approach rather than being managed cooperatively; and the disbursement of funding is slow[xvii].
- **Furthermore, the performance of the programme is difficult to measure in terms of output, notably patent registration.**

05. Under the Horizon 2020 programme (2014-2020), an additional EUR 159 billion would have been needed to fund all high-quality proposals. See: European Commission, Horizon 2020 evaluation shows that investment in EU research and innovation greatly pays off – press release, 2024.

BOX 3

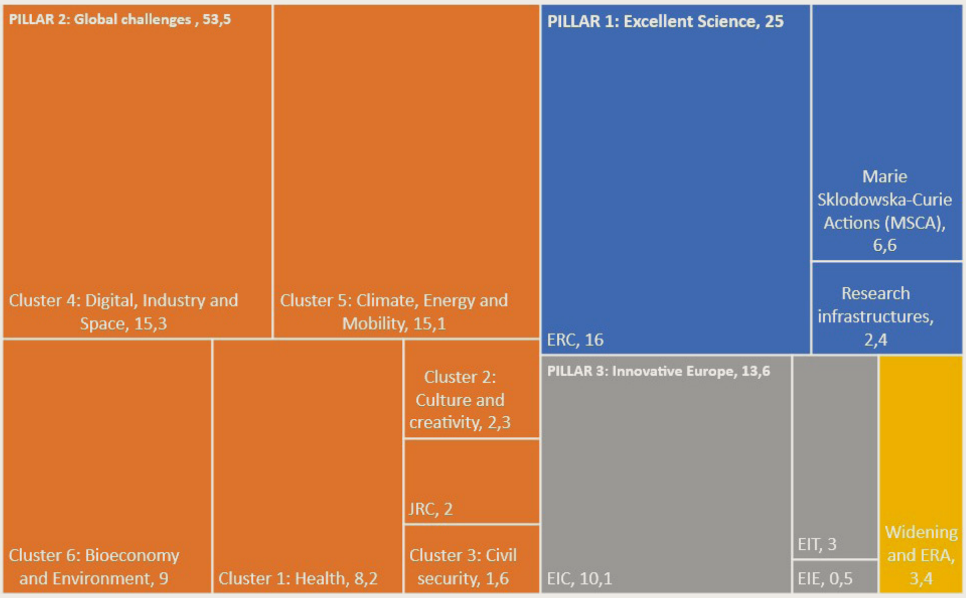
The structure of Horizon Europe

The current EU's Framework Programme for R&I – Horizon Europe – has a budget of EUR 95.5 billion for the 2021-2027 period.

FIGURE 10

Distribution of funding under the different pillars of Horizon Europe

EUR billion



Source: European Commission, DG RTD, 2024.

Horizon Europe is built on three main pillars:

- 'Excellent Science' (EUR 25 billion) aims to increase the EU's global scientific competitiveness. It supports frontier research projects under the ERC (EUR 16 billion), funds fellowships for experienced researchers, doctoral training networks and exchanges for researchers under the Marie Skłodowska-Curie Actions (EUR 6.6 billion) and supports Research Infrastructures (EUR 2.4 billion). Since its establishment in 2007, the ERC has become one of the most prestigious and successful science funding instruments in the world. It attracts excellent researchers, with the projects funded often producing significant findings in emerging areas leading to scientific breakthroughs. Scientific excellence is the sole criteria according to which the grants are awarded. The ERC's grants are open to any field of scientific inquiry. An important element of its success is its independence and use of the world's top scientists to evaluate and select proposals.
- The largest component of the programme is the 'Global Challenges and European Industrial Competitiveness' pillar (EUR 53.5 billion), which supports projects related to societal challenges striving to reinforce technological and industrial capacities. It consists of six thematic clusters (health; culture, creativity and inclusive society; civil security for society; digital, industry and space; climate, energy and mobility; food, bioeconomy, natural resources, agriculture and environment). This pillar funds the EU's public-private (industrial) partnerships[06] and EU Missions under the programme with ambitious goals addressing some of the EU's most significant societal challenges[07].

06. For more information on the partnerships, see: European Commission, European Partnerships in Horizon Europe.

07. Five EU Missions were established under Horizon Europe specialising in climate change, cancer, ocean and waters, climate-neutral and smart cities, and healthy soils. These missions embrace a collaborative approach to catalysing long-term R&I efforts. They integrate new forms of multi-level governance and citizen engagement. The Missions have clearly defined targets, timelines and procedures for tracking and evaluating their results. Together, they account for roughly one-tenth of Horizon Europe Pillar 2 funding.

- The 'Innovative Europe' pillar (EUR 13.6 billion) aims to make Europe a frontrunner in market-creating innovation under the EIC (EUR 10.1 billion) by supporting breakthrough disruptive innovation with potential for scale-up. The three main EIC instruments – the EIC Pathfinder, EIC Transition and the EIC Accelerator – are based on the concept of providing a 'one-stop-shop' for breakthrough innovators at all stages of their development. A key feature has been the creation of the EIC Fund – a dedicated equity investment fund for start-ups and SMEs selected by the EIC.

The three pillars are complemented by the horizontal 'Widening Participation and Strengthening the European Research Area' sub-programme (EUR 3.4 billion), which supports less innovative EU Member States in boosting their innovation potential.

3. The fragmentation of the EU innovation ecosystem

The innovation potential of the EU remains underused, as researchers and innovators do not fully exploit economies of scale and cooperate with other partners across the EU. Collaboration networks for R&I activities rarely extend across national – or even regional – borders. Today, about 70% of all co-owned patents are the result of collaboration within the same region and almost one-in-five are created by partners in different regions of the same country. Only around 13% of the co-patents filed each year involve organisations located in two different European countries. By contrast, in the US, R&I collaborations across States are much more common, accounting for almost one-third of collaborations overall. All in all, the US has almost 2.5 times more R&I collaborations than the EU[08].

An important factor that would enhance R&I capacity is the availability of world-leading research and technological infrastructure, capable of serving the whole European ecosystem. Most Member States cannot achieve the necessary scale in their financial or organisational capacities. This calls for a strategic coordinated approach, with a central role for the EU. The examples of CERN and the European High-Performance Computing Joint Undertaking (EuroHPC JU) showcase the importance of coordination when developing large R&I infrastructure projects. Despite these success stories, effective coordination in the development of EU-wide infrastructural projects is lacking and sometimes hampered by the fiscal constraints faced by some national governments.

The governance of R&I in the EU is highly fragmented and should be better coordinated among Member States. R&I in Europe is governed at multiple levels, with policy and investment being pursued at the local, regional, national and EU levels, scattered across ministries in different Member States.

4. Not enough academic excellence at the top

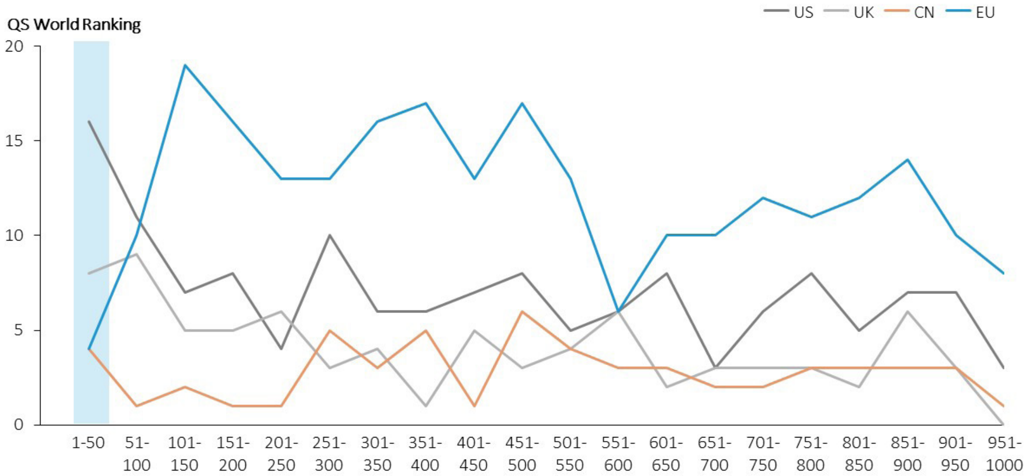
The EU boasts an excellent university system on average, but its presence among the top world-leading research universities is limited. The EU university system is quite inclusive and provides a high level of education and training to a significant portion of its young people. There are very large differences among European universities and some perform very well in many respects. Figure 11 (with all the known limitations of these kind of rankings) depicts the distribution of EU universities, as well as universities from the US, UK and China, across various ranking brackets using the QS World University Rankings in 2024. In all ranking brackets except at the very top, the EU has a greater number of universities compared to the US, UK, and China. Specifically, only four EU universities rank among the top 50 globally. Conversely, European universities dominate in lower ranking positions. A similar picture emerges when using the Shanghai and Times World University rankings. This indicates that while the EU academic system performs well overall, it lags behind in the number of top-performing, world-leading higher education institutions.

08. Considering the links between the two most innovative countries in the EU and states in the US, respectively, confirms this conclusion. California and Massachusetts collaborate 30% more than Germany and France (despite the latter being much closer geographically). These calculations were kindly provided by Pierre-Alexandre Balland.

FIGURE 11

Distribution of universities by quality

Number of universities, 2024



Source: QS World Ranking.

The EU's deficit of top world-leading research institutions in natural science and health science is even more pronounced. According to the Nature Index in 2022, which ranks institutions based solely on the volume of publications in a selected list of top academic science journals, the EU has only three research institutions among the top fifty globally. The US has 21, and China has 15, with the Chinese Academy of Sciences at the very top of the ranking, and Harvard University in second position. The UK and Switzerland have five. The remaining 5 top 50 global research institutions include 2 in Japan (the University of Tokyo in position 14 and Kyoto University in position 37), 2 in Singapore (the National University of Singapore in position 35 and the Nanyang Technological University in position 46) and 1 in Russia (the Russian Academy of Sciences in position 44).

FIGURE 12

Nature index

2022

Nature Index (2022)

	EU	EU, UK & CH	US	China
Top 50	3	8	21	15
Top 200	35	51	68	46
Top 500	120	162	136	108

Note: Global rankings of research institutions in 2022 based on the Nature index Nature Index data from 1 January 2021 to 31 December 2021. The Nature index uses the volume of research papers published in a selected list of top academic journals in science. An institution obtains credits for a publication if at least one of its authors is affiliated to the institution.

Source: Nature, 2024 (data from 2022).

These weaknesses hold back the innovation performance of the EU. Universities are one of the central actors in innovation ecosystems as they produce a highly-skilled workforce, generate breakthrough research, and help to turn fundamental research into practical innovation. High-tech innovation clusters typically form around first-class higher education institutions. A lack of these institutions in the EU and weak interaction between universities and businesses limit technology transfer, innovation capacity and ultimately economic growth.

Lacking excellence at the top stems from difficulties in attracting and retaining top research talent. This is due to several factors. In the US, financial resources are highly concentrated in some top research universities, which have a clear mission to stay at the forefront of world rankings, resulting in highly impactful research output[xviii]. The governance of European universities is sometimes burdened by heavy bureaucratic restrictions and lacks the necessary discretion for the drastic changes sometimes needed to remain at the forefront of global research. The European university system is also failing to provide sufficiently attractive conditions for the most talented researchers both from Europe and, importantly, from around the world. Some potential reasons for Europe's weakness in this domain include: slow career paths, flat remuneration and an inadequate working environment, including the lack of state-of-the-art facilities and research infrastructures. Compared to the top US universities, European universities often have more limited resources and more restrictive rules, which prevent them from offering tailored and attractive compensation packages, or expediting promotion for top researchers. Salaries are also often lower and not contractible. In the US, there is significantly more salary differentiation aimed at attracting and retaining the very best researchers. Moreover, heavy administrative workloads act as a tax on the time and energy of the most productive scholars.

The links between higher education and business are weak and researchers have few incentives to become entrepreneurs[xix]. There are several reasons why the links between higher education and business are weak, including insufficient awareness of the potential benefits of collaboration and an insufficiently developed management of intellectual property rights (IPR) and the commercialisation of research[xx]. Even if European universities now have Technology Transfer Offices, they are often understaffed, lack the necessary expertise and financial resources and struggle to effectively act as intermediaries between researchers and the private businesses sector. There are significant differences in the management of IPR across universities, including differences about who legally owns IPR and whether universities can acquire stakes in spin-offs[xxi]. In many cases, financial incentives for researchers are limited, as they cannot fully appropriate royalties from licencing IPR. Moreover, researchers' assessments do not adequately reward multi-track careers, and dual university-industry appointments are uncommon.

5. The underdevelopment of the EU's innovation clusters

The EU has numerous innovation clusters, but they are less developed and generate less value than those in the US and China. The high-tech sector (for example, computer science, semiconductors, and biology) is typically concentrated in a small number of Science and Technology (S&T) clusters, with leading clusters accounting for a large share of overall innovation in a country. According to the WIPO classification of world clusters (2023 Global Innovation Index), the EU has a similar number of clusters in the top 100 as the US and China [see Figure 13]. However, the presence of EU clusters diminishes as we ascend the ranking, with only one cluster in the top 20 (Paris in 12th position), compared to 6 for the US and 7 for China. None of the EU clusters appear among the top ten, while the US has 4 and China has 3. The remaining top 10 S&T clusters are 2 in Japan (Tokyo-Yokohama in 1st position and Osaka-Kobe-Kyoto in 7th) and one in South Korea (Seoul in 3rd). The world's five biggest S&T clusters are all located in East Asia. The first non-Asian cluster in the top 10 is San-Jose-San Francisco in 6th position.

FIGURE 13
Global ranking of S&T Clusters
Number of clusters in the EU, US and China, 2023

Global ranking of S&T Clusters (number of clusters, 2023)

	EU	US	China
Top 10	0	4	3
Top 20	1	6	7
Top 50	11	12	13
Top 100	24	21	24

Source: WIPO: Global rankings of science and technology clusters. Clusters are defined as geographical areas that show a high density of inventors and scientific authors. They often encompass several municipal districts. Two innovation metrics are employed in the compilation of the top 100 S&T clusters worldwide: location of inventors listed on published patent applications and authors listed on published scientific articles. See: WIPO, Appendix IV: Global Innovation Index science and technology cluster methodology, 2023.

The relative underdevelopment of the EU's innovation clusters is related to the EU's specialisation in more traditional industries and the lack of world-leading research institutions[09]. For example, the Paris cluster is centred around the automotive (PSA Automobiles), aeronautical (Safran Aircraft Engines) and chemical (L'Oréal) industries. By contrast, the largest international clusters (Tokyo-Yokohama, Shenzhen–Hong Kong–Guangzhou, Seoul, Beijing, Shanghai–Suzhou and San Jose–San Francisco) specialise in digital communications, computer and audio-visual technology. Many of the world's best-performing clusters are built around universities or Research and Technology Organisations (RTOs) with strong research programmes.

6. The underdeveloped financial system is a barrier to the creation and scale-up of innovative companies.

The EU's deficit in developing new technologies and scaling them up to reach their full business potential is also driven by a relatively underdeveloped financial ecosystem. EU companies are more likely to suffer from insufficient equity financing than their US peers. The external funding of EU companies still predominantly takes the form of debt financing, which is unsuitable for funding innovative projects in their early stages and generally insufficient for large-scale investment projects[xxii].

The limited development of angel investors, venture capital (VC) and growth finance is an important driver of the financial gap of innovative start-ups in the EU. While the availability of early-stage financing is improving in the EU, the provision of equity through angel financing remains relatively weak[xxiii]. Business angels can provide funding, guidance and mentoring to innovative start-ups and are essential components of any successful, innovative ecosystem, particularly in its early stages of development. The volume of early-stage financing provided by business angels in the US even surpasses that of VC firms[xxiv]. The proliferation of angel investors not only enables existing start-ups to thrive, but also helps attract new entrepreneurial talent. Often, angel investors are individuals who have previously founded or worked at successful start-ups, making them instrumental in initiating a self-sustaining cycle of innovation in localised clusters. In practice, the lack of information on cross-border investment opportunities, the general preference of business angels to invest locally, and differences in tax incentives across the EU contribute to heterogeneous and inefficiently fragmented innovation ecosystems in Europe.

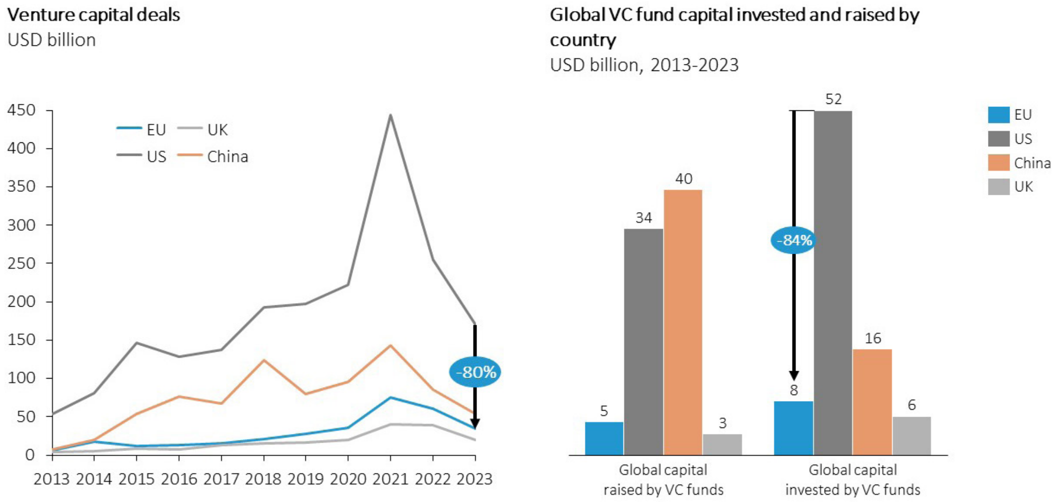
The EU's venture capital (VC) market is also underdeveloped, particularly as regards scale-up financing. While the size of the EU's VC market has grown rapidly over the last decade, its global market share remains small relative to that of the US [see Figure 14, left-hand panel]. The share of global VC funds raised in the EU is only 5%, compared to 52% in the US, 40% in China, and 3% in the UK. Currently, venture capital investment in the EU only represents 0.05% of annual EU GDP, a level almost six times lower than in the UK and in the US, where the VC share of GDP equals 0.29% and 0.32%, respectively. International investors still play a substantial role in the EU's VC market [see Figure 14, right-hand panel], highlighting the potential for the European VC industry to develop further. The gap in VC financing between the EU and the US is most pronounced in the later stage financing [see Figure 15].

In some Member States, the low volumes of VC may reflect a relative shortage of successful, high-growth potential start-ups, indicating a lack of demand for VC investment, rather than a deficit in its supply. The fragmentation of EU consumer and business markets, aggravated by regulatory, fiscal, and legal differences across Member States, limit the ability of EU companies to scale up efficiently, reaching a size appealing to VC funds.

On the supply side, the EU has fewer and less equipped large-scale VC funds. Since 2013, there have been 137 VC funds larger than USD 1 billion in the US compared to only 11 in the EU. This poses challenges for financing start-ups and allow them to scale up to their full potential. To finance large investment projects, VC funds need a large portfolio of well-diversified businesses. A lack of diversification may force VC funds to forgo valuable investment opportunities due to risk considerations.

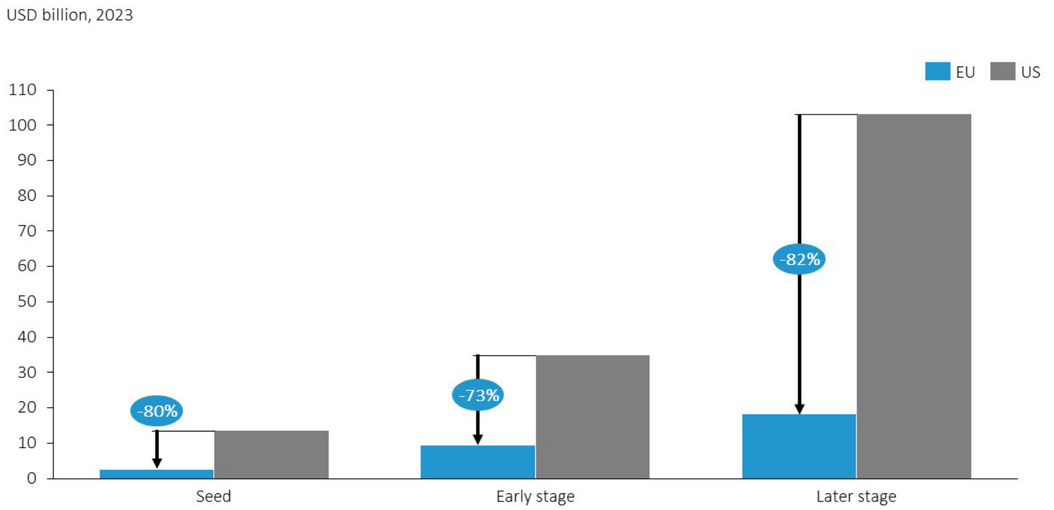
09. See the discussion on Europe's gap in transversal technologies above, and Fuest et al. (2024), for more detail.

FIGURE 14
Venture capital investment



Source: EIB.

FIGURE 15
Venture capital investment by development stage



Source: PitchBook data. Accessed 20 November 2023.

EU companies often rely on non-European capital markets to become listed and support their growth. Entrepreneurs and investors of innovative EU companies seek financing and exit opportunities through initial public offerings (IPOs), mergers and acquisitions, getting listed in non-EU stock markets and involving non-EU investors and competitors. As a result, the share of non-European buyers of EU companies is today high, exceeding 60%. IPOs of EU companies or their acquisition by foreign investors may also result in relocating the company's headquarters or part of its operations outside the EU. This implies that the EU might fail to fully reap the benefits of the innovation spillovers generated by ventures that are repositories of breakthrough innovation. While companies should remain free to seek the best financing options, Europe should also address the issue of EU companies abandoning the region for financial reasons by ensuring adequate financial conditions for companies interested in expanding their businesses or for investors interested in exiting their ventures.

7. Other barriers to the creation and scale-up of innovative companies

Companies in the EU also fall victim to multiple regulatory, legal, and bureaucratic barriers. Several regulatory, fiscal, and legal differences across Member States limit the ability of EU companies to scale up efficiently and fully leverage the advantages of the EU single market. The EU's extensive and stringent regulatory environment (exemplified by policies based on the precautionary principle) may, as a side effect, restrain innovation. EU companies face higher restructuring costs compared to their US peers, which places them in a position of huge disadvantage in highly innovative sectors characterised by the winner-takes-most dynamics. The EU also experiences difficulties in attracting and retaining entrepreneurial talent and skilled labour necessary to stimulate innovation [as detailed in the chapter on skills].

The commercialisation of research results is insufficient. Much of the knowledge generated in research institutions remains commercially unexploited. According to the European Patent Office (EPO), only about one-third of the patented inventions registered by European universities or RTOs are commercially exploited. EU companies, especially SMEs, underutilise the possibility of formally protecting their Intellectual Property Rights (IPR), which is often necessary to compete globally. Only 9% of SMEs in the EU own formal IPR such as patents, trademarks and designs, compared to more than 55% of large companies. This is partially due to the complex and costly procedures involved in filing IPR applications across fragmented national systems, as well as by a lack of expertise and awareness regarding the importance of protecting IPR.

8. Low diffusion of innovation

A slower pace of technology adoption is one of the underlying causes of the low productivity growth. There is evidence that the general slowdown in productivity growth across advanced economies can be partially associated to growing disparities in performance between top-performing companies and 'laggards'.

Among the main drivers of the diffusion of innovation, firm size, quality of digital infrastructures and skills [discussed in the chapter on skills] **are cited as dominant**. The gap in digital adoption between the EU and the US is mainly driven by SMEs. Adopting digital technologies involves large integration costs, making SMEs less likely to invest in this process.

Objectives and proposals

Competitive research and innovation systems are defined by several essential characteristics. Among them are sufficient funding for excellent research, its long-term stability, high-quality research and technology infrastructure, a sufficient talent supply, an effective valorisation strategy, openness and inclusiveness, and a strategy for implementation and alignment. This requires policy choices, based on the following principles:

→ Put research and innovation at the centre of EU strategic priorities

Because of its essential role in developing new knowledge, in addressing societal challenges and contributing to the EU's competitiveness, research and innovation should be held at the heart of EU policy-making. In recent years, new European policies and initiatives, including those related to R&I, were often formulated on an ad hoc basis, in response to crises. R&I investment and policies should be strategically adopted to foster the EU's resilience and preparedness, develop technological capacities and address major societal challenges from a long-term perspective. By deploying research and innovation as a 'tool of first resort', the EU can better equip itself to overcome future crises and shared challenges.

→ Focus on excellence

Excellence in research and innovation is fundamental to the EU's competitiveness in a global economy where technological leaders have the ability to capture huge market shares. If Europe wants to be able to compete with the rest for the world, it needs the best education, talent, infrastructure, technology and companies. It also needs to devise the best policies and to implement them as effectively as possible. Within the European research and innovation system, including the Horizon Europe programme, there should only be one selection criterion – excellence. An excellent, competitive R&I ecosystem produces not only world-leading science, innovation and technology, it also contributes to the resilience of European communities, regions and businesses. Ambition to pursue excellence needs to be put to work in an inclusive manner to exploit our societies', businesses' and regions' full innovation potential. Synergies between different policy instruments should be sought to this end, keeping in mind the specific policy goals of EU programmes (e.g. excellent R&I under Horizon Europe, and capacity-building under cohesion policy).

→ Focus on providing scale

Europe can only achieve its objectives if it can reach the required scale. In a world of winner-takes-all dynamics, scale is crucial – not only for individual companies, but also in terms of access to markets, resources and potential partners. The size and interconnectedness of innovation ecosystems matter. European (financial) instruments should focus on enhancing scale. This can be pursued in three ways. First, through closer policy alignment across the EU, i.e. bringing together 27 separate research and innovation systems, and sets of national policies. Second, by facilitating what individual Member States cannot do alone, but what is essential for the EU's competitiveness. One example is developing large-scale research and innovation infrastructure. Third, expanding the scale of collaboration between European researchers, innovators and businesses will be needed, across Europe and with partners around the world.

→ Focus on added value

The EU should focus on investment which has a clear added value at the European level. It should not substitute what can already be achieved by Member States. The duplication, substitution and fragmentation of investment and initiatives would be counterproductive. To stimulate competitiveness in all corners of the continent, European investment should incentivise capacity-building in Member States who are ready to pursue global excellence in sectors vital to strengthening Europe's leading position.

→ Focus on openness

Europe has a long and fruitful history of open global cooperation. This is one of its major comparative advantages. Today's new geopolitical reality highlights potential risks to this approach, including in the field of research and innovation. Our instruments should be as open as possible and as closed as necessary to mitigate the risks of unintended knowledge and technology transfer. Ensuring greater coordination between Member States on research security is crucial. The EU should actively and more strategically deepen it relationships with like-minded countries. The richer and stronger mutual ties with like-minded partners are, the more all parties will benefit.

→ Focus on inclusiveness and accessibility

Focus on excellence should benefit as many groups as possible across the whole of the EU to avoid deepening existing inequalities. Policies promoting research and innovation should be open, inclusive and readily accessible to researchers, businesses and regions. In reality, legislative complexity, excessive administrative burden and budgetary constraints limit access to EU funds.

→ Focus on European values

The EU's efforts to hone its competitive edge need to be guided by European values, which should be further reinforced by its action. These encompass fundamental values, including human rights, the rule of law and democracy, but also values of specific relevance to research and innovation, such as academic freedom and independence, research integrity and ethics, transparency, diversity, inclusion, gender equality, open science and open access to scientific publications and research data. These values and principles should remain at the core of Europe's approach and constitute the strength of its model of excellent, collaborative research. Promoting these values makes Europe a more attractive place for researchers and businesses from around the world.

On the basis of these principles, to address previously highlighted shortcomings, we now discuss several proposals. If jointly adopted, these measures would contribute to setting the European innovation ecosystem on a more dynamic path, helping the EU avoid widening gaps in critical sectors compared to the US and China, and maintain its competitive edge in global leadership areas. These initiatives should facilitate the emergence of science and technology clusters where the physical proximity of all agents involved in innovation (researchers, inventors, entrepreneurs, financiers, and workers) enhances the production of fundamental research and its translation into thriving business ventures. Successful science and technology clusters require robust academic institutions, building communities of inventors, a skilled labour force, and well-funded financiers endowed with the expertise required to identify potentially worthy start-ups and scale-ups.

The table below provides an overview of the policy proposals, which are detailed further in the text below.

FIGURE 16

	SUMMARY TABLE – INNOVATION PROPOSALS	TIME HORIZON[10]
1	**A better financing environment for disruptive innovation, start-ups and scale-ups**: i) increase support to disruptive innovation, through an 'ARPA-type' agency; ii) expand incentives for business 'angels' and private/public seed capital investors; iii) leverage the European Investment Bank (EIB) and National Promotional Banks (NPBs) to mobilise public-private funds and favour co-investment in ventures requiring larger amounts; iv) increase the appeal of European stock markets for IPOs and for companies after going public; v) review Solvency II requirements and issue innovative investment guidelines for EU Pension Plans [as detailed in the sustaining investment chapter].	ST/MT
2	**Design a simpler and more impactful tenth EU R&I Framework Programme**: refocus the next Framework Programme (FP10) on selected priorities (new 'EU Competitiveness Priorities') and increase the budget to EUR 200 billion.	ST
3	**Promote academic excellence and world-leading institutions**: i) scale up the budget for fundamental research through the European Research Council (ERC); ii) launch a highly competitive programme to foster the emergence of world-leading research institutions (an 'ERC for institutions' programme); iii) introduce a favourable regime to attract top researchers ('EU Chair'); iv) promote the mobility of researchers, extending Erasmus+; v) develop a European framework to facilitate private sector fundraising for public universities.	ST/MT
4	**Invest in world-leading research and technology infrastructure**: increase investments.	MT
5	**More R&I and strengthened coordination of policies through a Research and Innovation Union**: i) renew the commitment to increasing the EU's R&D expenditure to 3%; ii) establish an EU R&I Action Plan; coordinate Member States' R&I plans, setting priorities, fostering collaboration and initiating joint projects.	ST
6	**A more favourable and simpler regulatory ecosystem for innovative companies**: i) develop a new blueprint for royalty sharing between researchers and universities or Research and Technology Organisations (RTOs); ii) adopt a Unitary Patent system in all Member States; iii) introduce a new EU-wide statute for innovative ventures ('Innovative European Company'); and iv) review public procurement rules to favour strategic innovation.	ST
7	**Shared prosperity as a fundamental enabler of EU innovation**: i) promote a coordinated reduction of labour income taxation for low- to middle-income workers; ii) address practices that limit labour mobility between companies like the non-compete and no-poach agreements.	ST/MT

10. Time horizon is indicative of the required implementation time of the proposal. Short term (ST) refers to approximately 1-3 years, medium term (MT) 3-5 years, long term (LT) beyond 5 years.

1. A better financing environment for disruptive innovation, start-ups and scale-ups

To provide a more favourable environment for disruptive innovation, start-ups and scale-ups it is proposed to:

Proposal 1a. Develop a European 'ARPA-type' agency supporting the transformation of scientific knowledge into breakthrough innovation. The European Innovation Council (EIC) currently lacks the scale and the diverse set of expertise necessary to make strategic decisions in highly specialised fields. The existing EIC Pathfinder should be reformed to improve its governance and then endowed with substantially greater resources to become a genuinely new 'ARPA-type agency', supporting high-risk projects with the potential of delivering breakthrough technological advances[11]. In particular:

- The reformed institution should be complementary with and connected to the successful experience of the ERC. While its main directions should be aligned with the strategic priorities of the Commission (differently to the ERC, which is entirely 'bottom-up'), it needs to have a high degree of independence in how it selects and manages the development of disruptive solutions and breakthrough projects.
- Leading scientists should also have a central role in selecting the projects as in the ERC while the implementation of projects should be entrusted to a significantly larger number of independent high-profile project managers, who should be recruited among the most recognised experts in the field. Project managers should have significant responsibilities and discretion in selecting and managing specific projects, including shaping research endeavours, deciding on financial resources, and terminating projects.
- Project managers should have a broader set of tools to be able to support and develop disruptive innovation projects, depending on their stage and purpose. A greater use of innovation challenges, similar to those developed by the German SPRIN-D agency, should be the preferred approach. Similarly, a greater use of public procurement tools could be used to steer the direction of projects in a more active way.
- The approach to collaborative projects needs to be improved: collaboration should be encouraged, although it should not be a condition for granting support.
- Compared to existing governance arrangements under the EIC Pathfinder, processes need to be accelerated by reducing administrative burden.
- The reformed institution could engage in promoting dual use (civilian-military) innovation or triple use (linking innovation, defence and sustainability) for the benefit of European security and competitiveness.
- There should be a closer alignment and synergies with other recent initiatives stimulating disruptive innovation, such as the German SPRIN-D or French JEDI. This can provide greater leverage through the deployment of limited existing resources.

Proposal 1b. Expand incentives for business 'angels' and private or public seed capital investors to accelerate the creation of innovative business ventures. The re-investment of capital gains from initial successful ventures can catalyse innovation activity, and foster the emergence of successful high-tech clusters. So-called business 'angels' – wealthy individuals investing in start-ups on their own account – have become increasingly important as a source of equity finance at the early stages of company formation. The proliferation of angel investors not only enables existing entrepreneurs to thrive, but also helps attract new entrepreneurial talent, initiating a self-sustaining cycle of innovation. To foster this process, the taxation of capital gains from the sale of shares in unlisted companies could be delayed if the capital gains are further reinvested in innovative early-stage companies. By backloading the payment of taxes on capital gains, the policy supports EU entrepreneurship. The Swedish experience serves as a compelling example of the effectiveness of this policy. Sweden boasts a thriving start-up ecosystem, home to several successful unicorns. Similarly, incentives and support should be given to public and private accelerators and providers of seed capital aimed at transforming technology innovation into entrepreneurial initiatives.

11. The US Defense Advanced Research Projects Agency (DARPA) was designed in the 1950s to preserve US technology leadership in the field of defense. Since then, it has been replicated in different fields and countries.

Proposal 1c. Generate a significant increase in equity and debt funding available to start-ups and scale-ups. To increase the amount of public-private funds available to innovative business ventures and to fund high-tech projects requiring large investments, the following interventions should be considered:

- **Review Solvency II requirements to free up insurance companies' capital for private investment and issue guidelines for EU Pension Plans** (as detailed in the chapter on sustaining investment). Solvency II is the regulatory framework for insurance companies operating in the European Union, designed to ensure that insurers have sufficient capital to cover their risk exposure and protect policyholders.. A similar review should be conducted on the investment policies of EU pension plans, currently underinvesting in private companies versus their non-EU counterparts.

- **Increase the budget of the European Investment Fund (EIF) to enhance the EU venture capital ecosystem, coordinate EIF activities with those of the European Innovation Council (EIC), and rationalise European VC financing**. Two main European institutions operate in the European VC financing space. The European Investment Fund (EIF) provides finance to small and medium-sized enterprises (SMEs). Its main activities include offering venture capital, guarantees, and microfinance to support the creation, growth, and development of businesses in Europe. The EIF is part of the European Investment Bank (EIB) and works closely with other EU institutions, financial intermediaries, and private sector investors to facilitate access to finance for SMEs. The European Innovation Council (EIC) Fund is a VC fund for disruptive innovation established by the European Commission as part of the broader European Innovation Council (EIC) initiative. It provides direct equity investment and blended finance to high-risk, high-potential start-ups and SMEs developing breakthrough technologies or game-changing innovation. The budget of the European Investment Fund (EIF) should be increased. The EIF should also better coordinate its activities with those of the EIC-Fund and eventually European resources aimed at VC financing should be rationalised. This would help to feed the VC fund sector and strengthen public institutions like National Promotional Banks in providing capital to innovative companies in their start-up and growth phases.

- **Enlarge the mandate of the European Investment Bank (EIB)**. The European Investment Bank (EIB) is the European Union's bank, which provides finance and expertise for sustainable investment projects that contribute to EU policy objectives. While today the EIB does not provide directly equity investment, the mandate of the EIB should be enlarged to allow for direct equity investment in EU strategic high-tech priority sectors such as AI, semiconductors, life sciences/bio-medical etc., enabling also the option of providing contingent capital to NPBs to coinvest with the EIB in such projects when desirable.

Proposal 1d. Increase the appeal of European stock markets for IPOs and for companies after going public. To increase the appeal of European stock markets, the regulatory complexity for IPOs and for companies after going public should be reduced, aligned with the more competitive non-EU stock markets, and harmonised across EU stock markets. In particular:

- **Harmonise the rules for IPOs and the monitoring of public companies across all EU markets**. This would, de facto, create a true pan-European multi-located stock market. The task of simplifying and harmonising regulation should be assigned to ESMA.

- **Allow across Europe Dual-Class shares with different voting rights to make IPOs more attractive to founders**. Dual-class shares in case of IPOs allow founders to maintain control of the firm after it has gone public, increasing the appeal of IPOs to founders and supporting earlier capital raises in the early life of new companies.

The reorganisation of innovation financing proposed above concentrates resources where Europe today has strengths, and aims at avoiding overlaps, duplication and the fragmentation of resources, leveraging as much as possible public-private cooperation and EU Member states' co-investment: under the EIC for disruptive innovation (grants and equity), private angels and public institutions for acceleration and seed capital (equity), the EIF, NPBs to support venture and growth capital ecosystems (direct and indirect equity via funds, as well as private subordinated debt), insurance companies and pension plans for venture and growth capital (equity via funds), the EIB and NPBs for select EU strategic direct investment, EU exchanges and markets for IPOs and the growth of listed innovative companies.

2. Design a simpler and more impactful tenth R&I Framework Programme

The next Framework Programme should be designed in a way to address weaknesses of Horizon Europe, in particular:

- **Programme design and objectives**. The programme should consolidate the overall fragmented and heterogenous activities and refocus on European priorities. In particular, the approach and clusters defined in Pillar 2 ('Global Challenges and European Industrial Competitiveness') and the selected priorities of the programme (new 'EU Competitiveness Priorities') should be reviewed and closely aligned with the strategic priorities set by the Commission, as well as the new European R&I Action Plan discussed below (once it becomes operational). Public-private partnerships have to be simpler in their structure and governance, and more focused on key priorities, in line with the proposed new Competitiveness Joint Undertakings [see the chapter on governance]. Increased resources should be dedicated to ground-breaking fundamental research (as detailed below in the initiatives related to the promotion of academic excellence) and a new focus should be placed on disruptive innovation with increased resources and a new governance (as detailed above in the initiatives related to a better financing environment).

- **Budget allocation**. The overall budget allocation should be re-thought and re-directed towards the financing of disruptive innovation which now absorbs only 5% of the budget. Currently, funds are excessively directed towards addressing capital market imperfections, and benefiting mature companies. The programme should aim for transformational change rather than incremental advances and should refrain from targeting technologically mature medium-sized firms, to sidestep what has been labelled as the 'middle technology trap'[xxv].

- **Decision-making**. The governance of the programme should be managed by project managers and by people with proven track at the frontier of innovation. Current procedures are slow and bureaucratic. The organisation of the programme should be redesigned and streamlined to become more outcome-based and efficient, with projects to be financed being selected through evaluations from top experts (as is already done under the European Research Council's activities).

- **Process**. Administrative requirements and tender procedures should be reformed to facilitate applicants' access and reduce the administrative burden for both beneficiaries and administrators.

- **Budget size**. The financial capacity of the reformed framework programme should be strengthened by increasing its budget to EUR 200 billion.

3. Promote academic excellence and world-leading institutions

Proposal 3a. Double the support to ground-breaking fundamental research through the European Research Council (ERC). The ERC has become essential to the competitiveness of European science. Its sound reputation is built on a focus on excellence, independent decision-making and a rigorous, impartial evaluation system. The ERC is a key reason why several countries around the world want to join the Horizon Europe programme as associates. Currently, the ERC is not fully realising its potential, as it reaches too few researchers. Over its history, the ERC has funded more than ten thousand projects. However, due to a continuing lack of financial resources, many equally outstanding proposals have remained unfunded. This has reduced the incentive for top researchers to apply for ERC grants and hindered the EU's ability to attract and retain world-class research talent. Moreover, since 2009, grant sizes have remained roughly unchanged, progressively eroding the value and prestige of ERC's grants. The ERC's current budget is about EUR 2 billion annually. According to a 2003 report by an expert group on the European Research Council[xxvi], it was estimated that the ERC would need a budget corresponding to 5% of Europe's national research agencies, now equivalent to around EUR 5 billion per year. Doubling the ERC budget to significantly increase the current number of grant recipients without diluting the amount they receive would strengthen the positive spillovers of the programme, enabling the EU to attract and retain more world-class talent. The design of the ERC should remain untouched, preserving its independence and focusing on the financing of truly innovative research projects by top scholars over a five-year period. Attention needs to be paid, in particular, to support early-career researchers and to address possible bias against novel, cross-fields research, which can be more challenging to evaluate properly.

Proposal 3b. Introduce an instrument for supporting excellent research institutions: the ERC for Institutions, ERC-I. Currently, there are no EU programmes that directly target research universities and institutions, providing them with the necessary resources to develop and consolidate their position at the forefront of research in specific topics. A world-leading research institution necessitates a critical mass of talent, with a significant number of top-tier researchers collaborating on closely related topics within the same physical space. Today many EU universities, while hosting a few top scholars, lack critical mass. To attain the critical mass of talent that they need, research institutions should receive access to a newly launched programme, ERC for Institutions (ERC-I). ERC-I should build on the high number of well-established European research institutions that rank in the middle to high tiers of the global distribution and propel some of them to the very top of academic excellence. ERC-I could promote excellence and research, also by leveraging the European University Alliances. Because institutions progress slowly, funding should be committed over a relatively long-term horizon. Funding commitments for ERC-I should be subject to conditions and formal revision. Access to the programme should be open on a recurrent, competitive basis. Although the objective of the programme is to push academic and research institutions, the ERC-I should fund specific research units (e.g. a research centre, a lab or a whole department). To be entitled to apply for an ERC-I grant the unit should:

- Gather a significant number of world-leading researchers conducting frontier research on closely related topics.
- Offer top-level teaching to top skilled students, preferably at the doctoral and master's levels.
- Not to be virtual, but physically located in a specific place, with the requirement that its full-time faculty be physically present and actively involved in teaching and student supervision.

Access to ERC-I funds for applicant research units will be determined on the basis of scientific excellence, as well as the unit's ability to facilitate technology transfer, foster start-up creation, promote innovation clusters, and incentivise researchers to engage in entrepreneurial activities and collaborate with companies. The management of ERC-I and of the selection process should be guided by similar principles as those of the ERC and put under the umbrella of the ERC.

An example of a programme similar to ERC-I is the French LabEx (Laboratoires d'Excellence) initiative [see Box 4].

BOX 4

LabEx (Laboratoires d'Excellence)

The LabEx (Laboratoires d'Excellence) initiative is a French programme launched in 2010 as part of the 'Investissements d'Avenir' (Investments for the Future) plan for research and productivity. The goal of LabEx is to enhance the research potential of French research organisations by providing significant financial support to help them achieve excellence and international visibility. The initiative aims to promote high-quality research, to consolidate research capabilities, encourage innovation and foster interdisciplinary collaboration. Under the initiative, EUR 1.5 billion have been invested in 171 research units, both individual and groups of organisations pursuing joint research on a specific topic, selected in a highly competitive process by an international jury. The funding provided under the LabEx can be used for various purposes, including hiring researchers, purchasing advanced equipment, supporting doctoral and postdoctoral researchers, and facilitating international cooperation. Evaluations have shown that the LabEx initiative has also had positive spillovers for private sector companies in the innovation ecosystem[xxvii].

Proposal 3c. Create the position of 'EU Chair' for top researchers. Currently, the ERC funds frontier research projects led by top researchers, but transforming institutions also requires a policy specifically designed to attract world-leading researchers which can help to build these institutions and act as a magnet for other top talent. These world-leading figures are costly to attract and retain. Most European universities are State universities or State-funded research centres bound by wage standards that leave little discretion in determining the compensation for talent. Additionally, wage levels differ considerably across European countries. Some Member States cannot afford to pay global average wages, even to world-class researchers. This can be addressed with the creation of the position of 'EU Chair': a world-class scholar formally hired as a European official with the same treatment as other employees of EU institutions of a comparable level. EU Chair professors should be actively involved in the development of institutions and teaching activities. The selection of EU Chair professors will be based purely on merit and awarded to researchers globally recognised for their exceptional global standing, assessed according to the highest international academic standards. EU Chair professors are attached to a research institution through a procedure of double coincidence of wants: the EU Chair professor has to opt for a research institution and, in turn, the institution has to agree to incorporate the EU Chair professor fully to its ranks, even if, technically, she is an employee of the EU. The procedure gives to every European institution the same opportunities, but at the same time contributes to a virtuous circle that strengthens strong institutions willing to undertake a path towards worldwide academic excellence. A professor with an EU Chair can freely move within the EU from one to another research institution, as they are assigned to the researcher not to the research institution. Like the ERC-I, this programme should follow the same principles and be managed by the ERC.

Proposal 3d. Promote the mobility of researchers. To foster cross-border collaboration and the creation of networks, Erasmus+ should be extended to researchers. This would help ensure that researchers in higher education institutions and Research and Technology Organisations (RTOs) can partake in a teaching or research experience in another country of between two and six months at least once in ten years.

Proposal 3e. Develop a European framework to facilitate private sector fundraising for public universities. American universities benefit from substantial endowments and generous donations secured through systematic and well-organised fundraising policies. These financial resources provide US academic institutions, both public and private, with significant flexibility to design compensation policies that attract top talent and support scholars in conducting their research. Private donors are incentivised by the recognition of their contributions (such as having their name on a chair) and the opportunity for tax deductions on donated sums. In contrast, EU universities often lack such flexibility and incentives for fundraising campaigns. Depending on the country, donations to research institutions may or may not be tax-deductible, and universities may face constraints on using these funds, especially for enhancing compensation for top researchers. To complement the ERC-I proposal, it would be beneficial to develop an EU-wide framework to facilitate fundraising from private donors for public universities as well as to manage this philanthropic funding flexibly. Incorporating organised fundraising into the ERC-I proposal should be an evaluation criterion for ERC-I proposals.

4. Invest in world-leading research and technological infrastructure

Increase joint investment in world-leading research and technology infrastructure. Research and technology infrastructure is essential for ground-breaking R&I, and often serves as a focal point of R&I ecosystems. They connect academia and RTOs with the industry, enable the business valorisation of breakthrough research and are a magnet for talent. We have already discussed the remarkable returns from the creation of the European Organization for Nuclear Research (CERN) and emphasised that the future of CERN is at risk due to China's progress in emulating one of CERN's most promising current projects, the Future Circular Collider (FCC). Refinancing CERN and ensuring its continued global leadership in frontier research should be regarded as a top EU priority, given the objective of maintaining European prominence in this critical area of fundamental research, which is expected to generate significant business spillovers in the coming years. However, the example of CERN is not unique. There is a clear need for scale when developing globally competitive state-of-the-art infrastructure, whether it is single-site (as seen in the case of the European Southern Observatory) or distributed infrastructure (as seen in the case of the EuroHPC Joint Undertaking). To achieve the appropriate scale, there is a need for pooling resources from different sources: EU funds, national funds and private investment[12]. An accelerated process and faster selection are necessary to create more new ground-breaking infrastructure spanning Technology Readiness Levels (TRLs) and technologies. The focus should also be on technology infrastructure, which benefit companies in developing and testing new products and services.

5. More R&I and strengthened coordination of policies through a Research and Innovation Union

The EU needs to set as one of its key priorities the establishment of a Research and Innovation Union. Given the excessive fragmentation of the European R&I ecosystem, better coordination of public R&I expenditure across Member States is crucial to enhance innovation in the EU. The Research and Innovation Union should lead to a joint formulation of a common European R&I strategy and policy. The proposed increase in funding for the Horizon Europe programme represents an important first step in this direction. To improve coordination, the EU could promote a **'European Research and Innovation Action Plan'**, designed by Member States, together with the Commission, the research community, and stakeholders from the private sector. This action plan could identify key EU-wide strategic areas objectives, and joint projects, leveraging existing coordination mechanisms for competitiveness [see the chapter on governance]. The various forms of EU support envisaged in the action plan would be managed under a 'one-stop shop' in the Commission and a unique protocol.

In parallel, Member States, in coordination with the EU action plan, should develop their own **'National Research and Innovation Plans'**. These Plans should be developed in collaboration with universities, RTOs, and private businesses.

The failure to meet the 3% target for R&D expenditure set by EU leaders over two decades ago is a fundamental reason why the EU lags behind the US and China. Within the coordinated framework discussed above, the EU as a whole should reaffirm its commitment to increasing R&D expenditure to at least 3% of GDP within a defined timeframe. National R&D spending targets should be ambitious, but also take into account initial conditions in the respective Member State. EU support for National R&I Plans will be contingent upon compliance with these commitments.

6. A more favourable and simpler regulatory ecosystem for innovative companies

Proposal 6a. Facilitate the commercial exploitation of academic research. The EU has a deficit in bringing to the market academic research. An important obstacle is the lack of a suitable legal framework to incentivise universities, RTOs, and researchers to register Intellectual Property Rights (IPR) and engage in their commercial development. The EU should set up a blueprint for fair and transparent royalty sharing between institutions and researchers. This blueprint should specifically assist public universities and RTOs in overcoming bureaucratic barriers to managing IPR with their researchers. Member States should remove any legal obstacles to this process. Researchers should also get access to information on the management of IPR. Intellectual property rights can also be exploited by companies not directly related to universities and RTOs via licensing. Since licensing is sometimes too costly for start-ups with limited financial resources, the EU could promote the issuance of shares and stock options to finance the cost of using IPR owned by universities and RTOs[13]. A systematic effort is needed to develop the capacities of Technology Transfer Offices (TTOs), so that they are proactive, effective intermediaries between researchers and the private sector. The Commission should help harmonise capacity building for TTO staff to ensure its quality and facilitate the cross-border exploitation of knowledge.

12. Current support under Horizon Europe is limited to concept development and the early-phase implementation of new infrastructure capacity, the consolidation of existing infrastructure, transnational access to infrastructure and their services. Soft coordination is undertaken through the European Strategy Forum on Research Infrastructures (ESFRI) which brings together Member States and associated countries in support of a coherent, strategy-led approach to research infrastructure in Europe.

13. This approach is promoted, for example, in Japan and has also been proposed by the joint pilot programme of SPRIN-D, the Stifterverband and Fraunhofer ISI for IP transfer in the form of 'virtual shares'. The latter do not confer management rights, but provide an option to financially benefit from the future growth of a company in return for access to intellectual property. See: SPRIN-D, IP Transfer 3.0 – 'Pocketknife Transfer': A joint pilot program of SPRIND, Stifterverband and Fraunhofer ISI.

Proposal 6b. Adopt in all EU Member States the Unitary Patent and support its uptake. Fully adopting the Unitary Patent[14] system in all EU Member States would reduce patent application costs, offer broader and uniform territorial protection of IPR for patent holders, and limit litigation uncertainty through the jurisdiction of the Unified Patent Court. To support the uptake of the EU Unitary Patent system and promote the protection of Intellectual Property Rights, training programmes for IPR professionals should be enhanced and possibly subsidised.

Proposal 6c. Introduce a new EU-wide legal statute for innovative start-ups (an 'Innovative European Company').

The freedom of establishment and mobility enshrined in the Treaties is not yet a reality for EU companies. Significant differences in laws and regulations across Member States affect the functioning of consumer, labour, and capital markets, limiting firms' ability to seamlessly operate across EU Member States and preventing EU businesses from fully exploiting the benefits of the Single Market.

Innovative start-ups should be given the opportunity to adopt a new EU-wide legal statute called the 'Innovative European Company' (IEC). Adoption of the IEC status would provide companies with access to harmonised legislation across Member States concerning corporate law, insolvency procedure, as well as a few key aspects of labour law and taxation, to be made progressively more ambitious. Innovative European Companies could operate in all Member States through subsidiaries without needing to incorporate separately in each one. An innovative European Company will have a single digital identity valid throughout the EU and recognised by all Member States. Registration will be centralised at the EU level. In selected industries, certifications will be portable, and authorisations will benefit from passporting across all Member States. The portability of certifications and the passporting of authorisations will be progressively expanded to more industries as regulations become increasingly harmonised across Member States. Innovative European Companies should also get access to the simplified procedures for IPOs of high-tech companies [as discussed above in the section on innovation financing].

To reduce the regulatory burden due to aspects not covered by the new statute, the Commission should also establish a 'one-stop shop' available in all official EU languages, providing information about individual states' business requirements.

The IEC statute could be adopted by Member States participating initially under enhanced cooperation or intergovernmental agreement.

Innovative start-ups will qualify based on criteria such as the qualifications of their workforce, R&D expenditure, and ownership of intellectual property rights. For instance, defining innovative companies based on the criteria already put forward in the EU competition acquis (including at least 10% total operating costs devoted to R&D), would make the new statute accessible for at least 180,000 innovative SMEs (including start-ups) and innovative mid-caps (including small mid-caps) in the EU, based on estimations by the European Commission's Joint Research Centre[xxviii].

In successful innovation clusters, highly educated and well-paid workers are also highly mobile. Consideration should be given to how to facilitate workers' mobility among the European Innovative Companies.

Proposal 6d. Step up and streamline support to innovative start-ups. During their early stages, start-ups are very vulnerable and need enhanced support. Currently, support is extremely fragmented, as also witnessed by the emergence of so-called 'one-stop shops', which makes it impossible for start-ups to find the most suitable instruments. Therefore, greater coordination of instruments across Member States is needed to ensure a level playing field. EU-level instruments (e.g. the EIC, EIF, InvestEU) should be more aligned. This should be facilitated by providing an EU-level platform bringing together all relevant information, and developing an ecosystem of services for start-ups. Such a platform should help start-ups to analyse their situation and needs, and to find the most appropriate solutions. The platform should exploit the state-of-the-art digital solutions, including AI.

14. The Unitary Patent system was launched on 1 June 2023. It provides uniform protection across participating EU Member States on a 'one-stop shop' basis. 18 countries currently participate in the Unitary Patent system.

Proposal 6e. Review public procurement rules. Currently, the potential of public procurement for stimulating innovation is heavily underutilised in the EU, with most public procurement characterised by an excessive focus on minimising risks and meeting pre-specified requirements. Investment in innovation procurement, including both R&D procurement and the public procurement of innovative solutions, represents only about 10% of total public procurement expenditures in the EU, falling short of the recommended level of 20%. All Member States should put in place ambitious national innovation procurement policy frameworks, with clear goals, resources, timelines, and an effective monitoring framework. In particular, European innovative SMEs should be able to benefit as suppliers of innovative solutions and ensure their wide deployment. EU institutions, including the Commission, should lead by example and create their own action plan to mainstream innovation procurement. The EU should revise its rules and directives of public procurement to better emphasise its strategic importance for innovation. The EU should also set a target for Member States' innovation procurement, introduce more innovation-friendly IPR provisions, and prioritise quality over price when awarding contracts, thereby helping to establish a level playing field with low-cost countries. Furthermore, overly restrictive provisions – such as stringent financial capacity requirements or limitations on using innovative solutions as alternatives to established ones – should be avoided, as they unduly penalise innovative start-ups and scale-ups. The future framework programme for R&I should also establish a dedicated budget or sub-programme to strengthen innovation procurement practices, particularly in sectors where public procurers are significant clients.

7. Shared prosperity as a fundamental enabler of EU innovation

It is well known that an unmanaged, highly innovative, and dynamic economic environment generates winners and losers, increases inequality, enhances the risk of unemployment, entails transition costs unevenly distributed across the population, and leads to a disproportionate concentration of economic activity in a few prohibitively expensive areas[xxix]. The EU innovation model should ensure: (i) that workers are supported through social insurance policies, as well as active upskilling and reskilling programmes [see the skill chapter on skills]; (ii) the creation of high-quality jobs (in terms of pay, flexibility, and worker security); and (iii) that social and geographic cohesion remains an integral component of the model.

The example of Sweden – which has a tech sector that is more than twice as productive as the EU average – shows that a strong social model and a thriving technological environment are not only compatible, but even self-reinforcing when combined with programmes targeted at creating high-quality jobs for well-skilled workers living in affordable cities. Combining the creation of high-quality jobs with high levels of social protection and redistribution is a fundamental value of the EU model, which should be preserved to successfully transform the EU into a more technologically advanced society.

Therefore, the EU should consider to:

- Promote a coordinated reduction of labour income taxation for low- to middle-income workers.
- Competition policy should also address practices that limit labour mobility between companies like the non-compete and no-poach agreements.

ENDNOTES

i International Energy Agency, Net Zero Roadmap: A Global Pathway to Keep the 1.5 °C Goal in Reach, 2023: https://www.iea.org/reports/net-zero-roadmap-a-global-pathway-to-keep-the-15-0c-goal-in-reach.

ii Cervantes, M., et al., 'Driving low-carbon innovations for climate neutrality', OECD Science, Technology and Industry Policy Papers, No. 143, OECD Publishing, 2023.

iii Bergeaud, A., and Verluise, C., The Rise of China's Technological Power: the Perspective from Frontier Technologies, 2023.

iv Beebe, B., and Fromer, J.C., 'Fake Trademark Specimens: An Empirical Analysis', Columbia Law Review Forum, Vol. 121, 2020, p. 217.

v Prud'homme, D., and Taolue, Z., Evaluation of China's Intellectual Property Regime for Innovation: Summary Report, Summary report for the World Bank, 2017.

vi Putnam, J., and Luu, H., and Ngo, N., Innovative Output in China, 2020.

vii He A., What Do China's High Patent Numbers Really Mean?, Centre for International Governance Innovation, 2021.

viii EIB, EIB Investment Report 2023/2024: Transforming for competitiveness, 2024.

ix Atomico, State of European Tech 2023, 2023.

x Weik, S., Achleitner, A.-K., Braun, R., 'Venture capital and the international relocation of startups', Research Policy, Volume 53, Issue 7, 2024: https://doi.org/10.1016/j.respol.2024.105031.

xi European Commission, 2023 EU Industrial R&D Investment Scoreboard, 2023.

xii European Commission, Science, Research and Innovation Performance Report, 2024.

xiii European Commission, The global position of the EU in complex technologies, 2023.

xiv Fuest, C., Gros, D., Mengel, P-L., Presidente, G., and Tirole, J., EU Innovation Policy: How to Escape the Middle Technology Trap, Report by the European Policy Analysis Group, Institute for European Policymaking at Bocconi University, 2024.

xv European Commission, 2023 EU Industrial R&D Investment Scoreboard, 2023.

xvi Fuest, C., Gros, D., Mengel, P-L., Presidente, G., Tirole, J., Ibid.

xvii Fuest, C., Gros, D., Mengel, P-L., Presidente, G., Tirole, J., Ibid.

xviii Lepori, B., Geuna, A., and Mira, A., Scientific output scales with resources – A comparison of US and European universities, 2019.

xix European Commission, The State of University-Business Cooperation in Europe, 2018.

xx Conti, A., Gaule, P., 'Is the US outperforming Europe in university technology licensing? A new perspective on the European Paradox', Research Policy, Volume 40, Issue 1, 2011, p. 123-135.

xxi European Commission, The management and commercialisation of intellectual property in European universities, 2022.

xxii For more on innovation financing, see: Aghion, P., C. Antonin, S. Bunel, The Power of Creative Destruction: Economic Upheaval and the Wealth of Nations, Harvard University Press, 2023.

xxiii Lerner, J., Schoar, A., Sokolinski, S., and Wilson, K., 'The globalisation of angel investments: Evidence across countries', Journal of Financial Economics 127, 2018, p. 1-20.

xxiv Lerner, J., Schoar, A., Sokolinski, S., and Wilson, K., 'The globalisation of angel investments: Evidence across countries', Journal of Financial Economics 127, 2018, p. 1-20.

xxv Fuest, C., Gros, D., Mengel, P-L., Presidente, G., Tirole, J., Ibid.

xxvi Ministry of Science, Technology and Innovation, The European Research Council: A cornerstone in the European Research Area – A report from an expert group, Copenhagen, 2023.

xxvii Bergeaud, A., Guillouzouic, A., Henry, E., and Malgouyres, C., 'From public labs to private firms: magnitude and channels of R&D spillovers', Centre for Economic performance Discussion Paper, No. 1882, 2022.

xxviii For details, see: European Commission, 'Innovative firms in Europe: Tracking them among SMEs and mid-caps', 2024.

xxix These considerations are further developed in: Acemoglu, D. (Ed.), Redesigning AI, MIT Press, 2021; Acemoglu, D., 'Distorted innovation: does the market get the direction of technology right?', AEA Papers and Proceedings, Vol. 113, 2023, p. 1-2; and Gruber, J., and Johnson, S., Jump-starting America: How breakthrough science can revive economic growth and the American dream, 2019.

2. Closing the skills gap

The starting point

The competitiveness of the EU and the success of the European economic model – starting with the successful execution of the green and digital transitions – requires a labour force endowed with the right knowledge and skills. The EU has a highly skilled labour force, but it is suffering from persistent skills shortages across different sectors, both in low-skilled and highly skilled occupations, including in the strategic sectors discussed in earlier chapters. For example, in clean technologies, companies are facing important skills shortages, limiting their ability to compete at the global level. Moving forward, the challenge may become even more severe. Demographic headwinds will lead to a declining labour force, while the reorientation of the economy caused by the green and digital transitions will change the labour market and skills requirements. Without ambitious, yet pragmatic skills policies, the EU will not be able to achieve the objectives discussed in this report in an effective and equitable way.

SKILLS ARE THE FOUNDATION OF A THRIVING AND COMPETITIVE ECONOMY

Education and training systems have to equip citizens with high-quality skills in an inclusive manner. This concerns many of the basic cognitive skills that enable individuals to communicate, perform mathematical calculations, apply reasoning and acquire new knowledge. Basic skills are a key determinant of labour productivity. It is, therefore, important to ensure that the workforce has a sufficient level of basic skills to successfully participate in the labour market.

Basic literacy and numeracy skills, however, are necessary but not sufficient to cope with a rapidly evolving socioeconomic environment. The current economic system calls for a much broader range of skills than in the past, including:

- Digital skills. Digital skills are a necessary condition to develop capacities in digital technologies, to adopt new technologies and even promote the creation of innovative companies. As such, they are essential to the EU's digital transition. It is key that the population at large is digitally literate, but it is also important that the pool of workers with advanced digital skills, for example in the areas of AI, programming, data management and cybersecurity, expands.
- Green skills. The EU's green transition requires workers with appropriate skills to develop, manufacture and roll out green technologies. Moreover, society must develop awareness, practices and skills to function in a more sustainable and circular fashion.

TABLE OF ABBREVIATIONS

AM	Additive manufacturing
CEDEFOP	European Centre for the Development of Vocational Training
EIT	European Institute of Innovation and Technology
ESF+	European Social Fund Plus
ICT	Information and Communications Technology
MFF	Multiannual Financial Framework
NZIA	Net-Zero Industry Act
OECD	Organisation for Economic Co-operation and Development
RRF	Recovery and Resilience Facility
SME	Small and medium-sized enterprises
STEM	Science, technology, engineering and mathematics
VET	Vocational education and training

- Specialist skills. Fast technological developments put a higher premium on science, technology, engineering, and mathematic (STEM) skills. These so-called 'hard' skills are crucial to mastering the use of new technologies and advancing their development. The nature of many existing occupations is evolving and requirements in terms of specialist skills are increasing. This also concerns a number of traditionally medium-skilled occupations. For example, many manufacturing jobs have involved repetitive tasks, but the advent of new technologies (such as robotics or 3D printing) requires manufacturing workers to acquire advanced skills to operate the technologies used today.

- Transversal skills. Beyond technical or specialist skills, transversal skills (sometimes called 'soft skills') are crucial. These include creativity, teamwork, communication, adaptability, critical thinking, problem-solving, leadership and emotional intelligence. These skills are a key factor affecting labour productivity and will become more important for workers to add value in an increasingly machine-intensive environment. Transversal skills must be developed throughout the whole education and training process to complement more specialist skills.

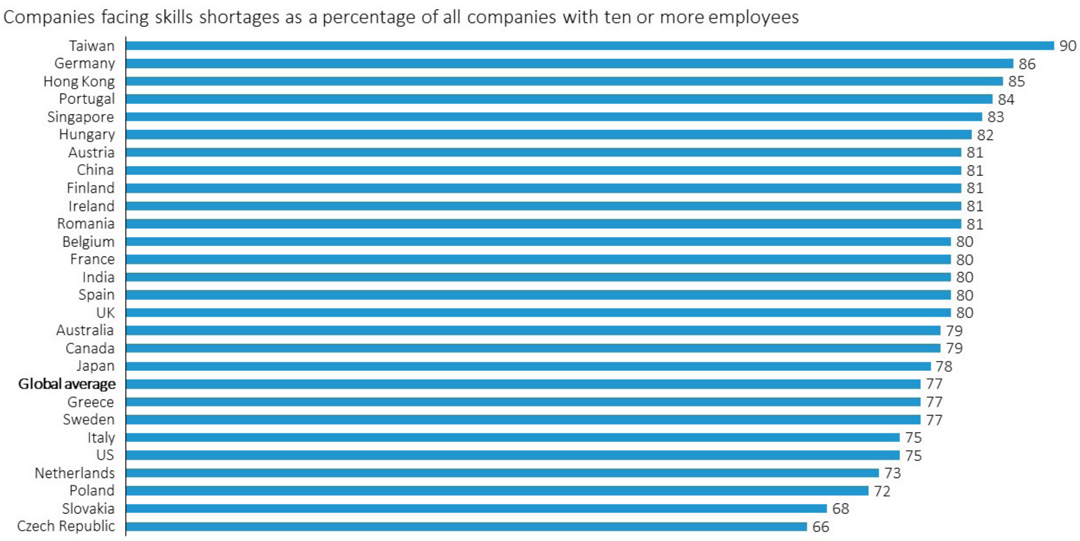
- Managerial skills. Management skills play an essential role for the adoption and productive use of new technologies and the optimal allocation of human capital. For example, the absence or inappropriate adoption of modern managerial practices is frequently given as a reason why SMEs fail to thrive. Entrepreneurs, however, often underinvest in the acquisition of managerial skills because of widespread misperceptions about the value of these skills, financial constraints, and a lack of easily accessible, publicly recognised, high-quality education programmes[i].

EUROPEAN COMPANIES ARE FACING SIGNIFICANT GAPS AND A MISALLOCATION OF SKILLS

Large companies and SMEs in the EU cannot find (or fail to attract) the necessary skills.

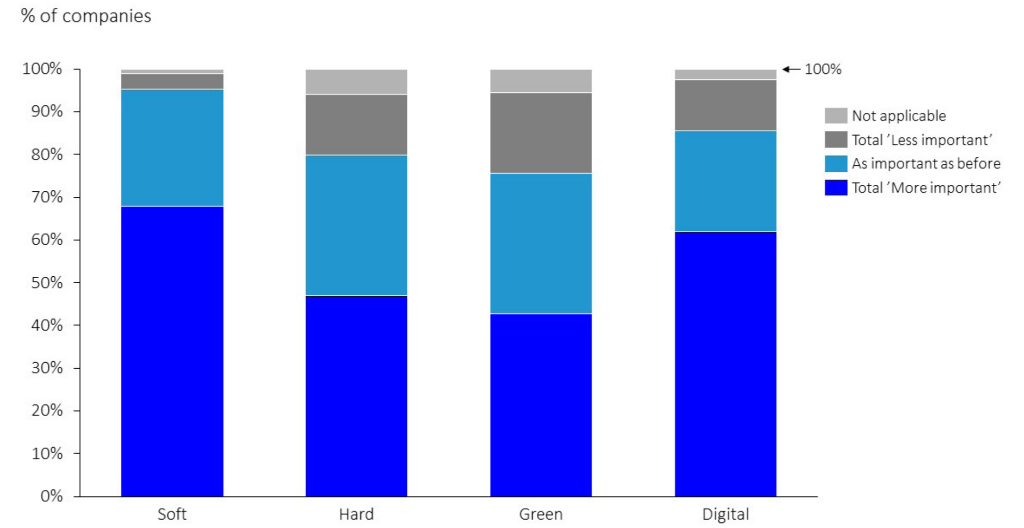
European companies are facing significant skills shortages, similar to other advanced economies [see Figure 1]. On average, 54% of European companies consider skills shortages one of their most pressing problems to solve, followed by administrative burden (identified as one of the most serious problems by 34% of respondents). While the intensity of this problem varies somewhat across countries, it is not only felt by large organisations but also by SMEs [see Figure 2].

FIGURE 1
Skills shortages in selected countries.



Source: Manpower Talent Survey 2023

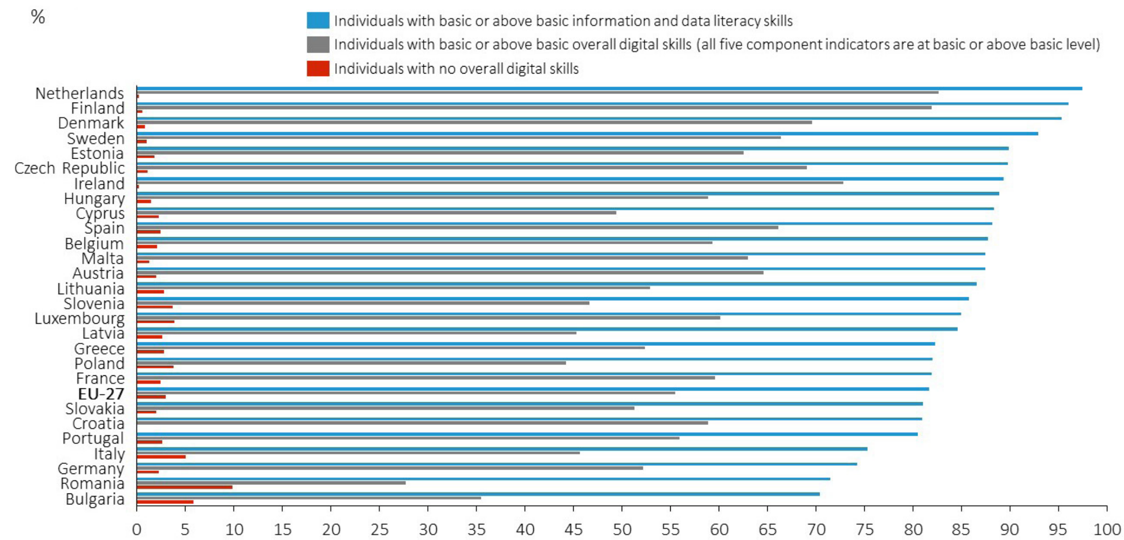
FIGURE 2
Importance of different skills for SMEs in the EU



Source: European Commission

Shortages in Europe are felt across a wide variety of skills and occupations. OECD data shows that one-fifth of adult workers in the EU lack basic skills[ii]. **Skills shortages are even larger in other key skills, starting with digital skills** [see Figure 3]. Around 42% of Europeans lack basic digital skills, including 37% of those in the workforce[01]. ICT experts with advanced skills are in high demand, which leads to increasing competition between sectors to recruit these experts. Approximately 63% of EU companies trying to recruit ICT specialists experience difficulties in filling these vacancies. Shortages in this occupation are likely to be persistent also due to high replacement needs.

FIGURE 3
Digital skills



Source: Eurostat

Skills shortages are exacerbated by the misallocation of skills within companies. Europe also shows systematic challenges in matching people with the right skills to the right jobs[iii]. Mismatches can arise from a variety of reasons leading to an imbalance between skills supply and demand. While to some extent these imbalances depend on the economic cycle (for example, labour markets may be tighter during economic booms), they can also arise from a poor alignment of education and training with labour demand, leading to systematic under or over qualification of

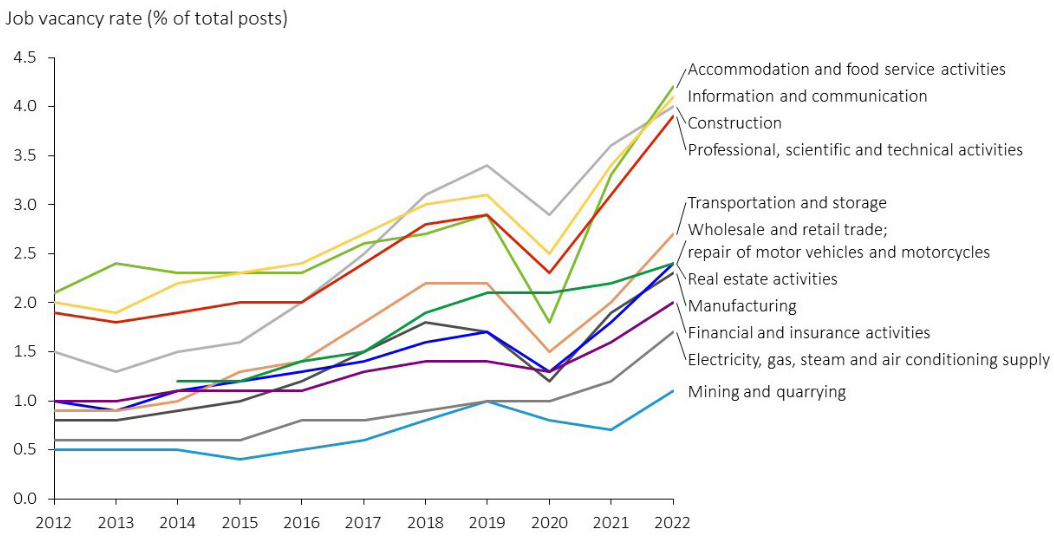
01. The EU Digital Decade set out to ensure 80% of working age Europeans have basic digital skills by 2030.

individuals especially in periods of heightened technological progress. Imbalances of this kind may be detrimental to company performance, as well as to employee morale and engagement, leading people to feeling trapped and unsatisfied with their jobs.

Skills shortages and talent misallocation are also pervasive in the managerial layers of organisations. The uneven adoption of basic managerial capabilities can account for a substantial part of the EU's productivity gap compared to the US. The uneven adoption of basic management practices – especially those needed to manage human capital – are likely culprits for the sluggish adoption of Information and Communication Technologies (ICT) in the late 1990s and the 2000s, especially in southern EU Member States.[ivv] For example, US companies' stronger ability to exploit the productivity-enhancing potential of ICT during the 1990s compared to companies in the EU is to an important extent due to differences in management practices[vi].

The deficit in managerial skills is particularly acute among SMEs, in the EU and elsewhere. Evidence suggests that lacking managerial competencies often stem from biased perceptions of management's importance to company performance, as well as the scarcity of available talent to fill crucial managerial roles and tasks[vii] and the concentration of ownership and control in family companies.

FIGURE 4
Skill shortages in the EU



Source: Eurostat

SKILLS SHORTAGES ARE LIKELY TO WORSEN IN THE FUTURE

As of today, the creation rate of new job vacancies has been on the rise in most sectors [see Figure 4]. Some of the highest increases in vacancy rates were recorded in sectors, such as information and communication, health and social work, and engineering.

While it is unclear in which specific direction new technologies will evolve and to what extent they will exacerbate existing skills shortages, some skills developments can be predicted with reasonable confidence. Future labour markets will be more automated and dynamic, which will put premia on skills that allow workers to complement machines, equip them to master new (digital) technologies and adapt to new developments.

The shift towards highly skilled occupations will require significant upskilling and reskilling of the workforce. CEDEFOP predicts that highly skilled occupations will expand by some 12 million jobs, whereas skilled (non-manual and manual) occupations will shrink by around 3.5 million positions. Elementary jobs will remain roughly constant. This implies that there will be an increased need for workers who have completed higher education to accommodate this shift.

Another point of certainty is the influence of the green and digital transition as a source of change in the labour market during the next decade. The chapters on digital and advanced technologies, as well as on clean technologies, energy-intensive industries and the automotive industry demonstrate the changes in skills needs in these specific sectors.

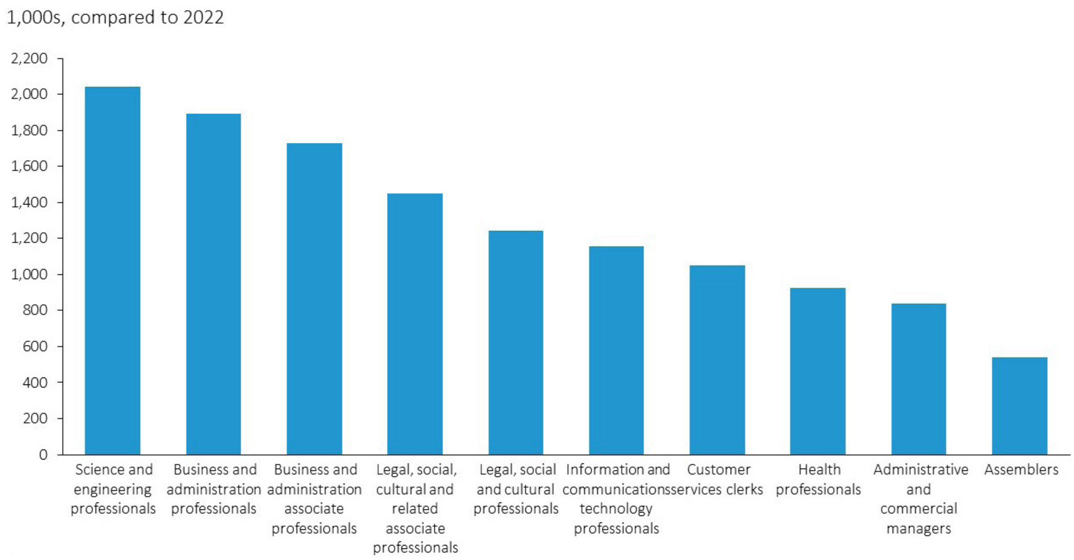
THE COMPETITIVENESS OF THE EUROPEAN ECONOMY DEPENDS ON ITS ABILITY TO CLOSE CURRENT AND FUTURE SKILLS GAPS.

Labour and skills shortages act as a drag on the EU's future competitiveness. They endanger progress in developing emerging technologies, achieving the green and digital transitions, and the development of businesses in strategic technologies.

The lack of appropriate workforce skills also weighs on companies' performance and ability to invest. According to an EIB survey, the inability to recruit an appropriately skilled workforce has ranked among the most important obstacles to long-term investment (81%), just after high energy costs, and before uncertainty concerning the future. Improving the supply of skills among the workforce could unlock long-term investment and help to promote the EU's overall competitiveness.

An example of a severe shortage occupation which can impact the EU's competitiveness is science and engineering professionals and associate professionals, which are essential to implement the twin transitions. There are currently 15 million workers in these jobs in the EU's workforce. According to CEDEFOP projections, there will be around 8 million job openings (new and replacement needs) between now and 2035. The majority of these jobs will be due to the replacement of current employees (six million job openings), but also around two million new jobs will be created due to the needs of the economy. Figure 5 shows the ten professions with the greatest predicted employment growth until 2035.

FIGURE 5
Additional jobs created by 2035



Source: Cedefop (forthcoming)

Similarly, a lack of skilled workers in 'green sectors' can become a severe obstacle to realising the EU's green transition, despite accounting for only around 5% of total employment today. In fact, the success of the EU's green transition will depend on the availability of workers with appropriate skills. Education and training systems need to have the capacity to train, reskill and upskilling the required workforce.

THE ROOT CAUSES OF THE GAP

The lack of relevant skills in Europe depends on a combination of factors related to the performance of education and training systems, as well as labour market dynamics. Overall, the structure for developing skills is insufficiently coordinated, efficient and effective, and there are not enough incentives for employers and employees to invest time and money in skills development. The specific reasons for shortages can be grouped into five main categories: the gradually deteriorating performance of the education system, shrinking active labour population, limited adult learning, low labour mobility, and poor working conditions.

1. The gradually deteriorating performance of the education system.

There are important differences in the funding of education, leaving education systems in some Member States grossly underfunded, which impacts the quality of education offered. The EU's public spending on education stands at 4.7% of GDP, with important differences between Member States. Ireland's education spending stands at 2.7% of its GDP, while Sweden and Belgium spend 6.3% respectively. By comparison, the US spends roughly 4.2% of its GDP on education, from public sources. However, private spending in the US accounts for another 1.9% of GDP, mostly due to funding allocated in higher education[02]. Hence, in total (public and private combined), the US spends more than the EU on education (which does not necessarily also imply better educational performance).

There are still too many children or young people who do not receive adequate education, leaving a great deal of talent unexploited. While increasing, enrolment in early childhood is still below the target set by Member States[03]. The EU and Member States have succeeded in bringing down the number of early-school leavers. The rate of 18-24-year-olds leaving school without attaining upper secondary education declined from 16.9% in 2002 to 9.6% in 2022. This, however, still leaves 3.1 million young people without appropriate qualifications. In terms of tertiary education, only 37% of people in the age group between 25-64 years in the EU have a university degree, below the OECD average of 40%, as well as placing it behind competitor countries like the US, Korea, Israel, Australia (all just above 50%) and Canada (more than 60%). Modern, high-quality and inclusive initial education and training systems are a stumbling block for equipping students with the range of skills needed to build their careers.

Moreover, the failure to adequately support talented youth from disadvantaged backgrounds has important implications for innovation and growth. Evidence shows that in the US the chances of becoming an inventor as an adult is ten times higher if you are born into the top 1% of high-income families than if you are born in the bottom 50%[viii]. Available evidence suggests a remarkably similar phenomenon in at least one European country (Finland). Consequently, education and skills policies supporting children with high potential from disadvantaged families is a powerful instrument to support innovation and competitiveness in the EU, pointing to a powerful complementarity between innovation and education policy, especially if the latter is able to attract into research talented individuals who are financially constrained or work in other sectors[ix].

Education systems' performance has deteriorated over time. The most recent results of the OECD PISA surveys show that the share of students reaching a high level of competence has declined in mathematics and reading across Member States. In 2022, only 8% of EU students reached a high level of competence in maths, and 7% in reading and science. The COVID-19 pandemic also affected the progress of top-performing students, often exacerbating existing negative trends. Promoting excellence in basic skills is a challenge for EU education systems. The performance gap compared with the world's best-performing education systems (typically found in Asia) has deepened over time.

The number of STEM graduates has been gradually increasing over time, but at an insufficient pace. There are now approximately 22 STEM graduates per 1,000 individuals aged 20-29, an increase from 18.5 in 2014[04], a pace that is not sufficient to keep up with the growth in demand in STEM jobs. A factor holding back supply is

02. Private spending on education is relatively less significant in most EU Member States, with the Netherlands recording the highest level of around 1% of its GDP.

03. The share of children (more than three years old) enrolled in early childhood education has increased and reached 92.5% in the EU in 2021, which is still below the target of 96% set by Member States

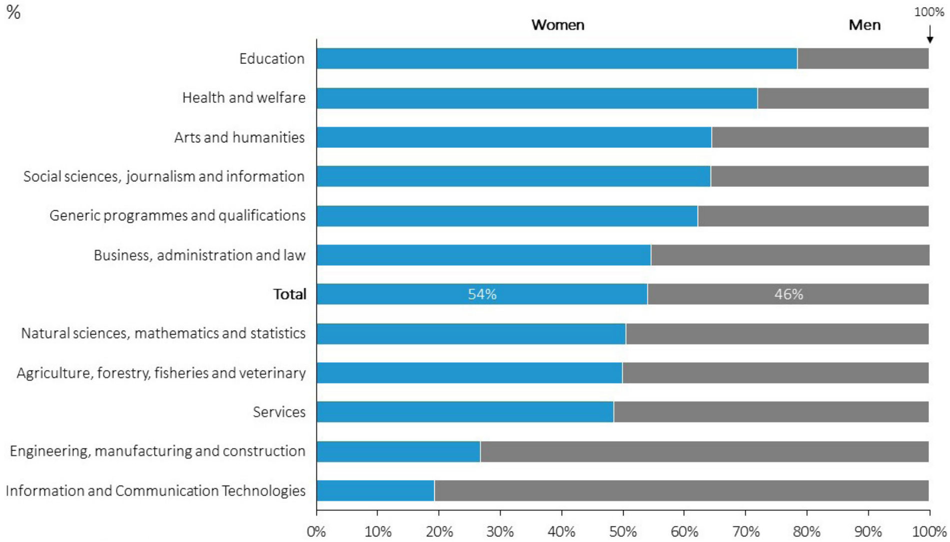
04. Eurostat, Tertiary education statistics, July 2023.

the heterogeneous propensity to enrol in STEM degrees by socio-economic status (with students with a 'lower' socio-economic status being less likely to do so), and by gender. There were almost twice as many male as female STEM graduates. These disparities are exacerbated in occupational choices after schooling. For example, there are almost four times as many men as women working in ICT occupations [see Figure 6].

Finally, some Member States still need to make progress in early childhood education. Failures to equip children with high-quality education are difficult and very costly to address later in life, especially for children coming from disadvantaged backgrounds.

FIGURE 6

Gender gap across fields of study



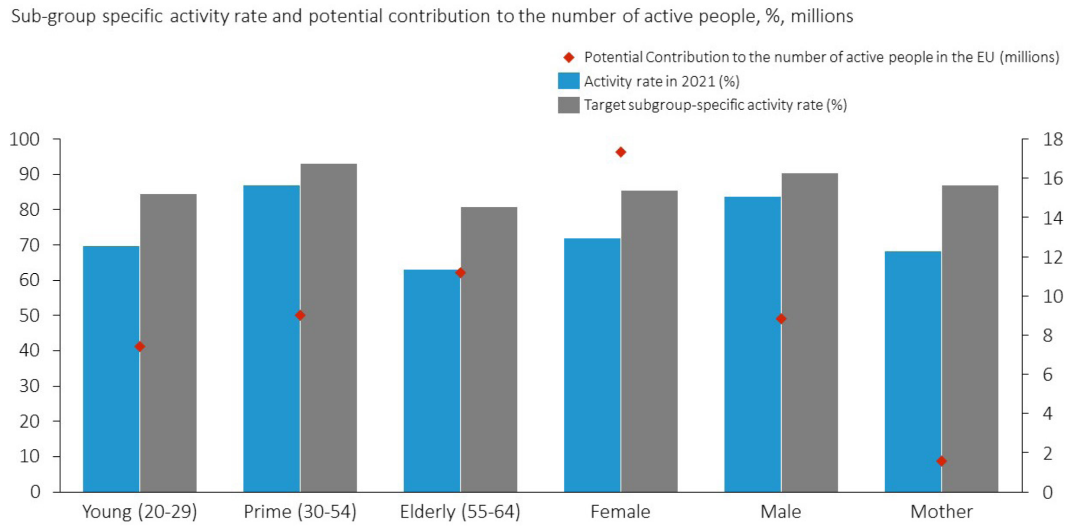
Source: European Commission

2. Shrinking active labour population.

As analysed in Part A of the report, in the coming decades the EU's population will shrink and become older on average. In fact, in 2010, the working age population already started to shrink. As of the mid-2040s, Europe's population is projected to start shrinking. By 2070, it will be 21 million people smaller. This stands in contrast with the US, whose population is projected to grow during this period. This decline will be entirely driven by the ageing of the population and only partially compensated by net migration. As a result, the working age population will shrink by 41 million (more than 15%), from 264 million in 2023 to 223 million in 2070. Without net migration (which is assumed to follow the current trend), this drop would be 46 million people higher. Between now and 2070, labour supply will fall by 12% and average working hours by 9%, despite the possible alleviating impact of labour market and pension reforms. While in 2022 there was one elderly person for every three people of working age, it is projected that in 2070 there will be more than one elderly person for every two people of working age. Moreover, the ageing of the EU population will happen within a relatively short timeframe. The lion's share of the reduction of the working age population is projected to take place by 2045.

There is still a large pool of untapped talent in Europe. Overall, 21% of today's population aged 20-64 remains inactive, with 8 million young people currently not in employment, education or training. The employment rate for women is still some 10 percentage points lower than that for men. This is primarily attributed to the unequal distribution of domestic responsibilities, as well as a lack of affordable childcare. The gender employment gap increases with age (e.g. women aged 55-64 have an employment rate 11.5 percentage points lower). Despite considerable improvement, the employment rate of those aged 55-64 remains almost 20 percentage points lower than that of prime-age workers [see Figure 7]. This significantly diminishes older people's employment prospects, bringing substantial societal costs.

FIGURE 7
Untapped potential in the EU's workforce



Source: European Commission

3. Limited adult learning.

Adult learning has become increasingly important. While initial education and training provide key skills and competences to successfully navigate the early years in the labour market, updating and acquiring new skills during one's career becomes essential during periods of heightened technological change. Adult learning is also crucial for company performance, as a lack of qualified workers is hampering innovation and company growth, ultimately limiting the EU's productivity and competitiveness.

Adult learning, however, is still not properly embedded in EU education and training systems. Participation in adult education and training is overall relatively low and is not enshrined within most national labour market regimes. While there is a general effort to improve participation in lifelong learning, progress is very uneven across Member States.

Similarly, despite the reported skills shortages, companies have generally been hesitant to increase their investment in training. A lack of funding is often perceived by companies as a main stumbling block for investing in training. Limited funding, however, is just one of many reasons for the limited impact of training initiatives undertaken by private companies. Furthermore, funding for training is often unstable and not always easily available. In addition, even when funding for training is available, it is rarely spent efficiently and effectively, reflecting knowledge gaps in the design and implementation of training programmes in companies.

The current underperformance of adult training systems reflects pervasive informational frictions and poor coordination between companies, workers and training organisations. The formal schooling system, including vocational schools and universities, lacks precise input about the skills required by companies. Companies, on the other hand, might have superior information about their skills needs, but may not have the incentive to provide training opportunities to workers (especially if these skills are perceived to generate general human capital) for fear of appropriation by other companies in the market[x]. Finally, while training providers face significant costs associated with the creation, advertisement and implementation of effective training programmes, information on the quality and effectiveness of their services is often lacking. This may dampen the incentive to set up high-quality training programmes, and for existing high-quality programmes to scale.

Adult learning systems will have to provide relevant skills to workers and offer high-quality courses targeted at the right audiences. For this to happen, a new approach that carefully reflects the needs of the labour market and involves employers and other stakeholders in all phases of the adult learning process (from programme design to implementation) is required. While some Member States have been able to get close to this model [see for example

Box 1 below], this is not the current reality in many Member States, where a wide variety of models pertaining to the funding, curriculum, organisation, eligibility, stakeholder involvement and communication of adult programmes persist regardless of their effectiveness.

BOX 1

Adult learning in Finland

Finland's adult learning system is one of the most successful in the EU (and the OECD). The participation rate of adults aged 25-64 in education and training during the past four weeks is 25.2% in Finland, while the EU average stands at 11.9%. Part of the success of the Finnish model is due to the deep enshrinement of lifelong learning in Finland's labour market and education system. Two-in-three adults participate in formal or non-formal learning activities every year. Finnish adults also have above average technology-related skills. There is a wide range of learning opportunities at all skills levels. Beyond the availability of training (and related funding), Finland appears to have a very positive attitude towards education, with upskilling commonly regarded as a necessary part of people's professional development.

Continuous learning providers are predominately public or quasi-public education institutions. Social partners are also involved in setting the curricula for adult learning. There is only a very limited presence of private education and training companies. In terms of funding, employers contribute significantly. A newly established government service centre promotes competence development for working-age people and the availability of skilled labour by directly linking labour market needs to lifelong learning. For example, the centre finances training related to the hydrogen economy and the battery industry to meet the needs of the twin transitions, alongside other training to acquire skills in demand on the labour market.

4. Low labour mobility.

Greater labour mobility can help alleviate existing shortages by improving the allocation of skills and labour capacity within and across Member States. Labour mobility allows workers to relocate to regions or countries with higher demand for their skills and better job opportunities. Labour mobility can also contribute to the expansion of the overall labour pool for a variety of occupations and sectors, giving employers access to more qualified workers.

However, the movement of workers within the EU is still limited, including relative to the US[xi]. Several factors explain this, such as language and cultural barriers as well as regulatory barriers. For example, access to many professions is regulated by EU Member States and requires specific professional qualifications. Assessing whether it is actually necessary to regulate entry into specific professions, and how to effectively and fairly recognise the validity of country-specific qualifications, and occupational licensing[xii] are still unresolved policy issues[05]. Other factors affecting labour mobility relate to non-compete agreements and related clauses, which prevent employees from joining (or starting) a competing company. While the use of such restraints has traditionally been justified on the basis that they protect legitimate business interests (e.g. trade secrets), there are increasing concerns that they are being deployed to stifle job mobility and competition. Furthermore, differences in social welfare systems, including healthcare, pensions, and unemployment benefits, create uncertainty for workers moving across the EU. The risk of losing access to social protection or facing difficulties in accessing social security in other Member States deters individuals from relocating, despite EU-level legislation ensuring the portability of social security rights. While some companies temporarily post workers from one Member State to another to fill skills gaps, more efforts are still required to facilitate this activity, for example reducing the related administrative burden for companies, while ensuring that the rights of workers are respected.

05. The EU recognition framework is based on the Professional Qualifications Directive, and includes initiatives, such as the European Professional Card and the establishment of Common Training Frameworks, enabling automatic recognition for more professions.

Beyond labour mobility within the EU, the EU fails to attract highly skilled migrants from abroad and to retain local talent[06]. Migration (both inward and outward) has a significant impact on the size, composition and skills of the EU's workforce, and as such it has been an important factor in reducing labour shortages. Europe, however, has become one of the important exporters of talent, and is struggling to attract and retain talent in highly skilled occupations[xiii][xiv]. And whereas migrant workers are almost 9 percentage points more likely to work in occupations with persistent shortages than workers born in the EU[xv], currently these workers are primarily employed in low-skilled occupations.

5. Poor working conditions.

Poor working conditions make it harder to attract workers[xvi]. In a number of professions, health and safety risks, as well as low wages may have aggravated existing labour shortages. Moreover, other working conditions, such as the availability of training and career opportunities, work-life balance and management practices play an important role in labour force participation. A case in point is teaching, where a lack of attractiveness of the job (low pay, poor recognition, and high workload) has been linked to shortages across the EU[xvii][xviii].

Besides job conditions, other circumstances including housing and connectivity can play a significant role in attracting workers. A shortage of (affordable) housing can prevent workers from taking up jobs in particular areas, which has become an issue in (expensive) urban areas. This problem is particularly acute in technological clusters, whose development is key for the EU's competitiveness, as discussed in the chapter on innovation. On the flipside, some rural areas with low levels of connectivity may also find it challenging to find employees with the required skills. There are also sector-specific issues: for example, almost 50% of workers in residential care, transport and healthcare report high levels of job strain, which may aggravate labour and skills shortages.

Finally, ill-designed social security measures could also prove counterproductive if they actually discourage work, for example poverty traps, excessive tax wedges or lower benefits when working more hours. Moreover, a lack of affordable, accessible and available childcare, together with lower salaries compared to male counterparts, prevent the participation of women in the labour market.

CURRENT POLICIES

Over the years, the EU has regularly reiterated the importance of skills provision. It has intervened to promote general policy frameworks for investment in skills and stimulate the formation of general and sector-specific skills across a broad coalition of actors. The legal basis for investment in human capital and skills in the EU is codified in the Treaties[07].

The EU has also offered direct funding to support education and skills provision in Member States. Under the current (2021-2027) Multiannual Financial Framework (MFF), around EUR 64 billion is dedicated to investment in skills (including co-financing), with a major part of this sum coming from the European Social Fund Plus (ESF+) and the Erasmus+ programme. In addition to this EUR 64 billion, approximately EUR 42 billion will be invested in developing skills under the Recovery and Resilience Facility (RRF).

06. In 2022, 3.5 million first-time residence permits were issued in the EU, 1.2 million of which for employment purposes. Highly-qualified workers from outside the EU can live and work in an EU country by obtaining a EU Blue Card. Across the EU, the total number of EU Blue Cards granted to non-EU citizens rose from 24,305 in 2017 to 52,127 in 2019. It then fell to 50,234 in 2020 and increased again to 67,730 in 2021 (by more than 35%) and to 81,851 in 2022 (by more than 21%). The majority of EU Blue Cards were issued in four Member States: Germany (63,242, 77.3% of the total), Poland (4,831, 6.0 %), Lithuania (3,924 or 4.8 %) and France (3,876, 4.7 %). As part of the November 2023 Skills and Talent Mobility Package, the Commission (together with the talent pool initiative) adopted a Recommendation on the recognition of qualifications of third-country nationals, which sets out measures to enhance the EU's attractiveness through swift and simple recognition procedures for third-country nationals.

07. Articles 145 until 150 of the Treaty on the Functioning of the European Union (TFEU) cover the elements related to employment. They specify that Member States and the Union, together, develop a coordinated strategy for employment and promoting "a skilled, trained and adaptable workforce" and that Member States shall regard employment as a matter of common concern. In addition, articles 151 until 160 of TFEU cover social policy and grant the Union rights to complement Member States' activities in the area of working conditions and labour market participation.

FIGURE 8
EU investment in skills

PROGRAMME	ESTIMATED INVESTMENT *(IN EUR BILLION) DURING THE 2021-2027 PROGRAMMING PERIOD*
European Social Fund Plus (ESF+), not including national co-financing	40.4
RRF	41.7
Erasmus+	16.2
InvestEU	4.9
European Globalisation Adjustment Fund	1.1
European Solidarity Corps	0.8
Digital Europe	0.5

These investments have, however, delivered limited results to date. For example, only 37% of adults participated in training in 2016 and this rate has hardly increased since. To achieve the 2020 European Skills Agenda target of having at least 60% of adults participating in training every year, some 50 million more workers should receive training.

The limited effectiveness of EU investment in training comes down to multiple factors. First, since Member States bear most of the responsibility in this area, Funds (e.g. the ESF+), are typically channelled under shared management, which considerably limits the ability of the European Commission to influence the quality and relevance of financed projects. Second, a lack of central control and oversight is exacerbated by the fact that there is limited interest from Member States to go beyond soft forms of coordination in the field of skills. At the same time, there are numerous EU initiatives under the Pact for Skills without substantive financing and Member State involvement. Third, reaching some of the targeted audiences, e.g. SMEs or unemployed workers, is objectively hard and would require greater investment and coordination between private and public sector stakeholders than current practice. Fourth, the absence of systematic evaluations of skills policies at both the project and aggregate level prevents learning and improvement. Existing audits focus on whether formal rules have been followed (e.g. the application of procurement rules). This also complicates assessing the effectiveness of the programmes compared to alternative uses of funding or alternative training approaches.

All in all, the review of current policy interventions suggests that to address the severe and consequential skills gaps Europe is currently facing, it will be essential to rethink not only how much funding is allocated to education and training, but even more importantly the way in which funding is being spent. This shift in approach will require much greater, and more effective, collaboration between Member States in the area of training and education.

BOX 2

EU skills policy framework

The EU policy framework for skills is based on the 2020 European Skills Agenda for competitiveness, fairness and resilience (Commission Communication COM/2020/274). The Skills Agenda is closely coordinated and aligned with the European Pillar of Social Rights, the European Industrial Strategy, and the European Green Deal.

It includes 12 actions organised around four building blocks: 1) a call to join forces in collective action; 2) actions to ensure that people have the right skills for jobs; 3) tools and initiatives to support people in their lifelong learning pathways; and 4) a framework to unlock investment in skills. As the first flagship initiative under the Agenda, the Pact for Skills was launched in 2020. It brings together more than 1,000 member organisations with the objective of enhancing adult learning.

1. General Frameworks

The basis for social policies in the EU is the European Pillar of Social Rights. It sets out 20 key principles aiming to build fairer and well-functioning labour markets, as well as strong welfare systems. In the context of skills, it is mostly the first principle that is relevant, referencing 'education, training and lifelong learning'. These principles have been translated into several policy initiatives. The importance of skills was underlined by the determination of 2023 as the European Year of Skills.

The current policy framework is built on the 2020 European Skills Agenda. The Agenda has two headline targets: 1) an employment rate of at least 78% by 2030; and 2) at least 60% of adults participating in training every year. While progress has been made in increasing the employment rate (reaching 74.6% in 2022), progress in strengthening participation in training leaves much to be desired. Participation in training stood at 37% in 2016 and has hardly increased since. To achieve this ambition, some 50 million more workers should receive training every year.

2. Funding

In the area of education and skills, the EU also provides funding to national initiatives under several financial instruments, provides high-level guidance on desirable policies, and promotes the 'soft' coordination of policies between EU Member States.

The overall priorities agreed under the ESF+ help to set the general direction, but decisions regarding specific projects are fully in the hands of Member States. With ESF+ measures, Member States focus on a wide range of issues, including on skills relevant for the green and digital transitions, with a focus on the young and the most disadvantaged.

Through Erasmus+, young people are empowered to acquire transversal skills. Erasmus+ has become one of the most widely known EU programmes. However, Erasmus+ only reaches 15% of the EU's young people today. To reach every young person in the EU, the funding of the programme would need to increase five-fold for the 2028-2034 programming period. For an 'Erasmus for all', its funding in the 2028-2034 programming period would need to be five times the size.

3. General Skills Initiatives

The EU has launched a number of initiatives in the field of skills. This makes the overall policy landscape extremely complex. Given the limited powers of the EU, most of these initiatives take the form of recommendations, which cannot be legally enforced. According to the survey on progress on the Pact for Skills[xix], the training activities organised by its members reached some 3.5 million individuals since 2022 (1.5 million in 2023). Cumulative investment in these activities is estimated to be EUR 310 million. As part of its activities, around 48,000 training programmes have been developed or updated. While these efforts are important, they do not nearly reach the scale needed to make important progress towards the objective of 60% of the workforce participating in training.

4. Sector-Specific Skills

As part of these efforts, significant initiatives strive to mobilise stakeholders to provide sector-specific skills. 20 Large-Scale Partnerships have been launched to date, covering all 14 of the EU's industrial ecosystems. There are, however, challenges – notably regarding reaching and involving SMEs, as well as the fact that no funding is attached to the initiative, meaning that companies willing to participate in a Partnership must self-fund their actions.

In addition to these partnerships, several skills academies for specific sectors have been launched. As these academies have been set up fairly recently or are still in the process of becoming operational, it is rather difficult to assess their effectiveness. They will typically develop education and training programmes, together with the industry and relevant parties, as well as develop learning credentials, which will certify the skills that people have acquired in their training courses. The deployment of the training is done through local institutions (VET providers, businesses, universities or other education and training institutions). The Commission provides some initial funding, but the academies should become financially sustainable over time. The European Institute for Innovation and Technology (EIT) implements these academies.

The European Battery Academy was launched as part of the Battery Alliance in 2022 to roll out national reskilling upskilling programmes. Approximately 800,000 workers will need to acquire additional skills in the battery industry by 2025. The Commission had supported the Battery Academy with a EUR 10 million grant. Following this example, the Net-Zero Industry Act (NZIA) introduced similar academies in the areas of solar photovoltaics, hydrogen, raw materials and wind technology. These academies aim to address critical skills shortages that may hamper the decarbonisation and reindustrialisation of the European economy.

Objectives and proposals

Europe needs to act decisively to overcome its current challenges and implement a significant rethinking of the design and implementation of skills policies. It needs to adopt a skills-based approach whereby the emphasis shifts from the formal delivery of diplomas to preparing students with the right skills for the rapidly evolving economy and labour market. In addition to fostering initial education (which remains essential to long-term growth and productivity), it is key to accelerate the quantity and quality of adult and vocational training undertaken in Member States. This is important to close the current productivity gaps in strategic sectors, and to lay the foundations for future growth.

It can no longer be assumed that formal education until the first years of adulthood alone is sufficient. By contrast, investment in education and training in the EU should: 1) become more responsive to the fast-evolving needs of the economy, in particular in light of the green and digital transitions; and 2) fully embed a lifelong approach through a continuous effort to upgrade and update skills, irrespective of gender, social background, age and sector; 3) be elevated to a strategic priority requiring not only adequate funds, but also much more effective governance and attention to implementation.

To realise this vision, it will be necessary to act on several fronts. It will be essential to make greater and more systematic use of granular data on stocks and flows of skills for the design and implementation of skills policies, simplify and harmonise the certification of skills acquired by individuals, regardless of their origin and occupation, and place much greater emphasis on the funding, implementation and evaluation of policy initiatives related to skills.

Implementing this new vision will require a radical departure from current governance models. In particular, it will be necessary to move from funding approaches based on soft coordination mechanisms, limited coordination in the design and implementation of skills investments, and limited evaluation of funded initiatives, to much greater and substantive coordination among Member States.

Similarly, it will be crucial to involve social partners and companies in the design and implementation of skills policies. Companies, in particular large ones, can play a valuable role in contributing to skills development in collaboration with local and regional employment offices, social partners and training providers. The direct involvement of companies – especially those that have already made significant investment in internal skills policies – in this process, is critical in many respects. First, to guide and support the design of training programmes in the context of a highly turbulent and uncertain technological landscape, which may be hard to truly understand without deep contextual knowledge; second, to clarify to potential participants whether and how participating in training may lead to concrete future job opportunities; and finally, to support the implementation of programmes through the identification of effective training partners and the inclusion of on-the-job training activities.

Following the logic outlined above, a number of specific initiatives is proposed. Taken together, these proposals amount to a significant change in the design, implementation and governance of skills policies in Europe, elevating skills policies to strategic investments. This implies obtaining clarity and focus on what skills are needed, leveraging new and granular data on needs; increasing investment, making use of systematic evaluations of investment, to learn and scale promising initiatives. This pragmatic approach needs to focus on specific areas that are key to the objective of regaining competitiveness, i.e. specific stages of education (adult learning and vocational training), specific sectors (strategic value chains) and skills (managerial capabilities).

The ultimate vision is to lay the foundations for the creation of a 'Union of Skills' with a focus on relevant skills of high-quality, irrespective of where and how they were acquired. Formal certification and recognition of these skills needs to be designed in a way that facilitates matching in dynamic and fast-evolving labour markets. Certification should become less reliant on formal education attainment, and more flexible and granular. This would imply recognising and validating skills acquired through diverse learning pathways, vocational training, and work-based learning. Micro-credentials and digital badges to demonstrate skills and competencies should also be considered and promoted. Finally, professional certificates issued across the EU should follow a uniform approach as much as possible to facilitate mutual recognition across Member States, as a real Single Market for skills, and as much as possible across different market segments for what concerns transversal skills.

While representing a significant departure from current approaches, the implementation of these proposals will rest on the willingness and ability of Member States to invest in complementary areas that are currently under their responsibility, starting with enhancing the quality of primary and secondary education systems, improving the availability and working conditions of teachers, and increasing labour market participation.

FIGURE 9

	SUMMARY TABLE – CLOSING THE SKILLS GAPS PROPOSALS	TIME HORIZON[08]
1	**Collect and leverage granular data on skills needs, stocks and flows ('skills intelligence') to design skills policies.**	ST
2	**Revise curricula** in light of changing skills needs.	ST/MT
3	**Improve and harmonise skills certifications** common to all EU member states, recognising and validating skills acquired through diverse learning pathways, vocational training, and work-based learning.	ST/MT
4	**Rethink the design, funding and implementation of skills policies**: i) dedicating a minimum share towards adult learning and vocational training; ii) focusing on strategic sectors and occupations; iii) including stricter requirements on the design, implementation and desired impact of the programmes; iv) systematically evaluating and comparing the effectiveness of policy initiatives in skills within and across Member States via dedicated evaluation units.	ST/MT
5	**Focus on adult learning** ensuring sufficient available funding by Member States and private organisations (including incentivising companies to allocate more resources to training, for example by offering tax benefits).	ST
6	**Promote and reform vocational educational training (VET)**, in partnership with VET providers, employers, industry associations, and trade unions.	ST/MT
7	**Attract more highly skilled workers from outside the EU** launching a new Tech Skills Acquisition Fund for a new EU-level visa programme; a large number of EU scholarships for undergraduate, graduate and PhD students; student internships and graduate contracts within participating research centres and public institutions.	ST/MT
8	**Reduce the misallocation of future talent**, implementing programmes to support talented children from disadvantaged backgrounds.	ST/MT
9	**Address skills shortages in critical value chains.**	ST/MT
10	**Promote managerial skills in SMEs** by: i) creating accreditation systems and incentives to elevate the quality of managerial training; ii) facilitating the acquisition of managerial skills through the use of vouchers to hire temporary managers.	ST/MT
11	**Improve the availability and working conditions of teachers.**	MT
12	**Increasing labour market participation.**	ST/MT

08. Time horizon is indicative of the required implementation time of the proposal. Short term (ST) refers to approximately 1-3 years, medium term (MT) 3-5 years, long term (LT) beyond 5 years.

LAYING THE FOUNDATIONS OF A NEW EUROPEAN SKILLS POLICY

1. Collect and use granular data on skills needs, stocks and flows ('skills intelligence') to design skills policies.

To design and implement effective skills policies, it is essential to improve the availability, granularity, reliability and comparability of information on skills needs, stocks and desired flows within and across Member States – which is broadly defined in this report as 'skills intelligence'. Such information is essential to assess existing gaps and to forecast skills gaps across sectors and regions, and thus to identify how to design and where to allocate funds for training or retraining initiatives in a targeted way, and to support governments and stakeholders in making better-informed decisions about the priority areas for investment in skills. As such, using skills data, and investing in the actual use of the data, has the potential to enhance the effectiveness of public spending by prioritising the right skills and foregoing investment in skills that is less crucial to addressing strategic skills gaps. This 'skills intelligence' data currently exists, thanks to the availability of new sources of information and methodologies to assess, project and validate skills needs (such as, for example, big data on skills adjacencies of job vacancies, or individual occupational transitions).

The use of this data for actual policy design purposes, however, is still low and uneven within both EU institutions and in individual Member States. To make progress on this front, it is essential to assess the gaps in current data assets (for example, skills demand extrapolated from online job vacancies) and to design an EU-wide skills intelligence gathering initiative coordinated across Member States and with relevant stakeholders within countries. This includes private sector organisations equipped with the most up-to-date information on their actual skills needs and stocks.

As a first step, this intelligence gathering will have to happen at Member State level, and to this aim the Commission will prepare a common standard for collecting this information. Ideally, such information should be available and comparable across and within Member States, and easy to use for planning purposes by individuals in charge of designing and evaluating skills policies (e.g. regional employment agencies). This will require equipping local organisations with the skills needed to understand and use data for these purposes.

2. Revise curricula in light of changing skills needs.

Curricula will need to be designed and delivered to meet new needs. The revision of curricula needs to be done through an inclusive approach, with the involvement of teachers, educational providers, social partners, companies and other stakeholders. Rather than focusing on generic programmes, curricula will need to explicitly target the development of the most needed skills within the EU labour market, ideally identified using granular data [see proposal 1]. This implies focusing on the development of:

- STEM skills, for example, by including interdisciplinary approaches that integrate STEM into other subject areas.
- Digital skills, for instance, by incorporating technology and digital literacy, as well as advanced skills in coding, programming and robotics.
- Skills for the green transition, for example, by introducing green skills in various subject areas, such as science, geography, mathematics, economics and technology subjects; and by integrating sustainability as a core aspect of curricula.
- Transversal skills, for example, by structurally developing communication, teamwork, problem-solving, creativity, adaptability, resilience and emotional intelligence. Entrepreneurship education should also become a regular aspect of curricula.

The design of curricula needs to adhere to agreed upon standards of excellence across Member States. This is especially needed in some areas – for example, STEM – which are currently taught under highly heterogeneous curricula across Member States. In skills areas that are relative newer and more specific – e.g. transversal skills – it will be key to leverage existing information and past experiences to identify effective approaches, and to base the adoption and scaling-up of new curricula on the basis of hard evidence on their effectiveness.

Higher education institutions need to be encouraged to flexibly respond to labour market needs and adapt the courses they offer by involving social partners in the process. In implementing revised curricula, universities should be encouraged and incentivised to experiment with new models for education, transformation and societal interaction. Funding models should be adjusted to foster innovative, transdisciplinary approaches.

3. **Improve and harmonise skills certification.**

To maximise the impact of skills investment policies on workers' employability, the skills acquired in training should be easily understandable by prospective employers throughout the EU. It is therefore important to set up a system of skills certification common to all EU Member States to facilitate the recognition of acquired skills and matching between the demand and supply of skills in dynamic and fast-evolving labour markets. Certification should become less reliant on formal educational attainment and more granular and flexible than it currently is. This would imply recognising and validating skills acquired through diverse learning pathways, vocational training, and work-based learning. Micro-credentials and digital badges to demonstrate skills and competencies should also be considered and promoted.

4. **Rethink the design, funding, implementation and evaluation of EU skills policies.**

The ESF+ should be redesigned by the European Commission, so that the funding allocated for skills policies can achieve a much greater impact. ESF+ funds should be conditional upon the effective implementation of agreed policies. Systematic efforts to identify and scale promising training approaches across Member States – which is currently largely absent – could significantly accelerate and improve the effectiveness of EU skills policy.

This implies a different approach towards the selection of funded programmes, which should be targeted towards the achievement of EU strategic priorities and focused on the areas where added value is greatest. This includes clean technologies, digital and advanced technologies, and the automotive industry, where the availability of an appropriately skilled and abundant workforce is crucial for the successful implementation of ambitious and equitable industrial policies. Additionally, the ESF+ should dedicate a minimum share of its funds towards adult learning and vocational training.

To improve the effectiveness and scalability of skills investment, the disbursement of EU funds will also need to be coupled with stricter accountability and impact evaluation. This implies that the design of skills policies – including the selection and funding of skills investment – should allow for the systematic evaluation of the outcomes achieved by these programmes. The use of ESF+ funds should be carefully monitored and evaluated against the criteria of cost-effectiveness, impact and added value, and this knowledge should be used to improve the selection and scaling up of funded initiatives. Finally, the proactive dissemination of the results emerging from different skills investments will accelerate the diffusion of actionable insights within the EU, which is now sorely lacking even across regions within Member States.

SPECIFIC INTERVENTIONS

5. **Invest in adult learning.**

Political commitment behind adult learning is key if Europe is to overcome the economic challenges outlined in this report. The EU currently lacks a comprehensive, performing approach to adult learning, due to the lack of coordination and the excessive dispersion of activities and investments among Member States.

Increasing participation in adult learning will require a multi-pronged approach. This includes providing sufficient available funding by Member States and private organisations (including incentivising companies to allocate more resources to training, for example by offering tax benefits), and paying much greater attention to the actual design and delivery of training programmes.

However, adult learning is not the sole responsibility of public institutions, but an outcome of broader partnerships between private and public stakeholders. Since a great deal of adult learning takes place in the workplace, it is important that employers are involved in the design, implementation and financing of adult learning systems. Equally key is the involvement of trade unions, who have the ability to build the trust necessary to shape pathways of technology and skills upgrades that can truly benefit both companies and workers, ensuring that the correct incentives to build up human capital exist for all stakeholders involved[xx].

For these models to be successful, the balance of benefits and costs needs to be positive for both the employee and the employer. The latter is a particular challenge for SMEs for whom training costs are often higher due to a lack of scale. Appropriate incentives and assistance (e.g. information, guidance and counselling services) should be provided to organisations that are willing to commit to training their workforce. Encouraging the creation of public-private partnerships focused on specific value chains [see proposal 9] could serve as a starting point to prototype and test different forms of collaboration between private and public stakeholders, and within coalitions of private stakeholders.

To promote adult learning, the EU should minimise the frictions that are currently preventing access to training opportunities for adult learners. An effective policy needs to recognise that adult learners face numerous obstacles – be it time constraints, informational frictions, or psychological barriers – that inhibit investment in the acquisition of new skills and/or the transition to new occupations. This means that information on training opportunities and their expected outcomes should be easy to find and to understand and to use (rather than being available only through private networks or untargeted to specific circumstances), funding opportunities should be clearly explained to individuals, and high-quality counselling services tailored to adult learners should be provided. Furthermore, the conditions surrounding adult learning should be made more favourable by adapting learning formats to people's needs, e.g. by providing part-time, evening, weekend, and online courses. Since these responsibilities are currently often delegated to regional entities, it will be essential to provide these actors with the adequate resources and organisational capabilities to implement these tasks.

A possible lever to lower the barriers to accessing learning opportunities for adults is to promote the use of individual learning accounts. Under such a scheme, individuals have their personal accounts where funds or credits are allocated, which can then be used to pay for a wide range of education and training opportunities according to their personal learning needs. These can be related to their current occupation, future professional aspirations or general personal development. Coupled with accurate and actionable information on the effectiveness of alternative training pathways, this approach would provide EU citizens the freedom to choose how and when to use the allocated funds, selecting programmes that best meet their needs. The EU could support these initiatives through funding, the provision of technical assistance and facilitating mutual learning between Member States. At the same time, some Member States already have alternative schemes, which successfully supply adult training. These should be further promoted.

6. Promote and reform vocational educational training (VET).

The structures of education and training systems differ across EU Member States, resulting in little coordination and alignment across States. Particularly, VET systems and apprenticeships are organised quite differently across the EU, and so is the extent to which companies offer vocational training. As a complement to the focus on adult learning, Member States must provide the necessary incentives to encourage participation in VET, by making it more financially attractive (through scholarships and grants) and increasing the attractiveness of these programmes for students (and their families), employers and society at large. Moreover, employers can be incentivised to provide VET training by introducing tax benefits for those who support apprenticeship programmes or invest in employee training.

The success of VET hinges on strong partnerships between VET providers, employers, industry associations and Trade unions. Vocational training programmes are local in nature and have important regional specificities that vary across Member States. Harmonising the quality and effectiveness of these programmes across Member States (for example, by more systematically sharing best practices, establishing a European quality assurance programme, etc.) would ensure that the ability to adapt to local economic realities does not come at the cost of providing low-quality training.

7. **Attract more highly skilled workers from outside the EU to contribute to closing the skills gap.**

To immediately address skills shortages in specific domains and sectors, the EU should launch a new Tech Skills Acquisition Programme to attract tech talent from outside of EU. This would be adopted EU-wide and co-funded by the Commission and Member States. The programme would include:

- A new EU-level visa programme for students, graduates and researchers in relevant subjects to stimulate inflow. This visa programme should have clear eligibility criteria and a simple application process without bureaucratic hurdles. Students that graduate in the EU should be encouraged to stay and offered work opportunities.
- A large number of EU scholarships for undergraduate, graduate and PhD students, to stimulate inflow, in particular in STEM-fields. These scholarships should be merit and need-based, but could be geared towards promoting diversity and inclusion. Private companies could be encouraged to co-sponsor scholarships and to align the fund with industry needs.
- Student internships and graduate contracts within participating research centres and public institutions EU-wide, to retain competencies in Europe in the early phase of researchers' careers. This requires job placement services to connect graduates with research organisations and public institutions. Additional incentives to stay in the EU, including tax incentives and housing assistance, could be considered.

Besides tech talent, the EU should simplify and streamline immigration procedures for highly skilled workers, including fast-track visa processing and residence permits for qualified professionals. Beyond immigration procedures themselves, Member States should offer attractive work opportunities for highly skilled professionals and EU mobility programmes, such as the Blue Card scheme, which facilitates the entry and residence of highly qualified non-EU nationals for work purposes.

8. **Reduce the misallocation of future talent.**

The EU also needs to limit as much as possible the misallocation of talent across critical occupations, especially in STEM. Member States, supported by the European Commission, should systematically implement programmes to support talented children from disadvantaged backgrounds in pursuing high-quality training in STEM by offering mentoring, providing information or financial support to study at good universities with the aim of increasing the quality and quantity of STEM skills in the EU in the medium-long term.

These programmes should aim to spot early talented students at risk of leaving education, and support them financially. For example, scholarships or honour loans based on merit and financial need for areas with greatest forecasted skills shortages) could be awarded. These programmes should also tackle cultural and social conditioning occurring in primary and secondary schools (e.g. teachers' implicit stereotypes, which reduce girls' performance in maths and the likelihood of pursuing scientific school tracks)[xxi]. Finally, it will be essential to design and implement tutoring and career counselling for high-ability young people at risk of diminished academic ambitions due to social and cultural reasons to encourage them to pursue technical and academic-oriented curricula[xxiixxiii].

9. **Address skills shortages in critical value chains.**

As discussed in previous chapters, it is imperative for the EU to bolster supply chains in strategic industries, such as energy, clean technologies, advanced technologies, and defence. The success of these industrial policy interventions in strategic domains to tackle the skills gaps identified in the sectoral chapters crucially hinge on the ability to address technology gaps and to meet skills shortages across network members within a selected value chain, including the numerous SMEs that support large downstream producers and often miss the appropriate scale and capabilities to properly train their workforce.

To identify these priority areas for action (bottlenecks in technology and skills needs) within a critical industry, policy-makers should encourage the formation of strategic partnerships with supply chain leaders, typically found in large downstream companies. These leaders could support the identification of bottlenecks, champion training initiatives, influence and shape investment in training and skills made by all companies throughout the chain and facilitate the coordination of investment and knowledge diffusion within the chain. The commitment of value chain leaders is also crucial to communicate the availability and quality of training opportunities to current and potential employees, thus contributing to overcoming the frictions to adult learning previously described.

The use of public-private partnerships to promote specific sectors is validated by academic research, as well as by recent policy interventions seeking to strengthen supply chains. For example, Additive Manufacturing Forward (AM Forward) is a voluntary compact supported by the Biden administration to foster the adoption of additive manufacturing (AM) among US SMEs. In a nutshell, supply chain leaders commit to "purchase additively produced parts from smaller U.S.-based suppliers; train the workers of their suppliers on new additive technologies; provide detailed technical assistance to support their suppliers' adoption of new capabilities; and engage in common standards development and certification for additive products." The federal government contributes by identifying "a range of federal programmes that US SME manufacturers can use to support their adoption of additive capabilities and increase their competitiveness".

10. Promote managerial skills in SMEs.

Management practices are essential to ensure that human capital is deployed effectively within organisations, for example ensuring that investment in new technologies or production processes are matched with the needed complementary skills. The management of human capital in organisations – which includes the ability to identify, reward and retain talent – influences the incentives for skills acquisition among employees and, in some circumstances, their location preferences.

Public interventions encouraging the adoption of managerial practices by SMEs – companies that show significant gaps in the adoption of basic management practices – have a long history, prove to be cost-effective, and yield long-lasting effects on company productivity[09].[xxivxxv] To promote the adoption of managerial skills by SMEs, it is necessary to increase both the supply and the demand of managerial education.

- On the supply side, an EU-level accreditation system could be opened to all universities and institutions in the EU interested in offering high-quality managerial training programmes specifically designed for SME leaders. The accreditation system would enable entrepreneurs to identify high-quality offerings, and alleviate current informational frictions. Such an accreditation system should be as light as possible to avoid increasing administrative burden. Quality assessment should be rigorous and conducted by independent experts. Following the UK's example described in the Box below, accredited training institutions would offer a standardised course in basic business training for SME leaders, but also allowing some possibilities of differentiation given the heterogeneity of SMEs in the EU.
- On the demand side, a subsidy scheme could be introduced to cover a portion of the education costs charged by accredited institutions. The subsidy should be targeted to entrepreneurs and top managers in SMEs.

The adoption of productivity enhancing management practices in SMEs would also benefit from policies that facilitate hiring external managers, for example using vouchers for temporary managers. SMEs sometimes lack the scale to hire managers with competencies in highly specific areas, such as digitalisation, exporting, and the green transition. Vouchers are an increasingly popular instrument for business support for SMEs. Overall, vouchers emerge as an effective and flexible tool to facilitate SMEs' digital transformation, enhancing innovation capacity and skills acquisition.

The success of both of these measures – improving the managerial skills of existing owners/employees or facilitating the hire of managers – rests on two key elements: i) it is fundamental that training providers are high-quality, competent and can be effective in helping companies to improve the adoption of managerial practices; ii) it is essential that programmes deliver high uptake rates among entrepreneurs.

09. See, for example, evidence from India (Bloom at al., 2010), China (Cai and Szeidl, 2021) and Mexico (Bruhn et al., 2018).

To meet these criteria, it will be important to involve institutions that can credibly advertise such programmes with entrepreneurs to improve uptake. For example, involving European trade associations, who could play an important role in supporting the design of the programme, as well as the recruitment of eligible SMEs.

BOX 3

The UK's 'Help to Grow: Management' programme.

In 2021, the UK government funded a programme 'Help to Grow: Management' to facilitate access to managerial training for SME leaders. It aims to improve leadership, management skills, and productivity in SMEs. The programme is delivered by a network of business schools across the UK. It consists of fifty hours of structured learning, ten hours of one-to-one mentoring, peer learning, and access to an alumni network. The course covers the basic elements of management training, from strategy to marketing, people management and digital transformation, tailored to the specific needs of SMEs. The cost of the programme for participants is GBP 750, which represents 10% of its actual cost. The remaining 90% is paid by the national government. The programme is evaluated every quarter, and the results of the evaluation are made publicly available on the programme's website.

According to an early review that covered the programme from its start until March 2023, 52 business schools were accredited to run it and 5,648 SME leaders were recruited, 84% of which completed the programme. Uptake was initially lower than expected and improved after some adjustments to the eligibility criteria and marketing strategy. This indicates the importance of enacting policies to sustain uptake among SME leaders, typically reluctant to enrol in formal education programmes. Participants reported high levels of satisfaction concerning the programme's quality. Self-reported management and leadership skills significantly improved after its completion. Two-thirds of participants had already made changes to the way they manage, organise or operate their business within six months of completing the programme.

11. Improve the availability and working conditions of teachers.

Teachers should be supported in their professional development, recognised for their work and be rewarded appropriately. Member States should provide ongoing professional development opportunities for teachers to enhance their skills, stay up-to-date concerning best practices, and adapt to changing education needs.

Teachers should receive competitive salaries and benefits that reflect the value of their work and qualifications. Fair compensation can help to attract and retain talented individuals in the teaching profession. This is important given the current lack of teachers in the EU. Establishing clear pathways for professional recognition and career development, including the adoption of leadership roles and the acquisition of specialised certifications, could be considered.

Finally, working conditions should be enhanced by providing adequate resources, support staff, and administrative assistance to help teachers to balance their professional responsibilities effectively. Teachers also need to be provided with access to high-quality educational materials and technology tools to enhance teaching and learning in the classroom. The opportunities that new technologies, including AI, bring to education need to be explored and fully embraced.

12. Increase labour market participation.

The realisation of an effective and equitable Union of skills requires efforts to remove the obstacles that are currently reducing labour market participation, particularly by women. Additional investment in high-quality early childhood education and childcare infrastructure is needed. This concerns the expansion and improvement of childcare infrastructure, including building new childcare facilities, renovating (or expanding) existing examples, and ensuring that childcare facilities meet high quality standards. Furthermore, providing training, professional development opportunities and fair wages to childcare workers is vital to attract and retain qualified staff. Financial assistance to families to help cover the costs of childcare, for example by offering subsidies, tax credits or vouchers to make childcare more affordable for low and middle-income families could also be considered as possible levers to lower the barriers to entry into the labour market. The EU could consider including specific social conditions to EU financing in certain sectors or for companies, such as childcare plans.

ENDNOTES

i Scur, D., Sadun, R., Van Reenen, J., Lemos, R., Bloom, N., 'The World Management Survey at 18: lessons and the way forward', Oxford Review of Economic Policy, Volume 37, Issue 2, Summer 2021, p. 231–258.

ii OECD, OECD Skills Outlook 2013: First Results from the Survey of Adult Skills, 2013.

iii CEDEFOP, Skill mismatch in Europe, 2010.

iv Sadun, R., Van Reenen, R., Bloom, N., 'The Organisation of Firms across Countries" Quarterly Journal of Economics (2012), 1663–1705.

v Schivardi, F., & Schmitz, T. (2020). The IT revolution and southern Europe's two lost decades. Journal of the European Economic Association, 18(5), 2441-2486.

vi Bloom, N., Sadun, R. and Van Reenen, J., 'Americans Do IT Better: US Multinationals and the Productivity Miracle', American Economic Review, No. 102 (1), 2012, p. 167–201.

vii Sauvagnat, J., and Schivardi, F., 'Are Executives in Short Supply? Evidence from Death Events', The Review of Economic Studies, Volume 91, Issue 1, January 2024, p. 519–559.

viii CEPR, Lost Einsteins: How exposure to innovation influences who becomes an inventor, 2017.

ix Akcigit, U., Pearce, J., and Prato, M., Tapping into Talent: Coupling Education and Innovation Policies for Economic Growth, Review of Economic Studies, 2024.

x Becker, G., 'Investment in Human Capital: A Theoretical Analysis', Journal of Political Economy, Vol. 70, No. 5, Part 2: Investment in Human Beings, 1962, p. 9-49.

xi Beyer, R., and Smets, F., 'Labour market adjustments in Europe and the US: How different?', ECB Working Paper Series, No 1767, March 2015.

xii Koumenta, M., and Pagliero, M., 'Occupational Regulation in the European Union: Coverage and Wage Effects', British Journal of Industrial Relations, Volume 57, Issue 4, 2019. OECD, Occupational entry regulations (OER) and their effects on productivity in services, 2020.

xiii Miguelez, E., & Fink, C. (2013). Measuring the international mobility of inventors: A new database (Vol. 8). WIPO.

xiv Miguélez, E., & Moreno, R. (2014). What attracts knowledge workers? The role of space and social networks. Journal of Regional Science, 54(1), 33-60.

xv European Commission, Employment and social developments in Europe 2023, 2023.

xvi Idem.

xvii Di Pietro, G., Indicators for monitoring teacher shortage in the European Union: possibilities and constraints, 2023.

xviii Van den Borre, L., Spruyt, B., Van Droogenbroeck, F., 'Early career teacher retention intention: Individual, school and country characteristics', Teaching and Teacher Education, Volume 105, 2021.

xix European Commission, Pact for Skills: Annual Survey Results, 2024.

xx Jäger, S., Noy, S., and Schoefer, B., ‚Codetermination and Power in the Workplace', Journal of Law and Political Economy, 3(1), 2022.

xxi Carlana, M., 'Implicit Stereotypes: Evidence from Teachers' Gender Bias', The Quarterly Journal of Economics, Volume 134, Issue 3, p. 1163–122, 2019.

xxii Carlana, M., La Ferrara, E., and Pinotti, P., 'Goals and gaps: Educational careers of immigrant children', Econometrica 90.1, 2022, p. 1-29.

xxiii Breda, T., et al., 'How effective are female role models in steering girls towards STEM? Evidence from French high schools', The Economic Journal 133.653, 2023, p. 1773-1809.

xxiv Bloom, Nicholas, Aprajit Mahajan, David McKenzie, and John Roberts. 2020. "Do Management Interventions Last? Evidence from India." American Economic Journal: Applied Economics, 12 (2): 198–219.

xxv Bruhn, M., Karlan, D., & Schoar, A. (2018). The impact of consulting services on small and medium enterprises: Evidence from a randomized trial in Mexico. Journal of Political Economy, 126(2), 635-687.

3. Sustaining investment

The starting point

In the EU, productive investment is low and private sector saving is high, contributing to a substantial current account surplus[01]. Since the 2007-2008 economic and financial crisis, a sizeable and persistent gap has opened between private investment[02] in the EU and in the US. While private investment recovered quickly in the US after the 2007-2008 economic and financial crisis and continued expanding, it recovered only gradually in the EU[03]. The emerging gap in private investment between the US and the EU has not been offset by higher public investment, which also dropped after the crisis and remained persistently lower as a share of GDP in the EU compared to the US thereafter. Even though overall private investment accounts for more than 80% of total investment in the EU, public investment acts as an enabler of private investment and may have contributed to the private investment gap between the EU and the US, particularly in Member States most affected by the sovereign debt crisis. The decline in aggregate investment as a share of GDP, coupled with a persistently high savings rate, explains why the EU's current account position has shifted from broadly balanced to a large and persistent surplus since the 2007-2008 economic and financial crisis.

01. Productive investment is defined as gross fixed capital formation minus residential investment.

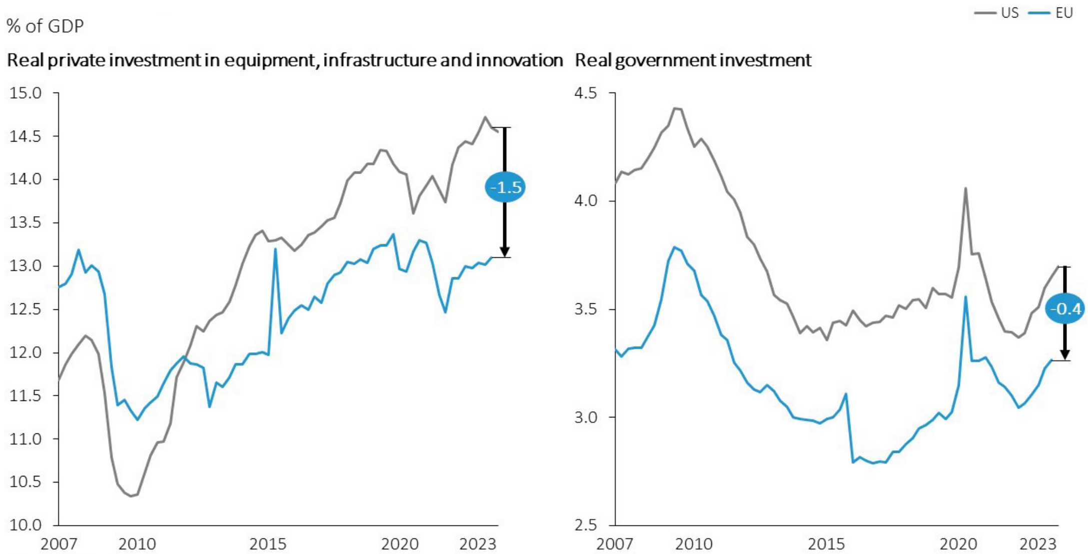
02. In this paragraph, all the references to private investments refer to productive private investment, defined as gross fixed capital formation minus private residential investment.

03. After a trough in 2010, it took the US a little over two years for productive investment (as a percentage of GDP) to exceed the 2008 level, while it took the EU nine years to reach the pre-crisis level.

TABLE OF ABBREVIATIONS

CCP	Central counterparty platform
CMU	Capital Markets Union
CSD	Central securities depository
CTP	Consolidated tape provider
ECB	European Central Bank
EIB	European Investment Bank
ESAP	European single access point
ESMA	European Securities and Markets Authority
GSE	Government-sponsored enterprise
IMF	International Monetary Fund
MFF	Multiannual Financial Framework
MiFIR	Markets in Financial Instruments Regulation
NCA	National competent authority
NGEU	NextGenerationEU
NPB	National Promotional Bank
SEC	Securities and Exchange Commission
TFP	Total factor productivity

FIGURE 1
Private and government investment



Source: Eurostat 2024 and OECD 2024

The failure of high EU savings to flow into productive investments in Europe comes down to less efficient financial intermediation. The persistent shortfall of investment vis-à-vis the US has occurred even though EU households save more than their peers in the US. In 2022, EU household savings were EUR 1,390 billion compared with EUR 840 billion in the US, reflecting the lower savings rate of US households, which is around a quarter of the EU level[04]. However, despite their higher savings, EU households have considerably lower wealth than their US counterparts, largely because of the lower returns they receive from financial markets on their asset holdings. Between 2009 and 2023, net household wealth increased by 151% in the US, compared with only 55% in the euro area[05]. This gap largely reflects the greater capacity of the US financial system to transform household savings into high-yielding investments, partly owing to the greater depth and efficiency of the US capital market. It also reflects the fact that US household wealth includes their pension wealth, while most European households' pension wealth takes the form of claims on public pay-as-you-go social security systems. Financial securities (listed shares, bonds, mutual funds and derivatives) directly held by households alone currently account for 43% of US household wealth, but only 17% of EU household wealth.[06].

Such low productive investment, together with an ageing population, has resulted in low growth in Europe. Moving forward, it would also hinder Europe's environmental and digital transition, its spending on R&I, and its planned increase in defence spending build-up. To meet the objectives laid out in this report, a minimum annual additional investment of EUR 750 to EUR 800 billion is needed, based on the latest Commission estimates[07] [see Figure 2]. However, the aggregate total is likely to be an underestimate, as it does not fully capture all the objectives laid out in this report, such as achieving economic security – by ensuring sufficient manufacturing capacity in critical technologies in the EU – and boosting skills. Moreover, other priorities, such as climate adaptation and environmental protection, are likely to require significant additional investment.

04. In 2023, the household savings rate was 3.2% in the US compared with 12.7% in the EU, in line with the corresponding averages in the past 20 years. Even though US household disposable income is about 50% larger than that of EU households, this does not compensate for the large gap between their savings rates.

05. Data from Federal Reserve Economic Data for the US and ECB Distributional Wealth Accounts for the euro area.

06. Idem.

07. These investment needs are expressed in annual terms for 2025 (a deflator is used in case of estimates for earlier years). Including both private and public investment. No distinction is made between public and private investment.

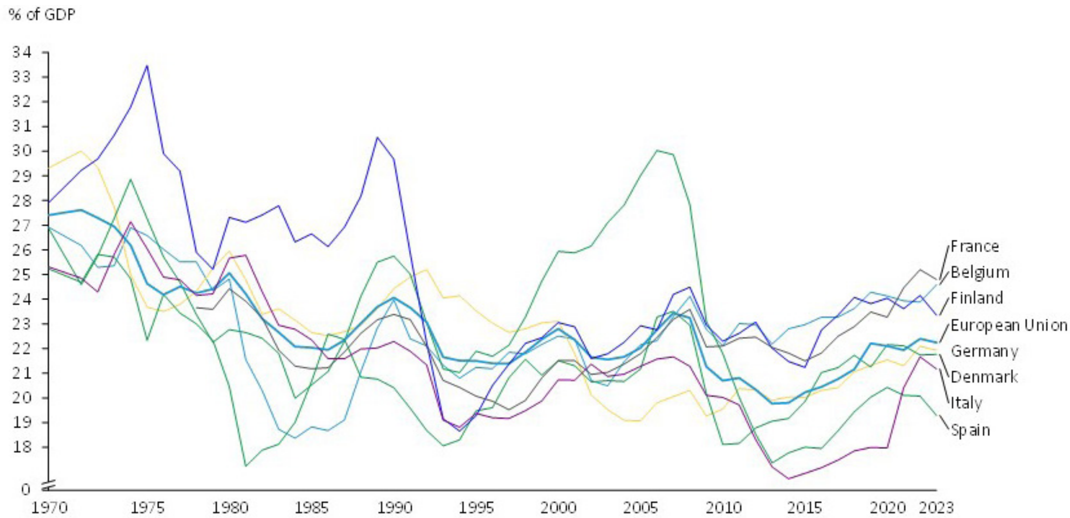
FIGURE 2
Annual additional investment needs (2025-2030)
In EUR billion

Investment category		2025-2030
Achieving the energy transition	Energy (including the deployment of clean technologies)	300
	Transport (including charging infrastructure)	150
	Total	450
Becoming a leader in digital technologies		150
Strengthening defence and security capabilities		50
Boosting productivity through breakthrough innovation		100;150
Total annual additional investment needs		**750;800**
ECB estimate		*771*

Source: Own calculations based on Commission estimates

These investment needs are massive and unprecedented from a historical perspective. Investment needs of EUR 750-800 billon for the EU correspond to 4.4%-4.7% of EU GDP (at the 2023 level). For comparison, investment under the Marshall Plan from 1948 to 1952 amounted to 1%-2% of GDP. Delivering such a massive increase in EU investment would require its GDP share to jump from today's 22% value to approximately 27%, reversing a multi-decade decline in most large EU economies [see Figure 3]. Europe has not had similar investment rates since the postwar period, when strong private investment led to a renovated capital base, at a time when government investment and social spending were considerably smaller.

FIGURE 3
Evolution of gross fixed capital formation



Source: World Bank national accounts data

The scale of the above investment needs raises fundamental questions for the European economy and economic policy. First, is such a massive increase in investment macroeconomically sustainable? Second, how can Europe unlock investment of the desired magnitude? The European Commission and the IMF Research Department, using their respective multi-country models, have simulated scenarios for investment packages in the EU and their macroeconomic implications [see Box 3 for a more detailed description]. Four main conclusions emerge from the analysis.

First, the investment drive increases European output with only limited and temporary inflationary pressure. The additional investment constitutes a positive demand shock, leading to an initial rise in inflation, accompanied by a lasting increase in output without long-term inflationary pressure. Across the various scenarios, output is projected to increase by around 6% within 15 years in response of additional investment in the magnitude of 5% of GDP (compared to a baseline without the investment package). Since supply adjusts more gradually than demand (the build-up of additional capital takes time), the transition phase implies some inflationary pressure, and a temporary decline in net exports. These inflationary pressures dissipate over time.

Second, even if capital markets become more integrated, improved market financing is unlikely to unlock investment of the targeted amount. Historically in Europe, around four fifth of productive investment has been undertaken by the private sector, and the remaining one fifth by the public sector. To unlock private investment in the order of magnitude of 4% of GDP through market financing alone would require a reduction in the private cost of capital – by approximately 250 basis points in the European Commission model. Although improved capital market efficiency (e.g. through the completion of the Capital Markets Union) is expected to reduce private financing costs, the reduction will likely be substantially smaller. Fiscal incentives to unlock private investment appear therefore necessary to finance the investment plan, in addition to direct government investment.

Third, fiscal interventions will have some impact on public finances. Increases in investment subsidies or corporate tax reductions to stimulate private investment will come with fiscal costs. Direct public investment expenditures will also need to increase. They represent one fifth of the investment package in some scenarios, while accounting for a larger share – up to 50% – in others. If the investment-related government spending is not compensated by budgetary savings elsewhere, government primary balances as a share of aggregate GDP in the EU will temporarily deteriorate before the investment plan fully exerts its positive impact on aggregate output (and the simulus is gradually withdrawn), with the primary surplus returning to its baseline.

Fourth, a sizable increase in total factor productivity, associated with the investment package and complementary reforms, would alleviate the adverse effects on public finances. The aim of the plan is to contribute to making the EU more innovative and competitive, with the goal of reducing the US-EU gap in aggregate total factor productivity (TFP), which is currently over 20% higher in the US compared to the EU, according to IMF estimates[08]. The implementation of the reform presented in this report will progressively lead to a significant increase in EU TFP, narrowing the EU's productivity gap relative to the US. A sizable increase in EU total factor productivity will improve the government budget surplus, significantly reducing the transitional costs of implementing the plan (increase fiscal space), provided that the resulting additional government revenue is not spend fully on other purposes. For example, a 2% increase in the level of TFP within ten years (a modest increase given the current 20% US-EU TFP gap) would already cover up to one-third of the fiscal spending on investment (investment subsidy and public investment) required to implement the plan. Note, however, that given the gradual increase in potential output (as TFP may rise slowly and capital takes time to accumulate), positive tax base effects will materialise more gradually than the initial expenditure increase.

THE ROOT CAUSES OF LOW INVESTMENT FINANCING IN EUROPE

→ Fragmented and undersupplied capital markets

Capital markets in Europe remain fragmented. While the Commission has introduced several measures to reduce fragmentation in EU capital markets [see Box 1], three main fault lines remain. First, the EU lacks a single security market regulator and a single rulebook for all aspects of trading, and there is still high variation in supervisory practices and the interpretation of regulations. The US, by contrast, has had a single supervisor since the 1930s, when the Securities and Exchange Commission (SEC) was established. Second, the post-trade environment for clearing and settlement in Europe is far less unified than in the US. In the US, there is a single central counterparty platform (CCP) and a single central securities depository (CSD) for all equity trades, while in Europe there are more than 20 CCPs and CSDs for equities alone, and different platforms use the services of different CCPs or CSDs. As a result, cross-border transactions are more complex and costlier than domestic transactions, hindering multimarket trading. Third, despite the recent progress made on withholding tax, tax and insolvency regimes across Member

08. See: IMF, 'Europe: Soft landing in crosswinds for a lasting recovery', Regional Economic Outlook, 2024.

States remain substantially unaligned. Different tax regimes that apply to different securities and/or sets of investors segment capital markets – a problem that also applies in the US for municipal bonds, which feature 'tax clienteles' keen on specific securities. Significant differences also exist across countries in thresholds for insolvency, rules for proceedings, priorities of claims, and restructuring mechanisms.

BOX 1

Recent progress in EU capital market integration

Significant progress has been in a number of areas fairly recently, in particular:

- Centralised access to standardised information on EU companies and investment funds is crucial for market participants, but was not existent in the EU (in the US already since 1996). An agreement was reached last year to create a single point of access to public financial and sustainability-related information about EU companies and EU investment products (ESAP). ESAP will be single location where all these data will be accessible, facilitating their consultation and comparison by all investors. However, the timeline is very slow: the development of a database similar to EDGAR should occur by 2028, and the completion of the ESAP would only be achieved in 2030.
- Another precondition for an integrated security market is that all investors can access security-level information about how and under which conditions it is traded. In the US, such a system already existed, but because such consolidation of market data did not exist in Europe, multimarket trading in the EU is more complicated and costly. However, in June 2023 the European Parliament and the Council agreed on the review of the Regulation governing rules about the structure of the markets in financial instruments ('MiFIR Review'). The review creates a mandatory framework for the so-called 'consolidated tape provider' (CTP), which will bring together the prices, trade times and volumes for all financial instruments from hundreds of execution venues across all Member States into a single stream of information. In 2025, the CTP will be implemented for bonds and then for stocks, and in 2026 (at the earliest) it will start to include derivatives.
- Last year, a political agreement was reached to introduce a common system to withhold tax at source, which is important to facilitate cross-border investment. The agreed directive will make it easier and faster for investors to claim back excess withholding tax that they have been subject to, and it also aims to combat complex tax abuse schemes by improving reporting standards and the processes around withholding tax refunds. Overall, these standardised procedures are expected to save investors around EUR 5.17 billion each year and not only facilitate cross-border investment within the EU, but also investment in the EU from third countries.
- Europe still lacks a sufficiently deep and liquid primary market for innovative companies, but steps have been taken with the Listings Act. This act will improve access to stock markets by reducing the administrative burden of listing, refine the listing procedure, and balance the regulatory and compliance costs for companies wishing to list, and for companies already listed. This Act also seeks to reduce the cost of the prospectus and proposes to have a standardised format. Moreover, it exempts secondary security offerings by companies already admitted to trading on a regulated market or on an SME growth market from the obligation to issue a prospectus. It is estimated that EU listed companies will save approximately EUR 100 million a year from lower compliance costs, with companies saving EUR 67 million each year from simpler prospectus rules alone. Finally, the Listings Act establishes common rules for companies seeking to have their shares traded on a growth market for SMEs and other multilateral trading facilities, regarding multiple vote share structures. The possibility to list with the more flexible governance structure allowed by dual-class share structures with different voting rights may enhance the attractiveness of European stock exchanges as an IPO route.

In the future, accessing public stock markets via the EU-wide listing process enabled by a growth prospectus may become even more attractive for innovative European companies if this were combined with the adoption of the new EU-wide legal status for innovative ventures [see the chapter on innovation]. This would include a single EU business identity and company charter, as well as registration and the portability of authorisations across EU Member States.

At the same time, the volume of finance flowing in capital markets is constrained by the underdevelopment of the second and third pillars of the pension system in most EU Member States. Retail investment in the EU is relatively expensive, with fees 40% higher than for other investor classes, which has made investments in financial assets rather unattractive for households. However, a type of retail participation to security markets that has proven effective in several countries is through second pillar and third pillar pensions[09]. Such investments are needed to ensure adequate income for retirees, but can also significantly increase the provision of capital by households via managed funds. However, pension funds are significantly underdeveloped in large parts of the EU. In 2022, the level of pension assets in the EU was only 32% of GDP, while total pension assets amounted to 142% of GDP in the US, and to 100% in the UK. Moreover, EU pension assets are highly concentrated in a handful of Member States with more developed private pension systems. The combined share of the Netherlands, Denmark and Sweden in EU pension assets amounts to 62% of the EU total. The relatively low level of pensions is a missed opportunity for Europe, as pension funds – by design – are intended to transform current savings into future consumption through long-term investments [see Box 2].

As for insurers, a political agreement on the revision of the Solvency II framework is in place since the end of last year. It covers additional incentives for insurers to make long term investment and reduces capital requirements.

BOX 2

Sweden's retail market

While European companies are struggling to acquire retail investment, Sweden has managed to induce a large share of its citizens to invest. Partly as a result of this, Sweden has a deeper capital market, relative to its GDP. This high level of retail investment has also translated into a booming IPO market with more than 500 IPOs over the past ten years, which is more than Germany, France, the Netherlands, and Spain combined. An important driver of the deep capital markets are the pensions funds that have large holdings of domestic equities. There is a so-called Pension Premium whereby 2.5% of pensionable income is automatically allocated to this Pension Premium, where savers can choose how these funds are then invested. These pension funds are also important funders of IPOs, contributing to creating a favorable climate for entrepreneurs and innovators. However, it is not only pension funds that lead to high retail participation. Swedish savers can also invest in small and midcaps via an investment savings account (Investeringssparkonton – ISK) that is beneficially taxed and has almost no reporting requirements. The depth of the Swedish capital market has also translated into better market performance, outperforming other stock market indexes. Finally, the depth of its capital markets has allowed Sweden to keep innovative companies that are homegrown within its own productive system.

→ Excessive reliance on banks relative to capital markets

Europe relies excessively on debt financing via banks. At least since the 1960s, Europe has relied much more on banks than on securities markets to fund its companies[10]. The ratio of bank assets to GDP fluctuated around 70% in both the US and European countries from 1880 to the 1960s, but started diverging thereafter [see Figure 4][11] The mirror image of this bank dominance can be seen in the composition of EU companies' funding. Even though the role

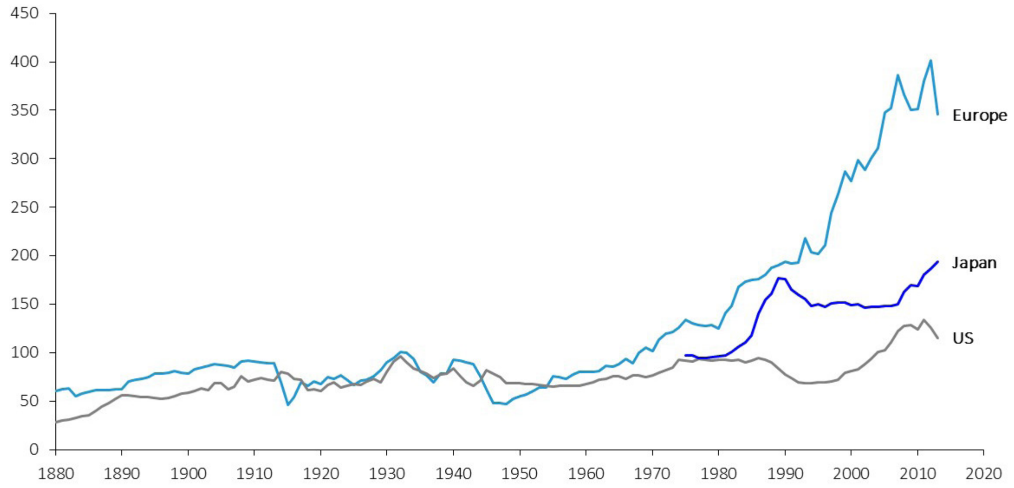
09. First pillar pensions refer to schemes funded through public funds and can be in the form of social assistance, separate targeted retirement-income programmes, basic pension schemes and minimum pensions within earnings-related plans. Second pillar pensions refer to work-related (occupational) pension schemes and is meant to ensure that people who retire have a retirement income relatively similar to their earnings before retirement. Third pillar pensions schemes consist of individual pension products. Such products are mostly used by self-employed or employees that are somehow not participating in a collective pension scheme.

10. Before the 2007-2008 economic and financial crisis, there was not a consensus view on whether bank-based financing or market-based financing was better. Especially when there is a high presence of SMEs (Mittelstand), relationship banking is a useful method to ensure adequate access to finance. However, for young, innovative companies with little collateral, bank-based debt financing could be much less appropriate (and market-based funding could be preferred).

11. In the late 1980s, this ratio rose to about 180% of GDP in Europe and Japan. In Europe, it increased further to nearly 400% today, while in the US it remained flat at around 100%, and in Japan at around 200%, respectively.

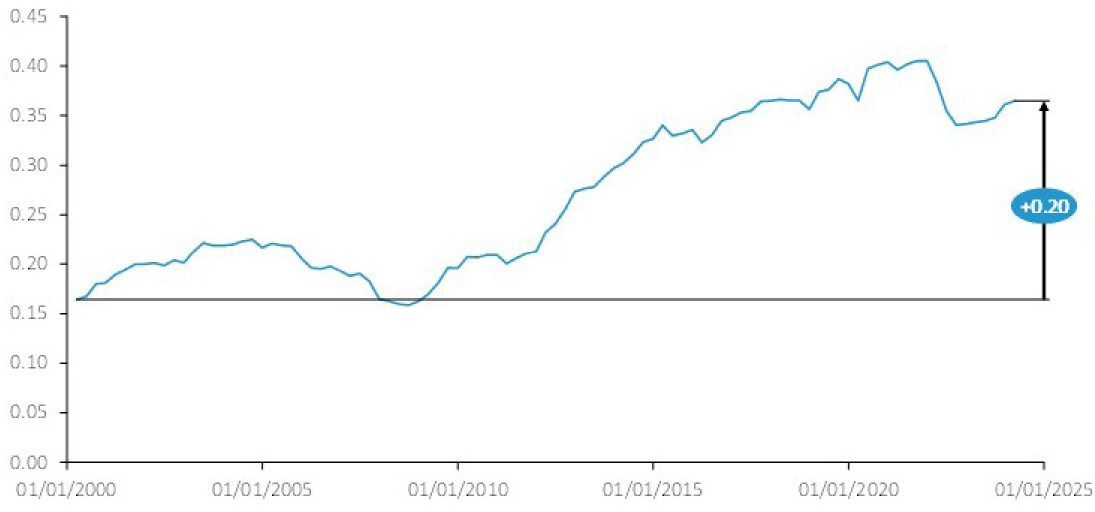
of non-bank finance has increased over time – with a rising ratio of bonds to loans in external finance – companies in the EU continue to rely much more on bank lending [see Figure 5]. Within Europe, reliance on capital markets is much greater in some Member States, such as Scandinavian countries and the Netherlands, than in others, including Germany, Italy and Spain. However, even in the Member States where capital markets are most developed, their role in financing the real economy is lower than in the US and the UK.

FIGURE 4
Total bank assets to GDP: Europe, the US and Japan
%



Source: Langfield and Pagano, 2015

FIGURE 5
Bond finance ratio



Source: ECB (2024)

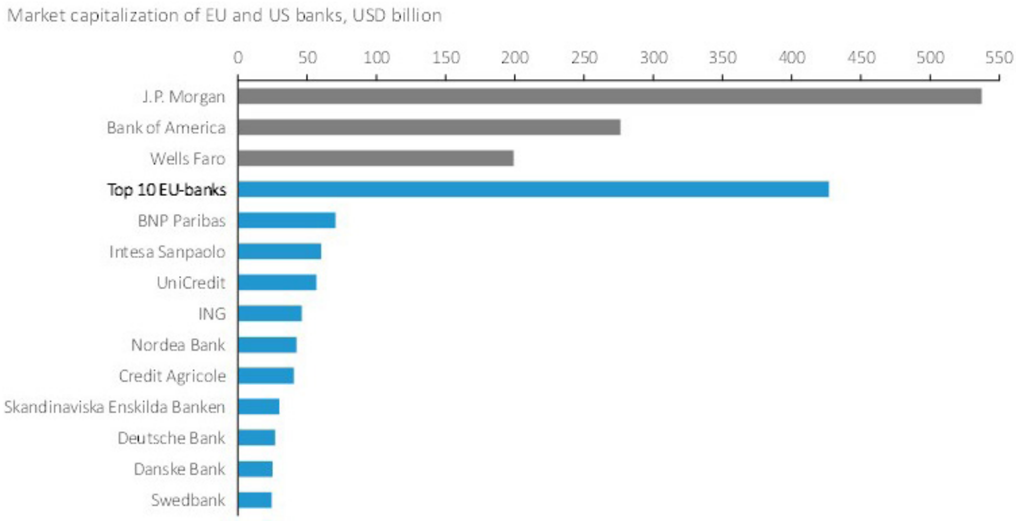
Within Europe, reliance on capital markets is much greater in some Member States, such as Scandinavian countries and the Netherlands, than in others, including Germany, Italy and Spain. However, even in the Member States where capital markets are most developed, their role in financing the real economy is lower than in the US and the UK.

Generally, banks are not best placed to finance innovation, which requires a greater presence of patient and risk-tolerant equity investors. Banks typically operate under a heavy burden of prudential regulation and lack the expertise to screen and monitor innovative companies, especially compared to angel financiers, venture capitalists and private equity providers. Innovative scale-ups tend to have highly volatile cash flows (many do not generate positive cash flows for several years) and, therefore, feature a high likelihood of bankruptcy even if they take modest amounts of debt. Moreover, their collateral is often largely intangible, being formed by patents and the human capital of highly skilled employees. Hence, it is difficult for banks to value it, and rely on it as a hedge against their credit risk. A financial structure that favours innovation should, therefore, not be dependent on bank financing. At a minimum, it should be at least partly equity-financed and/or have long-term debt financing. **One reason why transformational technological innovations have tended to occur in countries with market-based financial systems is that these systems tend to foster venture capital companies**[i].

→ Specific constraints on the EU's banking sector

EU banks' ability to finance major investment is constrained by lower profitability, higher costs, and smaller scale than their US counterparts. There is a strong relationship between banks' profitability and their ability to finance the economy. The less profitable banks are, the less likely they are to provide risk capital to finance major projects. There is a persistent gap in the return on equity between EU and US banks, driven largely by US banks' higher net fee and commission income (a function of US banks being more active in capital markets and benefitting from a single US capital market). The EU banking sector also faces higher regulatory compliance costs[ii] and is more fragmented, owing to an incomplete banking union. This fragmentation means that EU banks cannot match the scale of their US counterparts. The largest US bank (JP Morgan) has a larger market capitalisation than the ten largest EU banks taken together (and the second and third-largest US banks are larger than any of their EU peers) [see Figure 6].

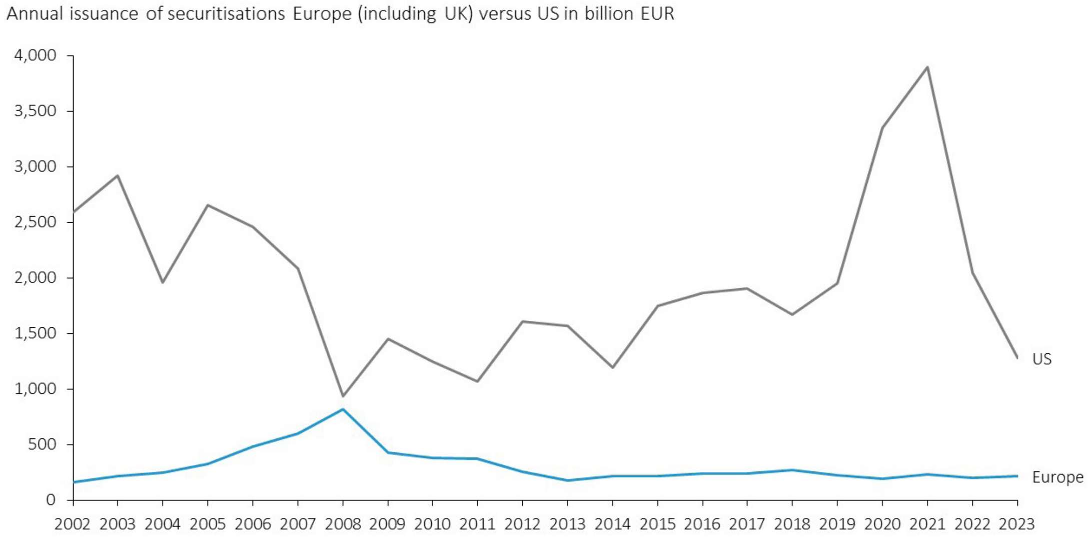
FIGURE 6
Bank market capitalization



Source: Bloomberg, March 2024.

Moreover, banks in Europe cannot rely on securitisation to the same extent as their US counterparts. On the one hand, securitisation makes banks' balance sheets more flexible by allowing them to transfer some risk to investors, release capital and unlock additional lending. on the other hand, it supports the development of capital markets. In the EU context, securitisation could also act as a substitute for the lack of capital market integration by allowing banks to package loans originated in different Member States into standardised and tradeable assets that can also be purchased by non-bank investors. This process would help to channel non-bank finance across EU financial markets. So far, the EU securitisation market is far less developed than in the US. EU yearly issuance of securitisations stood at just 0.3% of GDP in 2022, while in the US it amounted to 4% of GDP [see Figure 7]. These differences arise partly from a stricter EU regulatory framework in terms of prudential requirements and transparency and disclosure rules, which go beyond requirements in the US. Second, the EU lacks the equivalent of US government-sponsored enterprises (GSEs). GSEs have been crucial in fostering the standardisation of mortgage products across American banks and States, reducing transactions costs, lowering credit risks for both banks and buyers, and building a large and deep market. However, one should not forget that the dismantling of the market and banking regulation before the 2007-2008 economic and financial crisis was one of the main causes of the crisis. Therefore, to fully exploit the benefits of securitisation for capital market development, vigilant market supervision and prudent banking regulation should remain in place.

FIGURE 7
Securitisation volumes EU versus US



Source : AFME

Furthermore, the EU has a wide array of prudential regulations derived from the international standards set by the Basel committees. Prudential regulation is crucial in safeguarding financial stability. However, the EU has been accused of 'gold-plating' the Basel framework, leading to an overly restrictive and cautious regulatory environment for banks. At the same time, the US has been delaying implementation of the new Basel framework ('Basel III'). Last month, the Commission announced it would also delay part of the Basel III implementation.

Last but not least, the fragmentation of European banking along national boundaries owes much to the incomplete implementation of the Banking Union. While the euro area has unified bank prudential supervision, it has so far failed to implement a common deposit insurance and the single resolution authority lacks a financial backstop, complicating the resolution of large systemic banks. Absent these reforms, European banks with cross-country operations risk facing regulatory ring-fencing at times of turmoil, which would fragment their internal capital markets along national lines as indeed was the case during the 2011 sovereign debt crisis. Banks have little incentive to engage in cross-border operations if the transfer of resources from healthy to impaired subsidiaries will be prevented in a crisis. Yet, enabling cross-border banks to engage in international risk-sharing on a sufficiently large scale is of crucial importance for the integration of European capital markets. Hence, completing the Banking Union would mitigate the current strong 'home bias' of EU banks, and the fragmentation of credit markets along national boundaries that so far has been a hallmark of the European financial system. A minimal reform in this direction might be limited to a small set of banks with cross-border operations, by creating a set of cross-border banking norms specifically suited only for these banks, intended to shield them from regulatory ring-fencing and entrusting their possible resolution to a European resolution authority.[iii] Banks with a truly continental span of operations would not only better support European companies that operate in multiple EU Member States, but they are also the necessary players on integrated capital markets, in underwriting securities, taking companies public, and assisting them in M&A operations. Hence, completion of the Banking Union would be complementary to making progress towards the Capital Markets Union in Europe.

→ A lack of viable projects

While the inefficiency of capital markets is a key reason that EU savings do not flow into productive investments, another important factor is barriers to innovation and firms' growth that limit demand for financing. As explained in the previous chapters, various institutional features of the EU lead to lower demand for financing across different categories of investments. The incomplete Single Market in goods and services prevents innovative, high-growth companies from expanding in the EU, leading them instead to seek out investment from US venture capitalists and scale up in the US market. Fragmented equity markets also limit their exit options in Europe – and, therefore, potential financial returns – creating further incentives to scale up in the US from the start. All this leads to lower volumes of risk capital being deployed in Europe. At the same time, Europe's static industrial structure leads to mature companies investing much less in new technology. Indeed, the productive investment gap between the US and the EU is driven by machinery and equipment investment, and in particular ICT equipment and intellectual property products. This lack of dynamism in Europe entrenches established bank-company relationships and leads to lower corporate demand to develop new forms of finance. Finally, bureaucratic delays in Europe related to permitting regulation lead to slower infrastructure deployment than would otherwise be the case. As a result, pressure on the financial system to increase capacity is diluted. Historical examples, such as the development of the US railroads or the need to finance municipal infrastructure in the UK in the 19th century, suggest that capital markets tend to grow when major transformative projects exceed the capacities of the banking system[iv].

→ Inefficiencies in EU public financing of investment

Required investment in Europe are not constrained only by capital market fragmentation, but also by the limitations of the EU budget and by the planned repayment of NextGenerationEU (NGEU) bonds. The EU's annual budget is small, amounting to just over 1% of EU GDP, while Member States' budgets are collectively close to 50%. It is also not allocated towards the EU's strategic priorities. Despite attempts at reform, the shares of the 2021-2027 Multiannual Financial Framework (MFF) allocated to cohesion and the common agricultural policy are still 30.5% and 30.9%, respectively. The decision to create NGEU in 2020 strengthened the focus on green and digital investment, and allowed the overall budget to reach EUR 2 trillion – with the additional EUR 807 billion funded by EU borrowing, which will be repaid until 2058[12]. Repayment will start in 2028 and account for EUR 30 billion per year. The political agreement reached in 2020 envisaged that the repayment of both interest and principal on the grant component of NGEU borrowing would be financed by new own resources. The Commission tabled a proposal to this end in June 2023. However, in the absence of a decision on new own resources, effective spending power at the EU level would be mechanically reduced by interest and principal payments. Member States would have to increase their GNI-based[13] contributions to maintain current levels of spending or spending cuts would have to be applied to programmes under the next MFF. However, any possible increase in resources or delay in repayment should be accompanied by reform of the EU budget.

Where the EU does spend collectively, its effectiveness is hampered by fragmentation, complexity and rigidity. First, financing instruments are fragmented and lack focus on strategic priorities. The EU has close to 50 spending programmes which prevents the EU budget from reaching sufficient scale for larger projects at pan-European level. It also leads to duplication and overlaps, as the same policy area can be funded by a multitude of EU programmes managed by the Commission or by Member States. Second, access to EU public financing is complex and overly bureaucratic for private actors. For example, the EU has several funds to support clean tech, deep and digital technologies, but these funds are spread across various spending programmes and follow different rules. Third, the EU budget is much more rigid than national budgets. The MFF is proposed more than two years before implementation and sets the Union budget for seven years. With the inherent delays in programming, actual funding typically reaches the ground nearly five years after conception. In addition, the MFF delineates specific spending over key categories and transfers between different headings or different programmes are difficult, offering limited room to accommodate new policy priorities or respond to unforeseen developments.

The capacity of the EU budget to mobilise private investment through risk-sharing instruments is constrained by too little appetite for risk. The largest risk-sharing instrument currently in place is the InvestEU programme that seeks to promote investments in areas considered of strategic interest for the EU. The basis for this programme is an EU budget guarantee that can be used to reduce risks for public and private investors. The most important implementing partner of InvestEU is the EIB Group, which operates alongside National Promotional Banks (NPBs) and other international financial institutions. However, in the implementation of InvestEU, the EIB Group remains mostly focused on the lower-risk scope of investment. While there has been a cautious attempt to move the InvestEU guarantee to riskier products, InvestEU is still insufficiently oriented to risk absorption, which is where the highest added value of public support lies. In terms of NPBs, operating under the InvestEU framework has brought a further

12. The loans will be repaid by the borrowing Member States, while the grants will be repaid by the EU budget and to that end the Commission has proposed additional own resources.

13. Gross National Income (GNI)-based contributions from Member States.

alignment of national policy objectives with EU priorities, standardisation of practices and increased cooperation. Yet, a large share of the overall operations of NPBs is not sufficiently focused on the most innovative sectors.

→ The case for a common European safe asset

It is unquestionable that the issuance of a common safe asset would make the CMU much easier to achieve and more complete. First, it would facilitate the uniform pricing of corporate bonds and derivatives by providing a key benchmark, in turn helping to standardise financial products across the EU and making markets more transparent and comparable. Second, it would provide a type of safe collateral that can be used in every country and in all market segments, in the activities of central counterparties and in interbank liquidity exchanges, including on a cross-border basis. Third, a common safe asset would provide a large, liquid market that attracts investors globally, leading to lower costs of capital and more efficient financial markets across the EU. This asset would also form the basis of international euro reserves held by other central banks, enhancing the role of the euro as a reserve currency. Fourth, it would provide all European households with a safe and liquid retail asset accessible at a common price, reducing information asymmetries and 'home bias' in the allocation of retail funds.

Some joint funding of investment at the EU level is necessary to maximise productivity growth, as well as to finance other European public goods. The more that governments implement the strategy laid out in this report, the greater the increase in productivity will be, and the easier it will be for governments to bear the fiscal costs of supporting private investment and of investing themselves. Joint funding for specific projects will be key to maximise the productivity gains of the strategy, such as investing in breakthrough research and infrastructures to embed AI into the economy. At the same time, there are other public goods identified in this report – such as investing in grids and interconnectors, and financing joint procurement of defence equipment and defence R&D – that will be undersupplied without common action and funding. Finally, for Member States to converge more closely in their policies – be it the Single Market or more generally in the policies described in this report such as climate, innovation, defence, space, education – both regulation and incentives will be required. Incentives will also require common funding. However, if the strategy is not fully implemented and productivity growth does not pick up, a broader issuance of public debt may be needed to make funding of the transitions a more realistic proposition.

The issuance of common safe assets to fund joint investment projects could follow existing templates – however, it would have to be accompanied by all the safeguards that such fundamental step would entail. The use of a common safe asset has a well-established precedent with the funding of the NGEU. The present circumstances are equally serious, even if less dramatic. But issuing such assets on a more systematic basis would require a stronger set of fiscal rules which ensure that an increase in common debt is matched by a more sustainable path of national debt. In this way, all EU Member States could contribute to such an asset without prejudging the sustainability of their public debt. Issuance would also have to remain mission and project specific.

BOX 3

Macroeconomic effects

Carrying out the investment needs for decarbonisation, digitalisation and defence outlined above will require a sizeable increase in investment, amounting to nearly 5% of annual EU GDP, as indicated in Figure 2. This box provides model simulation results on the macroeconomic effects of such a large-scale investment plan during and following its implementation.

The European Commission and the International Monetary Fund's (IMF) research department simulated the macroeconomic effects over time of a surge in EU investment of the proposed scale[14]. The European Commission uses a two-region (euro area, rest of the world) version of the QUEST model[v]. The IMF uses the IMF's G20 model[vi]. Both are structural, general-equilibrium, macroeconomic models of the global economy, where households and companies in each country interact dynamically under systematic government policy

14. I thank the European Commission and the IMF for agreeing to undertake this work. At the European Commission, the model-based analysis was conducted by Philipp Pfeiffer and Lukas Vogel and at the IMF by Jared Bebee and Rafael Portillo. I am also deeply grateful to Pierre-Olivier Gourinchas, the Fund's economic counsellor.

characterising the fiscal and monetary authorities. Inflation in these models temporarily rises when aggregate demand exceeds potential output. The model simulations characterise the response of endogenous variables to exogenous shocks (e.g. discretionary changes in policies or technology).

Key assumptions for results

Both models include public and private investment. While public investment is under the direct control of government, private investment is an endogenous variable that responds to changes in the return to capital and its private cost. An overall increase in investment could then result from: (i) a direct increase in public investment; (ii) fiscal incentives to stimulate private investment (through government subsidies to investment or a reduction in corporate taxation); or(iii) a reduction in market investment financing costs (e.g. a reduction in the equity premium). Regardless of the trigger (i-iii), additional investment translates into an increase in aggregate demand in the short term, leading to a temporary rise in inflation and deterioration in the trade balance. In the medium to longer term, this demand-side effect is followed by capital accumulation, leading to a persistent increase in potential output and per capita income. While overall investment and long-term supply effects are similar, the composition of the investment package and the drivers of the private investment increase matter for the quantitative impact on public finances. The government primary deficit tends to be less pronounced when private investment is more prominent in the overall package and when lower market financing costs contribute more significantly to the increase in private investment than fiscal incentives. In addition, an increase in total factor productivity (TFP) as a consequence of investments and of the proposed reforms broadens the government's fiscal space (in particular through tax base growth) as long as the additional tax revenue is not earmarked for other expenditure (government purchases, transfers).

Different scenarios

In both the European Commission and the IMF simulations, the investment package is composed of public investment and private investment, the latter incentivised through investment subsidies. Different assumptions about the investment composition (mostly private investment, or more balanced) have been considered. The IMF simulation adds a 20 basis-point reduction in the private cost of capital. The European Commission simulates an increase in investment of about 5% of ex ante GDP over a period of 10 years, after which the stimulus is gradually withdrawn.

Results

In the European Commission's simulation, output takes some time to increase, in line with the gradual response of private investment and the gradual build-up of the additional capital stock. In response to the investment package, real GDP rises by 2% by 2030 and eventually converges to a 6% increase after 15 years. The push to aggregate demand, combined with a more gradual expansion of supply (potential output), causes an initial rise in CPI inflation, which remains around 1.2 percentage points above baseline inflation during the first five years of the implementation of the investment package, before returning to and reaching baseline after approximately 15 years, in conjunction with increased potential output and the phasing-out of stimulus. During the initial five years of the plan's implementation, without compensating budgetary measures, the government primary balance worsens and then gradually returns to the baseline by year 20, in response to positive tax base effects and the gradual withdrawal of the investment stimulus. When the simulation also allows for a 2% increase in EU total factor productivity (TFP), gradually building up over the first ten years after the start of the plan's implementation, output grows faster and the deterioration of the government primary balance is mitigated by one percentage point of GDP after the full materialisation of the TFP gain. The assumption of a 2% increase in the TFP level over ten years is (highly) conservative given the plan's objectives of reducing the US-EU gap in aggregate total factor productivity, which is currently more than 20% higher in the US than in the EU, according to IMF estimates.

The IMF simulations combine the large-scale increase in investment with a 2% rise in TFP over 10 years, similar to the assumptions in the European Commission analysis. Output increases by 1.5% in the three years following the plan's start and by 5% at the end of the first 10 years. The initial rise in EU inflation is contained, reaching only half a percentage point 5 years after the plan's implementation begins.

Objectives and proposals

Europe is faced with an unprecedented need to raise investment at both massive scale and rapid speed. In its current state, the European financial system is unlikely to succeed in meeting these investment needs owing to excessive dependence on banks, regulatory burdens on bank finance and a lack of equity and bond financing. At the same time, as currently designed, the EU budget is less effective that it could be both at financing public investment directly and at leveraging private investment through risk sharing.

The key objectives for the EU are, therefore, as follows:

- Reduce fragmentation of the Single Market removing barriers for innovation, company growth and large infrastructure projects in Europe – thereby, increasing demand for risk capital and for higher volumes of finance through capital markets.
- Reduce dependence on bank financing in Europe by accelerating the development of the CMU, as well as increasing flows into capital markets by encouraging increased enrolment in private pension plans.
- Expand bank finance, overcoming excessively restrictive regulation on securitisation, and where necessary revisit prudential regulation to have a strong and competitive banking system.
- Make more effective use of the EU budget by focusing funding on strategic priorities, simplifying the administrative burden, improving the leverage of the EU budget and of the overall EU financial architecture to support investment.
- Introduce regular and sizable issuance by the EU of a common safe and liquid asset to enable joint investment projects among Member States and help integrate capital markets.

These high-level objectives are translated into concrete policy proposals set out below.

1. Reduce capital market fragmentation

A. Introduce a European Security Exchange Commission

- As a key pillar of the CMU, ESMA should transition from a body that coordinates national regulators into the single common regulator for all EU security markets. To this purpose, ESMA should be entrusted with exclusive supervision over: (i) large multinational issuers (i.e. those with subsidiaries in various EU Member State jurisdictions and revenue, and/or total assets above a certain threshold, a natural identifying criteria would be issuers belonging to major indices such as the CAC40, DAX, Euro Stoxx 50, FTSE MIB, IBEX 35, or else – if one wants to be more encompassing – the STOXX Europe 600); (ii) major regulated markets with trading platforms in various jurisdictions, such as EuroNext (where ongoing supervision would be done by ESMA, while sight visits might be done by joint supervisory teams with national competent authorities (NCAs, such as Consob, AMF, BaFin, CNMV, CONSOB, etc.); and (iii) central counterparty platforms (CCPs).
- An essential step to transform ESMA into a regulatory and supervisory agency similar to the SEC is to modify its governance and decision-making processes along similar lines as those of the ECB Governing Council, so as to detach them as much as possible from the national interests of EU Member States. Currently, ESMA's governing bodies are composed of national competent authorities, plus the Chairman and some non-voting members. To enable ESMA to take swift and decisive action in sensitive areas, it would be important to add six independent and highly-qualified individuals, including the Chair, to ESMA's Management Board, as proposed by the Letta report. Another all-important step in this transition is to shift EU security market legislation to a principles-based approach, outlining the key strategic policy choices of co-legislators, while delegating technical work to ESMA, and enhancing its powers to develop and change technical rules and streamline their adoption; and increasing its funding to enable it to efficiently carry out its regulatory and supervisory tasks.

- To overcome likely opposition, the EU regulator will have to share supervision with national regulators and elicit their cooperation along lines similar to what the ESM does with national central banks in euro area bank supervision. Turning national security market regulators into subsidiaries of a single, EU-wide one will face fierce resistance, not only by the national bureaucracies that will feel directly displaced, but also by trading platforms and market participants who draw sizeable rents from the status-quo fragmentation, as suggested by both theory and evidence[vii]. Therefore, tactically wise steps would be to: (i) leave the supervision of purely local issuers to national regulators, as done for the prudential supervision of smaller banks within the Eurosystem; (ii) start from the supervision of issuers and market structures, and subsequently turn to that of mutual funds, which is likely to be more controversial; (iii) create Joint Supervisory Teams between ESMA and national supervisors to supervise significant issuers and market structures, and mechanisms to ensure a constant and timely information flow among them.

B. Reduce regulatory fragmentation to deepen the CMU

- Harmonise the insolvency framework. Investors cannot be envisaged to invest cross-border if there is no cross-border certainty about what happens if a company goes bankrupt. Therefore, further steps have to be taken towards a common, harmonised insolvency framework.

- Eliminate any taxation obstacles to cross-border investing in the EU. EU citizens should be able to invest in other Member States without complex taxation procedures, effectively resulting in double taxation. Preferably, the taxation related to capital investments should be synchronised as much as possible to reduce fragmentation in terms of incentives.

- Foster centralisation in clearing and settlement. An important step towards the integration of the security market in the EU would be to create a single central counterparty platform (CCP) and a single central securities depository (CSD) for all security trades. However, as for smaller clearing houses, the benefits of consolidation may not be so large. A practical pathway towards consolidation may also be in this case to start consolidating the largest CCPs and CSDs, and then count on their gravitational pull to attract smaller ones.

C. Encourage retail investors through the offer of second pillar pension schemes where the successful examples of some EU Member States can be replicated.

The EU must better channel household's savings to productive investments. The easiest and most efficient way to do so is via long-term saving products (pensions). As discussed, pension funds are significantly underdeveloped in the EU, and EU pensions assets are highly concentrated in just a few Member States. The Netherlands, Denmark, and Sweden's combined shares of EU pension asset amounts to 62% of the EU total. In these Member States, the relatively high participation in second-pillar pensions has contributed to a better channelling of household savings towards productive and innovative investment. Therefore, the following measures are proposed:

- Member States are encouraged to evaluate different forms of second pillar products and systems in order to increase the options available to all citizens in the workforce.

- This has to go hand in hand with transparent and simpler pension dashboards. This would allow citizens to track the build-up of their assets, drawing on the experience gained in some Member States with such dashboards, increasing the awareness among EU citizens of their future pension levels.

- A fixed share of pension contribution should be tax-exempt to make it financially attractive.

D. Assess whether further changes to the capital requirements under Solvency II are warranted by further reducing the capital charges on equity investments held for the long term.

2. Increase the financing capacity of the banking sector

A. Enable the European securitisation market

- The Commission should make a proposal to adjust prudential requirements for securitised assets. First, capital charges must be reduced for certain STS categories for which the capital charge is not reflecting the actual risk. Second, a targeted and appropriate reduction of the p-factor should be considered (which increases capital requirements for securitised assets and under the current rules is criticised for being excessive and discouraging securitisation, in particular, for corporate and SME portfolios).

- The Commission should review transparency and due diligence rules to facilitate issuance and acquisition of securitised assets. Currently, the transparency requirements for these assets are relatively high compared to other asset classes and reduce the attractiveness of securitised assets for financial parties.

- The EU should set up a securitisation platform to deepen the securitisation market, like other economies also have done. This would reduce costs for banks (especially smaller ones) and could foster standardisation in securitised products. More standardisation would make investing in securitised products also more attractive.

- The EU has to consider targeted public support (for example, well-designed public guarantees for the first-loss tranche). This could encourage issuance and increase lending in certain sectors that are particularly relevant for competitiveness, while ensuring adequate incentives for risk management.

B. Assess whether the current prudential regulation, also in light of the possible upcoming implementation of Basel III, is adequate to have a strong and international competitive banking system in the EU.

C. Complete the Banking Union

A minimal step in this direction would be to create a separate jurisdiction for European banks with substantial cross-border operations that would be 'country blind' from the regulatory, supervisory and crisis management viewpoints, aimed at:

- Protecting these banks from the danger that capital or liquidity regulatory ring-fencing may segment and paralyse their internal capital markets' capital;

- Strengthening provisions that tend to maintain the internal cohesion of these groups in case of distress;

- If these groups are declared failing or in distress by supervisors, ensuring that they are resolved by the European resolution authority, rather than nationally;

- Creating a separate deposit insurance system for these groups, contributed by the groups themselves, leaving national banks within existing deposit insurance schemes.

3. Overcome fragmentation in the Single Market for goods and services removing barriers for innovation and company growth [See the chapters on innovation, energy, clean technologies, digital and advanced technologies, and skills.]

4. Deploy the EU budget more effectively

- **Refocus EU funding on strategic priorities**: The EU's financial resources should be refocused on jointly agreed strategic projects and objectives, where the EU brings most added value. Under the next EU budget, a 'Competitiveness Pillar' would direct EU funding towards EU public goods and multi-country industrial projects, as defined under the Competitiveness Coordination Framework [see Governance Chapter]. Dedicated funding schemes should be put in place to address the investment gap for growth-stage strategic and critical technology companies in the EU, as well as manufacturing capacities in certain cases (e.g. clean technology). Support should focus on the strategic sectors identified in this report, including semiconductors, grids, space, etc.

- **Simplify and streamline to achieve scale**: Simplification and streamlining of the EU budget structure, as well as the rules that govern EU spending, should allow the EU budget to reach sufficient scale to support strategic projects and facilitate access for beneficiaries. To achieve simplification:
  - Regroup and substantially decrease the number of all funding programmes to decrease duplication and fragmentation;
  - Enhance the flexibility of the EU budget to reallocate resources across and within programmes and potential beneficiaries to respond to evolving policy needs;
  - Harmonise rules and horizontal requirements (e.g. environmental requirements) across funding programmes and EU financial instruments to decrease the administrative burden for beneficiaries;
  - Establish a single contact point for project promoters and reduce the time they need to wait to receive EU funding or support.
- **Increase leveraging of the EU budget**: EU-funded schemes should support on a much larger scale the mobilisation of private investment into the strategic sectors of the economy. To better leverage the resources of the EU budget:
  - Substantially increase the use of guarantees in particular, loans, blending instruments and other types of financial instruments in support of strategic sectors of the economy across the policy priorities supported by the EU budget;
  - Increase the size of the EU guarantee for the InvestEU programme with the objective of expanding the scope of the Implementing Partners' existing financial instruments and mobilising higher volumes of investment in the EU's strategic sectors.
- **Higher risk and more scale-up investment financed through the InvestEU programme and through a dedicated equity arm of the EIB Group**. The InvestEU programme should combine unfunded instruments and a funded component. The lending policy of the EIB Group should be in part refocused to provide greater support to: (ii) higher risk investments, mostly in innovative companies; (ii) the scaling up of EU strategic companies; (iii) long-term transition projects that cannot get funding from the private sector. To that end:
  - Enable the EIB Group to take on more and larger high-risk projects, focusing on innovative projects, start-up and scale-ups, making greater use of EIB Group's own financial firepower;
  - Establish a dedicated fully funded equity arm within the EIB to support investment in equity and quasi-equity of companies and funds, including through venture capital and venture debt.
- **Increase coordination among National Promotional Banks with the aim to focus financing in support of innovative and strategic investment**.
  - Dedicate a higher share of investment from NPBs to innovative and higher risk projects and companies in the newly emerging and strategic sectors of the economy, as discussed throughout this report;
  - Improve coordination between NPBs to develop common practices and common investment programmes focused on innovative and strategic projects;
  - Ensure that product offerings, including under InvestEU, are complementary and coordinated and that NPBs' investment strategy remains in line with EU priorities and amplify efforts made at the EU level.
- **Together with the above reforms, to finance a variety of programmes focused on innovation and on raising productivity, Member States could consider increasing the resources available to the Commission through deferring the repayment of NGEU**.

5. Issuance of a common safe asset to finance joint investment projects

If the political and institutional conditions are in place as outlined above, the EU should continue – building on the model of NGEU – to issue common debt instruments to finance joint investment projects that will increase the EU's competitiveness and security. As several of these projects are longer-term in nature, such as financing R&I and defence procurement, common issuance should over time produce a deeper and more liquid market in EU bonds, allowing this market to progressively support the integration of Europe's capital markets.

ENDNOTES

i Pls replace with: Black, B. S., & Gilson, R. J., Venture capital and the structure of capital markets: banks versus stock markets, Journal of financial economics, Vol. 47, No. 3, 1998, pp. 243-277, https://www.sciencedirect.com/science/article/pii/S0304405X97000457.

ii European Commission, Study on the costs of compliance for the financial sector – Final report, 2020, https://op.europa.eu/en/publication-detail/-/publication/4b62e682-4e0f-11eb-b59f-01aa75ed71a1.

iii Angeloni, I., The next goal: euro area banking integration, 2024, https://www.bruegel.org/blog-post/next-goal-euro-area-banking-integration.

iv ECB, A Kantian shift for the capital markets union – Speech by Christine Lagarde, President of the ECB, at the European Banking Congress, 2023, https://www.ecb.europa.eu/press/key/date/2023/html/ecb.sp231117~7d3f2a51f0.en.html.

v Burgert, M., Roeger, W., Varga, J., in 't Veld, J., & Vogel, L., A Global Economy Version of QUEST: Simulation Properties, European Economy Discussion Papers 126, European Commission, 2020, https://economy-finance.ec.europa.eu/publications/global-economy-version-quest-simulation-properties_en.

vi Andrle, M., Blagrave, P., Espaillat, P., Honjo, K., Hunt, B., Kortelainen, M., Lalonde, R., Laxton, D., Mavroeidi, E., Muir, D. V., Mursula, S., & Snudden, S., The Flexible System of Global Models—FSGM, IMF Working Paper 15/64, International Monetary Fund, 2015, https://www.imf.org/en/Publications/WP/Issues/2016/12/31/The-Flexible-System-of-Global-Models-FSGM-42828.

vii Foucault, T., Pagano, M., & Röell, A., Market Liquidity: Theory, Evidence, and Policy, Oxford University Press, 2023, https://global.oup.com/academic/product/market-liquidity-9780190861759.

4. Revamping competition

The framework of the Treaty reflects the belief in the importance of free and fair competition to create a level playing field for undertakings based in any Member State. Competition policy ensures the undistorted functioning of the internal market and effectively protects European consumers and businesses against abuses of economic power. It guards against cartels, abuses of dominant positions, and companies consolidating economic power to undermine the competitive process, and harming consumers and trading partners. At the same time, State aid rules exist to prevent countries from distorting the competitive playing field and from creating harmful subsidy wars. The new Foreign Subsidies Regulation (FSR) follows the same approach for subsidies provided by non-EU countries.

These are ever valid principles, but they need to be adapted to the radically changing world we have described. In particular, there is a question about whether vigorous competition policy conflicts with European companies' need for sufficient scale to compete with Chinese and American superstar companies. Likewise, the lack of innovation in Europe is sometimes blamed on competition enforcement. Although stronger competition will in theory generally both lower prices and foster innovation, there are cases where it can be harmful to innovation. Schumpeter worried that tough competition would erode the profit rents from innovation and thus disincentivise R&D. While it is true that businesses support competition, typically as long as it is not in their own industry, in some cases the Commission has come under attack for not allowing mergers that would create companies of sufficient scale to invest to compete with Chinese and American superstar companies.

A summary of the current empirical evidence overwhelmingly shows that stronger competition generally not only delivers lower prices, but also tends to stimulate greater productivity, investment, and innovation[i]. Thus, it is a concern when many indicators show that competition appears to have declined over the last few decades around the world[ii]. Aggregate price-cost margins and profitability have risen. Industrial concentration levels are up, and company performance is increasingly divergent, with the size, productivity and wages of a few 'superstar companies' pulling ahead of the rest, most notably in the high-tech digital sectors, but in other sectors as well (e.g. retail, wholesale, finance, etc.).

Nevertheless, much needs to be done in light of changes to the business landscape. The economy has shifted towards more innovation-heavy sectors where competition is usually based on digital technologies and brands, where both scale and innovation are critical to compete rather than just low prices. Many of these markets have high fixed costs, strong data and network effects, and a 'winner-takes-all' character, making it more likely for a market to become dominated by one or two companies or platforms. This has been recognised in the introduction of the Digital Markets Act (DMA).

TABLE OF ABBREVIATIONS

DMA	Digital Markets Act
EIC	European Innovation Council
FSR	Foreign Subsidies Regulation
GBER	General Block Exemption Regulation
GSOA	Global state-of-the-art
IPCEI	Important Project of Common European Interest
JEF-IPCEI	Joint European Forum for IPCEI
M&A	Mergers and acquisitions
NCT	New Competition Tool
RD&I	Research, development and innovation
SME	Small and medium-sized enterprises
TCTF	Temporary Crisis and Transition Framework

Competition authorities need to be more forward-looking and agile. For example, since innovation in the tech sector is rapid, merger evaluations in this sector must assess how the proposed concentration will affect future innovation potential, despite its uncertainty. This evaluation is more complex than the simple assessment of the price effect of a merger. To solve this more difficult problem, DG COMP needs more resources. As Nobel Laureate Jean Tirole (2022) puts it: "...what is needed is not a drastic change in antitrust law; indeed, the age-old statutes are worded in a broad enough manner that many of the behaviours we are concerned about are somehow already embodied in law. In contrast, the regulatory apparatus must be made more agile and in tune with evolving economic thinking in the digital age."

Although it might sound paradoxical, strengthening competition goes well beyond traditional competition policy. Historically, opening markets to foreign trade and, in particular, deepening the Single Market have been powerful tools for strengthening competition. However, the Single Market is currently much less developed for services than for goods. Regulatory alignment and the mutual recognition of occupational qualifications are solutions that could greatly foster competition and raise companies' productivity. Given the strong and growing need for scale and the trends towards de-globalisation, strengthening the EU's internal market has become ever more pressing.

Key elements of a new approach to competition policy supporting a new Industrial Deal would include the list of measures described below, which would apply to all sectors[01]. Some of the following proposals represent more radical changes to the current way competition policy is enforced (for instance, items 1 and 3), while others involve revisions of the current approach. In all cases, the motivating situation, the task that the reform seeks to achieve, and the specific action to be undertaken are briefly specified.

1. **Emphasise the weight of innovation and future competition in DG COMP decisions, enhancing progress in areas where the development of new technologies would make a difference for consumers.** DG COMP decisions in the last decade have already started to consider more than just price impacts on consumers and to evaluate other dimensions, such as quality and innovation. Yet, the approaches are sometimes too backward-looking, focusing on existing market shares, whereas in multiple sectors what matters much more is future potential competition and innovation.

   Since the articles in the Treaty are already worded broadly enough to allow the Commission to account for innovation and future competition in its decisions, what is needed is a change in operating practices and updated guidelines to make the current Merger Regulation fit for purpose.

   These guidelines should explain how the authority assesses the impact of competition on the incentive to innovate. Likewise, updated guidelines should explain what evidence merging parties can present to prove that their merger increases the ability and incentive to innovate, allowing for an 'innovation defence'. The criteria for proving the innovation-enhancing effects of a merger must be specific enough to limit the risk of companies abusing this defence strategy, while still giving them the opportunity to justify their merger. An 'innovation defence' would be justified by the need in certain sectors to pool resources to cover large fixed costs and achieve the scale needed to compete at the global level, as has been the case, for instance, with Airbus.

   To prevent improper uses of this defence, the merging parties should commit to levels of investment that can be monitored ex post. Failure to comply should be associated with adequate disincentives to deviate from the investment plan. The burden of showing that the merger is needed, and that it would cause no harm to consumers in the long run, falls on the merging parties.

   An innovation defence cannot be used to justify further concentration by already dominant companies or in cases in which the concentration poses significant risk of entrenching a dominant position, ultimately harming effective competition. Scale economies and network effects can create significant barriers to entry: short terms benefits to innovation linked to increased scale must, therefore, be weighed against future costs of reduced incentives to innovate by both the companies seeking to concentrate and their rivals, clients and suppliers. Finally, an efficiency defence is unlikely to apply to non-tradable sectors: tradable goods and services have

01. Additional sector-specific policy proposals are presented in the specific chapters.

international competitors unless there are policies that block access to the domestic market. In areas where trade restrictions in pursuit of diversification and resilience are not needed, foreign competition is relevant, and, hence, it is for non-tradable sectors that the enforcement of competition policy needs to be particularly careful against the risks of any abuse driven by concentrations.

2. **Provide clear guidance and templates on novel agreements, coordination and co-deployment between competitors.** The Commission enforces a general prohibition of business agreements or arrangements that prevent, restrict, or distort competition within the internal market. However, horizontal cooperation agreements and concerted practices are sometimes necessary to achieve R&D investment, sustainability transitions, and other initiatives that require standardisation and coordination of solutions across players but greatly benefit European consumers.

   There is a need for a simple, streamlined process that groups of EU industries can follow to work together to reach scale when it would benefit consumers. For instance, if individual companies lack the scale to find and contract for certain raw materials (e.g. in the Critical Raw Materials space), a group of companies working together must be able to jointly procure the materials or stimulate new production and increased output. Likewise, a group of companies that wants to collaborate to develop a standardised technology may also increase consumer access to new products.

   The existing process should be further streamlined and simplified to provide complete clarity to companies concerned about their liability for potential infringements of competition law. DG COMP could provide clear guidance, templates, and ease of access to this process. Specific illustrations of what is needed for some critical areas are discussed in the chapters devoted to the specific sector. An example of a crucial case were co-deployment and coordination are needed is defence. There, the fragmented industrial structure is not the result of vibrant competition among small players, but the outcome of insufficient and non-coordinated public spending geared towards national players typically operating only in their domestic markets. But defence is a sector where scale is decisive and, to achieve it, the proposals in the chapter stress the crucial role of product standardisation. Indeed, the dire consequences of not having EU-wide standards have been felt on the ground in Ukraine.

3. **Develop security and resilience criteria by expert authorities and include them in DG COMP assessments.** The current practice of enforcing competition policy does not emphasise security, resilience, and the related disruption risks to the EU economy. Although security and resilience aspects are somewhat taken into account in the competition assessment (e.g. when looking at the viability of firms, supplies to the market along the supply chain), these elements should get more weight in competition evaluations, since they have become increasingly important in today's world.

   A security and resiliency assessment could be performed when these dimensions are relevant and, for those sectors and firms that are strategic, but this should be done outside the Competition unit (e.g. by a Resiliency Assessment Body)[02].

   This assessment should then be used as an input for DG COMP as an additional public interest criterion. To make this new assessment useful to enhance security and resiliency of the EU economic area, but without creating too much additional red tape in the enforcement of competition policy, this assessment should be required exclusively for those sectors where the security and resilience dimensions are particularly crucial. These areas include security, defence, energy and space (e.g. in dual-use decisions). For decisions in these areas, the public interest

02. Weak resilience sectors are as such for several reasons and, even if it is not per se a competition policy objective, fragility of a sector or supply chain can be assessed by looking at, for instance: (i) domestic supply concentration (in case of within-country supply chains); (ii) import diversification and reliability (in case of cross-border relations with other regions of the world). The latter criteria are similar to those typically used by trade departments and agencies to assess supply chain vulnerabilities. A financial analysis of the companies' profitability in the market and the extent to which they are financed through debt (i.e. leverage) can provide additional insights on the level of vulnerability to shocks and to changing trading conditions. Additional factors increasing the risk of supply chain disruption include: (i) the criticality of its input; (ii) the presence of legal or de facto entry barriers; and (iii) market-specific vulnerabilities.

toward security and resiliency should thus be weighed along with other considerations[03]. Finally, in devising its remedies, DG COMP should also aim not to weaken, and, whenever possible, to enhance security and resiliency.

4. **State aid control as a competition tool for efficiency enhancing industrial policies.** State aid control is a founding element of the European Union. It plays a key role to avoid inefficient subsidy races among Member States and the waste of public resources. The application of State aid control in times of crisis, like those triggered first by the COVID-19 pandemic and later by the energy crisis, has entailed expanded ability for Member States to support companies, thus effectively easing the pain of EU citizens and businesses but it also fragmented the common market, distorted competition, deteriorated public finances and triggered inefficient subsidy races[iii]. A key example, discussed in the chapter on energy, regards the more than 400 emergency measures adopted during the 2021-2023 period for both electricity and gas, which were for the most part made non-coordinated and, according to ACER, had a negative impact on market integration. Returning to a normal enforcement of Sate aid controls serves to accompany the new industrial strategy characterised by strategically designed and coordinated policy actions.

   This implies that at the same time State aid control is strongly enforced, and that coordinated aid at EU level is expanded to enhance productivity and growth in strategic sectors. Measures to achieve this goal involve the strengthening of the IPCEI instrument discussed in greater detail point 5 below. Moreover, the compatibility assessment under State aid control shall more closely consider the coherence of the State aid with any EU-wide industrial policy and allow for greater amounts of aid where EU coordination is enhanced. Steps towards making this type of assessment feasible have already been taken. For instance, this is the case in the energy sector under the Revised Guidelines on State aid for climate, environmental protection and energy of 2022. But even in this sector, these steps are not sufficient and, as discussed in the chapter on energy, changes to the State aid rules would need to be modified to allow for the price relief mechanisms that should be part of a new strategy on energy. Finally, greater emphasis on the potential impacts on both innovation and resiliency should be given in decisions involving State aid control.

5. **Reform and expand the IPCEIs – Important Projects of Common European Interest.** IPCEIs are a form of State aid designed to support breakthrough innovation that, due to its cross-border nature, can significantly enhance the competitiveness of the Union. The Innovation Scoreboards, regularly published by the Commission, have consistently shown that the EU falls behind the US in many indicators and that the gap is growing.

   To address this gap through the IPCEIs and make it a key instrument of the new Competitiveness Coordination Framework [see Governance Chapter], the conditions to finance projects need to be expanded to include not only breakthrough innovation – fulfilling a demanding 'Global State of the Art' standard – but also a broader notion of innovation.

   Details on this type of State aid model and some specific actions that can be undertaken to enhance its role are discussed in the box at the end of this section. The key provision would be to allow the financing of a broader class of innovations (as opposed to breakthrough innovations), provided that they offer the potential for Europe to jump to the technological frontier in strategic areas where it is lagging behind and where State aid framework for research and development and innovation (RDI framework) is not sufficient. Furthermore, speeding up the administrative procedures leading to the approval of the projects admitted for IPCEI support is essential[04]. This point is stressed also with regard to the recommendations for specific sectors, for instance in the case of energy regarding the need to foster network upgrades and investment in grids to address the electrification of the economy and avoid bottlenecks.

03. Examples of the public interest to be weighed include geopolitical risks in relationships with certain regions or supply chain risks in critical sectors, such as pharmaceuticals or medical supplies. As an example of how this could be operationalised, if an entrant would make supply more resilient, this could be a positive factor to consider in State aid decisions. In the case of merger reviews, limiting the potential for a single company controlling key upstream inputs may be directly reflected in the merger analysis.

04. This reform should be coordinated with other proposed reforms for the European Innovation Council (EIC) to help Europe to invest in more technologically advanced sectors. See: Fuest, C., Gros, D., Mengel, P-L., Presidente, G., and Tirole, J., EU Innovation Policy – How to Escape the Middle Technology Trap?, EconPol Policy Report, April 2024.
Further revisions of the IPCEI framework should involve streamlining and speeding up the review process. Useful recommendations on the framework's enhancement are also contained in 'Much More than a Market', April 2024 (the 'Letta Report').

6. **Incentivising the adoption of open access, interoperability, and adherence to EU standards through State aid and other competition tools.** Open access and interoperability are pro-competitive forces, as is the adoption of common technological standards. Important advances in promoting open access and interoperability in digital markets have been achieved through the DMA.

   Expanding the benefits of open access and interoperability beyond the core platform services regulated by the DMA is possible, but requires either additional regulations or the introduction of incentives for businesses to adopt these choices.

   A promising solution is to link State aid contributions and their review process by DG COMP to the enhancement of open access and interoperable solutions, and to the development of Europe-wide standards. This approach should not be limited to digital services, but could involve sectors such as energy, connectivity and transportation. For instance, State aid toward vehicle charging infrastructure might be considered a determinant positive factor if interoperability standards were made mandatory for those receiving aid[05]. An example in this direction are the guidelines and practice on open access to state-aided broadband networks. Furthermore, as discussed in the chapter on defence, interoperability and standardisation are essential in that area too.

   In digital markets, in addition to the strong enforcement of the DMA provisions, new requirements involving open access and interoperability should be enacted when the presence of strong network effects and barriers to entry related to data impede market competition. The New Competition Tool [see point 9 below] can be used to identify the markets in need of these types of interventions[06]. As stressed in the 'Joint statement on competition in generative AI foundation models and AI products' of July 2024, AI products and services and their inputs have greater potential to benefit societies if they are developed to interoperate with each other and, accordingly, any claims that interoperability requires sacrifices to privacy and security must be carefully assessed against the potential benefits of interoperability. Finally, it is worth emphasising that sector-specific recommendations on common standards are presented in the chapter on digitalisation and advanced technology sectors regarding the need for coordination of standards both across telecom operators and within specific services, such as broadband. These provisions will foster a Single Market in services that is crucial both to enhance competition and to make it easier to achieve scale when that is crucial for innovation.

7. **Apply effectively the new powers associated with the enforcement of the Digital Markets Act (DMA) and the Foreign Subsidies Regulation (FSR).** The need to respond to a new economic and geopolitical situation has triggered the introduction of new powers for the competition authority in the form of the DMA and FSR, greatly expanding the possibilities for DG COMP interventions in the economy.

   The evaluation of the potential distortive effects of foreign subsidies and the compliance assessment of tech platforms to the digital regulations share a high degree of complexity. It is of paramount importance for the EU that these new rules are applied effectively and result in the intended benefits for EU consumers and businesses. Otherwise, not only would the credibility of the EU as a regulator be hurt, but economic damages would also follow, such as the reduced appetite of multinational companies to invest in Europe and the delayed deployment of technological advances.

05. Charging stations can be made compatible with just one specific brand, or they can be made interoperable across brands. In the US, the interoperability of electric vehicle charging infrastructure has been encouraged through public subsidies, leading Tesla, for instance, to make its stations interoperable with non-Tesla battery electric vehicles. See: NARUC, Electric Vehicle Interoperability – Considerations for Public Utility Regulators, Summer 2022.

06. These types of interventions would need to take place in close connection with the regulatory provisions regarding data. The Data Act, the Data Governance Act, and all other regulatory provisions involving data markets should favor, and not obstruct, the adoption of open access and interoperable systems. In this regard, a promising policy direction is the regulation of intermediaries who can collectively bargain for user data and make deals on their behalf, such as a 'data union' (See: Curzon-Price, 2023). Finally, a tool to further promote the adoption of open access and interoperability can be public procurement, which should be part of the proposed revision of the Public Procurement Directive.

Adequate resources must therefore be provided to the enforcer[07]. The types of specialised knowledge required by these new powers are different. Therefore, the development of skills related to both the technological sector and international taxation/finance should proceed in parallel and involve both the training of internal resources and the hiring of new resources. As discussed in the chapter on defence, this sector has seen a significant increase in foreign military sales and the evaluation of foreign subsidies in this area might be particularly complex and time-consuming. Overall, it is crucial that the enforcement of the new instruments does not come at the cost of weaker enforcement of more traditional competition policy tools.

8. **Reinforce ex-post versus ex-ante regulation and monitoring.** It is too labour-intensive and unrealistic for the authority to engage in monitoring all markets, especially in light of the additional roles recently acquired by DG COMP [see point 7 above].

   To ease the enforcement of competition policy, it is reasonable to require some parties involved in competition decisions to report metrics that are useful for evaluating the extent of competition ex post. Competition authorities may then be allowed to intervene based on concerns arising from these reports.

   To make this happen, DG COMP should have the right to define the content of the reports and to demand additional information if the reports submitted by the companies are incomplete. The merging parties (or defendants, more generally) should agree to this information access as part of the settlement of their case. To limit the burden on companies, this provision should be limited exclusively to: (i) the cases posing the greatest concerns about future competition (such as cases of repeated violations of competition law or cases of mergers cleared with remedies or involving a dominant company or resulting in highly concentrated markets); (ii) the minimum information required to evaluate competition concerns related to what the Commission considered in its ex ante assessment. DG COMP should be allowed to maintain and use the data and all relevant case information even after a case is closed, which would be helpful for future assessments of competition based on company reporting. Finally, this ex-post process of monitoring and enforcement could be integrated as part of a New Competition Tool [see point 9 below].

9. **Introduce a 'New Competition Tool' (NCT) in four areas.** The NCT is a market investigation instrument designed to address structural competition problems and to determine a solution together with firms as a potential instrument for enforcing competition policy in today's rapidly evolving economy, but it has not yet been adopted.

   The introduction of an NCT would allow DG COMP to carry out a Market Study to identify the problem and then a Market Investigation to determine the solution together with firms to solve it. The design of this tool must strike a balance between the potential benefits of fixing structural competition problems and the limits of competition enforcement, especially given the limited resources available for the latter.

   A possible approach would involve defining four areas of potential intervention where current competition tools are known to be insufficient. These four areas are: i) tacit collusion; ii) markets where the need for consumer protection is more likely to be needed, for instance due to consumers belonging to sensitive categories or having behavioural biases; iii) markets where economic resilience is weak, one cause of which could be market structure (e.g. reliance on a single source of raw material) leading to frequent shortages or other harmful outcomes; iv) past enforcement actions where the information/data received by the authority indicate that the commit-

07. In an FSR policy brief published in February 2024, the European Commission indicated that in the first 100 days alone, there were 14 FSR M&A notifications and 53 cases in the pre-notification discussion stage. This number of cases is remarkably high, especially given that the European Commission's 2021 Impact Assessment had predicted only 33 M&A notifications per year.

ments or remedies adopted are not delivering competition [see point 8 above][08]. The NCT would be activated following specific indications of possible anti-competitive conducts or a preliminary assessment of the expected positive impacts of solving the identified structural problems. The Commission shall be given the power to design together with firms and accept effective remedies to tackle systematic failures of competition and impose their application. If enacted, this provision would require adequate resources for DG COMP, additional to those already discussed earlier [see point 7 above].

10. **Accelerate the decision-making processes and increase the predictability of decisions.** The high stakes involved in most European competition policy cases create a systematic conflict between the needs for accuracy and those for speed and certainty. Decade-long cases like the Intel case are the most visible instance, although not frequent they are not isolated episodes. The DMA is a response to this situation for the digital sector.

The processes through which competition policy is enforced must continue to be revised to make business operations easier and faster, assessing all instances where it is possible to reduce the burden on companies.

Initiatives like the 2023 Merger Simplification Package could be expanded to all areas of competition policy enforcement. Other existing ambiguities regarding which non-notifiable mergers can be reviewed and by which public authority, which novel cooperative agreements are legitimate, which types of contracts entails an exclusionary abuse of dominance and which State aid programmes in line with EU-wide industrial policy are not distortive must be clearly specified by reinforcing guidelines and templates[09]. Ex-ante regulation like the DMA should not become the primary tool to foster competition in markets unless special structural impediments to competition, like those present in digital markets, exist.

08. Further considerations on these four areas are as follows:
(i) NCT and Collusion – DG COMP already has the authority to open ex-officio investigations and conduct simple market inquiries under Article 101. Therefore, if the NCT is introduced, it would need to be integrated with these existing antitrust mechanisms.
(ii) NCT and Markets in Need of Consumer Protection – there are certain market situations and outcomes that are characterised by an enhanced need for consumer protection. These markets are particularly well-suited for the NCT. An example is a market where consumers are fragile (for instance, elderly individuals) or where consumer biases and bounded rationality are pervasive.
(iii) NCT and Weak Resilience Sectors – these are markets where economic resiliency is weak, one cause of which could be market structure (e.g. reliance on a single source of raw material) leading to frequent shortages or other harmful outcomes. For instance, inquiry could investigate supply chain disruptions aimed at shedding light on market conditions and business practices that may have worsened these disruptions or led to asymmetric effects. This type of analysis would assist not only the work of competition authorities, but also help to ensure any government interventions in support of resilience are targeted and effective.
(iv) The NCT and Past Enforcement Analysis – Past enforcement actions where the information/data received by the authority indicate that the commitments or remedies adopted are not delivering competition [see point 8].

09. Three concrete examples of areas that need to be urgently streamlined are as follows. First, regarding merger control, this has become increasingly complex and uncertain with new practices linked to, among others, (i) the use of article 22 of the Merger Regulation to cope with non-notifiable mergers (as highlighted by ECJ ruling in the Illumina/Grail case), (ii) the application of Article 101 and 102 to review non-notifiable mergers, (iii) emerging theories of harm and innovative approaches, (iv) the Foreign Subsidies Regulation for mergers involving foreign buyers, and (v) the Digital Markets Act for large digital platform mergers. A simple solution to the ambiguity related to (i) and (ii) would be to set a threshold based on the value of the transaction for mandatory notifications, as done in certain jurisdiction like Austria and Germany. Second, excessive discretion on the finding of exclusionary abuses is left by the draft Guidelines on the enforcement of article 102 released in August 2024. As an example, tying can be presumed to have exclusionary effects, but the Guidelines do not detail under which conditions; similarly, there is no safe harbor for dominant firms setting prices above average total cost. Third, regarding the DMA, the provision in art. 1(6.b) about how the DMA Regulation is without prejudice to the application of national competition rules that “amount to the imposition of further obligations on gatekeepers” introduces uncertainties that need prompt clarifications to limit the risk of the potential of fragmenting the regulatory landscape of EU digital markets.

BOX

Reinforcing the IPCEI instrument – the new Competitiveness IPCEI

IPCEI (Important Projects of Common European Interest) is a State aid instrument that enables Member States to pool resources in strategic sectors and technologies of common European interest, where the market alone does not deliver (market failure). The projects aim to stimulate cross-border cooperation, allowing for the funding of RD&I and first industrial deployment. The potential of the instrument is limited primarily by three elements: the perimeter of application (breakthrough technologies), the absence of an EU budgetary line, and procedural length and complexity. Proposals to improve the IPCEI instrument include:

a. **Extend the IPCEI instrument beyond only breakthrough technologies** and the 'global state of the art in the sector' to include industrial (e.g. infrastructure) projects of common interest and all forms of innovation that could effectively push Europe at the frontier in strategically important sectors, and expand the Single Market[10].

b. **Make part of EU funding available**, with companies eligible for EU subsidies, conditional on their Member State undertaking reforms to harmonise and facilitate common markets.

c. **Lessen the burden of proposing projects.** The tool should be based on rigorous market studies conducted by national authorities, some unit of the Commission, or national sectoral regulators, all in consultation with companies, or even at the request of companies themselves, provided a public body is involved to ensure the project is in the public interest. The Joint European Forum for IPCEI (JEF-IPCEI) should be strengthened and tasked with developing a systematic monitoring of both the procedural bottlenecks and the innovation outcomes. It should also be given resources to conduct Cost Benefit Analyses to support decisions to initiate IPCEIs. Setting up an 'Excellence Centre for IPCEIs' can help by offering (with the JEF-IPCEI) technical assistance and support to Member States and companies to screen and prepare projects.

d. **The review process should be much faster** once DG COMP is given a correctly done Market Study by another part of the Commission or national authorities (e.g. within one year). Subject to a complete notification and to timely responses to requests for further specific information, the Commission shall be required to take its decision within a given deadline. The Market Study is required to identify upfront the market failure being targeted and to outline the set of policy options (e.g. subsidies, trade measures, regulation harmonisation, competition remedies) that will mitigate the externalities or other market failures[11].

10. The 'Global State of the Art' standard is not in the IPCEI Communication, but it has emerged as a key criterion for a project to be approved. For instance, according to the IPCEI Project Portfolio, the company has to provide "a short description of the expected innovations going beyond the global state-of-the-art (GSOA) (i.e. summarise the planned R&D&I activities)". The DG COMP 'Code of Good Practices for a Transparent, Inclusive, Faster Design and Assessment of IPCEIs' states that "DG COMP will invite Member States to withdraw from the IPCEI those projects for which a first screening reveals that they are insufficiently developed (for instance in terms of cross border co-operation) or poorly substantiated (for instance regarding the innovation and the global state of art)".

11. Currently, the IPCEI framework remains very complex and costly for businesses to manage. Companies face significant opportunity costs as they may have to wait years to learn if their project will receive funding and to what extent. Additionally, the substantial administrative costs due to the numerous procedural requirements imposed by the Commission further complicate the process. This combination of factors discourages the use of the IPCEI framework, especially by SMEs, which should theoretically be among its primary beneficiaries, as they pose fewer competition distortion concerns and struggle more to finance innovative projects independently. The fact that SMEs might nevertheless obtain State aid support under GBER is not a valid solution.

ENDNOTES

i European Commission, Protecting Competition in a Changing World – Evidence on the evolution of competition in the EU during the past 25 years, 2024.

ii Bajgar, M., Berlingieri, G., Calligaris, S., Criscuolo, C., and Timmis, J. (2023). Industry concentration in Europe and North America. Industrial and Corporate Change.

iii Reuters, Nine European countries warn of subsidy race from easier state aid, 2024.

5. Strengthening governance

Reinvigorating the EU's competitiveness calls for reflection on the institutional set-up and functioning of the European Union. As demonstrated throughout this report, no Member State can address key competitiveness challenges alone or compete with Europe's main global competitors. As such, the EU represents more than ever an opportunity for its Member States. At the same time, in various sectors the EU's complex governance system can negatively affect the efficiency and effectiveness of our collective action compared to that of the US or China – global competitors that can act as one country with a single geoeconomic strategy and align all the necessary policy tools behind it. At the same time, excessive regulatory and administrative burden can hinder the ease of doing business in the EU and the competitiveness of EU companies.

Strengthening the EU's unique political and institutional model would require a Treaty change, but much is already possible with targeted adjustments without the need for such a change. Namely, a renewed European partnership should be built on three overarching pillars:

- **Refocusing the work of the EU**. Doing fewer things better at the EU level, prioritising policies and acts where EU action has the greatest added value, while ensuring full implementation and enforcement at all levels of government. This means 'more Europe' where it really matters, while leaving more leeway and accountability to Member States and the private sector – in compliance with the subsidiarity principle. This would, at the same time, provide new legitimacy to coordinated EU policy-making.

TABLE OF ABBREVIATIONS

AI	Artificial intelligence
BNETZA	Federal Network Agency
CEA-PME	European Entrepreneurs
CFSP	Common Foreign and Security Policy
CSR	Country-specific recommendation
CSRD	Corporate Sustainability Reporting Directive
DNSH	'Do no significant harm'
DPA	Data Protection Authority
EIB	European Investment Bank
EPR	Extended producer responsibility
ERA	European Research Area
ESPR	Eco-design for Sustainable Products Regulation
ESRS	European Sustainability Reporting Standards
ETS	Emissions Trading System
FTC	Federal Trade Commission
GDPR	General Data Protection Regulation
IED	Industrial Emissions Directive
IPCEI	Important Project of Common European Interest
MFF	Multiannual Financial Framework
NECP	National Energy and Climate Plan
NRRP	National Recovery and Resilience Plan
QMV	Qualified majority voting
R&D	Research and development
REACH	Registration, Evaluation, Authorisation and Restriction of Chemicals
REFIT	Regulatory Fitness and Performance Programme
SGP	Stability and Growth Pact
SME	Small and medium-sized enterprises
SMET	Single Market Enforcement Taskforce
STEM	Science, technology, engineering, and mathematics
TEN-E	Trans-European Networks for Energy
TFEU	Treaty on the Functioning of the European Union
TSCG	Treaty on Stability, Coordination and Governance
TSI	Technical Support Instrument

- **Accelerating EU action and integration.** Moving forward faster in policy areas prioritised as part of the refocusing exercise, thanks to enhanced cooperation or even at the cost of opting for a model of deeper integration based on 'concentric circles'.

- **Simplifying rules.** Increasing legal certainty and reducing regulatory and administrative burden by ensuring that there are fewer, clearer, more fit-for-purpose, future-proof and coherent rules.

To achieve these objectives, specific proposals are presented in this chapter [Figure 1]. As detailed below, priority initiatives under each of the three pillars include:

- **Developing a new Competitiveness Coordination Framework,** which will replace various non-fiscal coordination tools of the EU. This tool will translate EU-wide competitiveness objectives into national policies, promote greater coordination between Member States and ensure financing for each strategic priority through a profound change to the structure and implementation of the EU budget.

- **Extending or generalising qualified majority voting** (QMV) as opposed to unanimity in the Council of the European Union, as the key principle for establishing common rules through legislation and regulation.

- **Streamlining the EU acquis in a systematic way** – under a Vice-President for Simplification coordinating a new 'evaluation bank' to stress-test all existing EU laws and regulations at the start of each Commission mandate. This should ensure harmonious regulation across Member States, with the ultimate objective to make EU and national regulation a consistent single corpus representing a competitive strength for our Union.

FIGURE 1

	SUMMARY TABLE GOVERNANCE PROPOSALS	TIME HORIZON
1	**Refocusing: Develop a new Competitiveness Coordination Framework.**	**ST/MT**
2	Launch an EU-wide inquiry to analyse the role of national Parliaments in the scrutiny of the principle of subsidiarity. Reinforce the role and administrative capacity of national Parliaments and Member States in controlling the EU institutions' legislative activity.	ST
3	Filter future initiatives up for adoption, building on proposals under 'Simplifying', such as a single methodology to assess the cost of regulation and a revamped competitiveness test.	ST/MT
4	**Accelerating: Generalise Council votes subject to QMV as opposed to unanimity.**	**ST/MT**
5	Opt for a model of deeper integration based on 'concentric circles', including enhanced cooperation or coalitions of the willing, where action at the EU level is hindered or blocked by existing procedures.	MT/LT
6	Have an Interinstitutional Pact clarify and extend the use of Article 122 TFEU to facilitate swift EU action during crises.	ST/MT
7	**Simplifying: Streamline the EU acquis under a Vice-President for Simplification, including coordinating a new 'evaluation bank' to stress-test existing EU regulations.**	**MT**
8	Use a single, clear methodology to quantify the cost of new legislation for EU institutions and Member States.	MT/LT
9	Minimise the cost of Member State transposition and enhance enforcement of Single Market legislation.	MT
10	Uphold proportionality for SMEs and small mid-caps in EU law, including by extending mitigation measures to small mid-caps.	ST/MT
11	Review the Commission's system of Expert Groups.	ST/MT
12	Create 'EU innovation hubs' to support Member States' efforts to define sandboxes and promote their use across countries, by offering centralised information to EU businesses.	MT/LT

Refocusing the work of the EU

ACTIVE EXERCISE OF THE PRINCIPLE OF SUBSIDIARITY

EU policy and legislative action should refocus on domains where the EU truly has greater added value compared to national or subnational policy action, in line with the subsidiarity principle. Contemporary challenges require collective reflection on where the EU can have greatest added value through collective action, and how to act in these areas in the most efficient and effective way. Examples include ensuring a secure, decarbonised and affordable energy supply under a true Energy Union, or boosting digitalisation and the development, deployment and adoption of advanced digital technologies in the EU – in particular, AI. The subsidiarity principle set out in the Treaties defines the best level of governance at which to act – EU, national, sub-national or regional (depending on each Member State's institutional organisation) – to achieve the EU's policy objectives, including revitalising its competitiveness. In this context, a crucial role is played by the Court of Justice of the EU, Member States, their national parliaments, and Europe's regions in the examination of the EU's legislative proposals, as well as their transposition and enforcement.

The Commission's legislative activity has been excessively growing, also due to passive scrutiny of the subsidiarity principle, which sets the boundaries of its right of initiative. The institution with the main right of initiative, the European Commission, justifies each of its legislative proposals in light of the principle of subsidiarity. However, there is evidence that compliance with the principle of subsidiarity is not always actively scrutinised, for instance by national parliaments [see below]. This has affected the standing of EU action, which should remain focused on what needs to be done at the European level, leading to the passing of laws that could be better formulated at the national or regional levels, closer to citizens and businesses. It has also contributed to growing legislative activity by the European Commission, which is not actively challenged in its right of initiative[01]. This runs counter to the principle of regulatory simplification required to strengthen the EU's competitiveness – as described under 'Simplifying rules' below.

National parliaments make limited use of their power to scrutinise the compliance of EU legislation with the principle of subsidiarity through reasoned opinions. National parliaments can exercise this control at the moment when a piece of legislation is proposed and can trigger the so-called 'yellow card procedure'[02]. So far, this procedure, which could act as a 'filter' on new initiatives, has only been triggered once. In 2023, while the European Commission adopted 141 relevant legislative proposals undergoing subsidiarity control, it only received 22 reasoned opinions from national Parliaments highlighting concerns on ground of subsidiarity – with a long-term declining trend in this mandate compared to previous ones[03]. Of the 39 national parliaments or chambers, only nine (from seven Member States) issued reasoned opinions in the context of scrutinising subsidiarity. Two-thirds of all reasoned opinions came from three chambers. Of the 39 national parliaments or chambers, nine chambers belonging to six Member States did not send any written opinion in 2023. In fact, the ten most active chambers issued 80% of total opinions.

01. Namely, 2,419 new legislative acts were passed during the 2019-2024 mandate (excluding 2019), compared with 2,319 during the 2014-2019 mandate (excluding 2014).
Source: EUR-LEX, Legal acts – statistics, retrieved on 19 August 2024.

02. The 'yellow card procedure' refers to the opportunity given to Member States' national parliaments to examine a Commission proposal for legislative action. This examination takes place at the moment when legislation is presented by the Commission. It allows national parliaments to raise an objection indicating that action could be more effectively carried out at the Member State level in accordance with the principle of subsidiarity.

03. European Commission, Annual Report 2023 on the application of the principles of subsidiarity and proportionality and on relations with national parliaments, 2024 (upcoming). The total number of legislative acts proposed by the Commission in 2023 is 319, but only legislative acts proposed by the Commission in areas of shared competence are subject to subsidiarity control by national parliaments under Article 4 of Protocol 2 of the TFEU. 141 refers to such acts adopted between 1 November 2022 and 1 December 2023.

An EU-wide inquiry should be launched to analyse the reasons behind national parliaments' passive exercise of their scrutiny of the subsidiarity principle. Building on its conclusions, initiatives should be taken to reinforce the role of national parliaments and Member States in upholding the principle of subsidiarity – not least via the 'yellow card procedure' – and, in doing so, control the EU institutions' legislative activity. This could include by further supporting administrative capacity at the national, regional and local levels, for instance building on a revamped use of the European Commission's Technical Support Instrument (TSI)[04].

Moreover, the EU institutions should apply a 'self-restraint' principle in policy-making, both by better filtering future initiatives, and by streamlining the existing acquis. Beyond the mentioned subsidiarity control, various initiatives and proposals as detailed under 'Simplifying rules' below would also contribute to refocusing the work of the EU. Namely, adopting a single methodology across all impact assessments – also taking into account national spillovers – and subjecting all new proposals up for adoption to a revamped competitiveness and SME test would allow the effective filtering of all future actions and proposals. In parallel, the existing EU acquis should be codified, consolidated and streamlined under a new Vice-President for Simplification.

COORDINATION OF COMPETITIVENESS POLICIES

The European Semester is the Union's main tool for coordinating economic governance, but it does not entail the EU-wide coordination of policies. Introduced in 2011 as a response to the 2007-2008 economic and financial crisis, its objective is to contribute to ensuring convergence and fiscal stability in the EU. The tool has evolved over time into a range of complex procedures, which today cover the implementation of the Stability and Growth Pact (SGP), as well as the reporting on the implementation of National Recovery and Resilience Plans (NRRPs). The European Semester delivers country-specific recommendations (CSRs) to individual Member States on diverse policies (fiscal, employment and social, as well as structural reforms related to energy, justice, and education systems, for instance). By design, the European Semester is a tool assessing individual Member States against common criteria and encouraging peer reviews to foster convergence at the EU level. Soft coordination tools also exist at the EU level for specific sectors, such the National Energy and Climate Plans (NECPs) for energy policies, or the Pact for Research and Innovation in Europe under the European Research Area (ERA) for R&D policies. In all these examples, the established processes have so far proven to be largely bureaucratic (mainly producing reports) and ineffective in delivering relevant reforms at the EU level, favouring national initiatives under a common framework over true EU-wide coordination.

To achieve the vision of this report, it is proposed to modify the European Semester to only focus on fiscal policy surveillance, while the coordination of all other policies relevant to the EU's competitiveness would be merged into a new Competitiveness Coordination Framework. The Competitiveness Coordination Framework would only address **EU-level strategic priorities – 'EU Competitiveness Priorities' – formulated and adopted by the European Council**. These priorities would be defined at the beginning of each European political cycle in a European Council debate and adopted in European Council conclusions[05]. The Competitiveness Coordination Framework would minimise the number of reports required from Member States' administrations[06] and foster genuine EU-wide coordination of policies that matter the most for the future of Europe's competitiveness. In doing so, this instrument would support the Industrial strategy presented in part A of this report.

04. Through the Technical Support Instrument (TSI), the European Commission (DG REFORM) currently offers technical support to Member States, upon their request, to design and implement reforms. By providing advice and expertise on the ground, (i.e. accompanying the national authorities of requesting Member States throughout the reform process or according to defined stages or to different phases of this process) the TSI contributes to strengthening the administrative capacity of public administrations. The fact that no money is given to the beneficiary authority, but only knowledge and expertise, is one of the main reasons for the success and the efficiency of TSI.

05. Article 121 TFEU provides a legal basis for establishing a Competitiveness Coordination Framework. The procedure involves the Council and the European Council.

06. EU Competitiveness Action Plans would merge into one of the existing frameworks that translate EU priorities into concrete measures for implementation at the national level, such as the National Energy and Climate Plans, the Annual Single Market and Competitiveness report, the Digital Decade report, the reports under the European Semester, etc. This would represent a major simplification exercise for both EU and national administrations.

The Competitiveness Coordination Framework would be organised in 'EU Competitiveness Action Plans' by areas (e.g. the chapters of this report), and for each area it would define the means of action: governance, financial incentives, and measurable objectives. Multiple Action Plans would be needed to achieve the goals outlined in the Competitiveness Priorities. The involvement of all relevant stakeholders, Member States, experts, the private sector, EU institutions and agencies is essential to define and use the most agile and efficient model of governance, depending on the area concerned. For example, the European Commission should have a mandate for exclusive EU competences and horizontal actions, such as revamping competition policy and reducing regulatory and administrative burdens (as discussed, two priorities for 'scaling up'). Instead, for shared competences like closing the skills gap and accelerating innovation, the Commission would provide guidelines but share the institutional set-up to implement the proposals with national structures and experts, as discussed in the relevant chapters of this report. In specific sectors of the economy, a new set-up bringing the Commission together with industry experts and Member States, as well as relevant sectoral agencies where they exist, could be in the lead in defining and implementing the Action Plans.

Different means and financial incentives (European or national) could be mobilised depending on the area of action. For all areas, crowding in private funding would be essential to achieve the objectives. The different means and incentives are listed as below:

- **Investment in EU public goods.** Under the next MFF, a 'Competitiveness Pillar' would direct EU funding to where it has the greatest impact and added value for the EU. It would be possible under the current MFF to support EU-wide public goods under programmes, such as InvestEU, and partners including the EIB Group[07] and National Promotional Banks.
- **Launch multi-country industrial projects** potentially activated only by a sub-group of interested Member States. Under the next MFF, multi-country industrial projects could rely on funds with nationally pre-allocated envelopes. Under the current MFF, they could be financed using existing instruments, such as the European Digital Infrastructure Consortia and the reprogramming of Cohesion Policy funds and of the RRF to fulfil STEP objectives. National investment could also be mobilised using two revamped tools including new Competitiveness IPCEIs[08] providing State aid to cross-border projects and a new Competitiveness Joint Undertaking[09] to quickly set up public-private partnerships between the Commission, interested Member States and industries.
- **Coordination of national policies for competitiveness**. Under the next MFF, financial incentives for Member States to coordinate national policies and engage in regulatory adjustments and reforms would come from national envelopes. Under the current MFF, Cohesion Policy funds could be reprogrammed to fulfil the objectives set.

07. InvestEU could be leveraged by extending the statute of the EIB Group to allow more risk-taking for the provision of European public goods, particularly by increasing lending volumes with the same underlying capital, as well as considering the provision of equity.

08. A new simplified Competitiveness IPCEI would replace the current IPCEI framework and extend its scope to cover first-of-its-kind and industrial infrastructure; define a time limit to collect the necessary agreements to start the project and offer the possibility for companies – especially the smallest and newest in a market – to contribute through EU subsidies.

09. For applied and breakthrough industrial research, a new Competitiveness Joint Undertaking would attract adequate resources for the translation of the envisaged technology into actual deployment, particularly for large-scale technological projects and related infrastructure. Member States should be incentivised to pool national resources and large private risk capital should be attracted using simplified rules serving the delivery of the joint project. The new Competitiveness Joint Undertaking would continue to be partly financed through the Research and Innovation Framework Programme as Joint Undertakings are today.

The 'Competitiveness Action Plans' would be made public, and the Commission and relevant EU agencies would review progress made annually to assess the use of the financial incentives disbursed up front, and report back to the European Parliament and the Council (as budgetary authorities). Every year, at a European Council meeting, the 'EU Competitiveness Priorities' would be assessed against the latest political and market developments, so that the means defined for their implementation could be adjusted if needed – first and foremost, the implementation of the EU budget under its annual procedure. For the very first cycle, the Competitiveness Coordination Framework could take this report as a starting point presenting priorities as illustrated below:

- **EU Competitiveness Priority 1**: Accelerate innovation across the EU.

The **EU Innovation Action Plan** would translate the EU Priority into targets and objectives, such as: designing and coordinating national R&D plans aiming to map and support centres of excellence across the EU, coordinating efforts in building technological and research infrastructure, and setting national R&D spending targets to progress towards achieving the goal of spending at least 3% of EU GDP on R&D. To achieve these objectives, incentives described under the 'Coordination of national policies for competitiveness' would apply.

- **EU Competitiveness Priority 2**: Ensure secure, decarbonised and affordable energy under a true Energy Union.

The **EU Energy Action Plan** would translate the EU Priority into measurable objectives aimed at lowering the price of energy and create the infrastructure needed to manage a decarbonised system in a cost-efficient way at the EU level. This includes decarbonised supply, energy grids and interconnections, the achievement of TEN-E links and cost-efficient investment at the EU level on demand flexibility (grids, storage, demand flexibility schemes, capacity mechanisms for batteries and renewable sources, etc.), identifying potential IPCEIs. The action plan would specify the use of the funding instruments listed above under 'Investment in EU public goods'. The action plan would also set objectives of a regulatory nature, such as: repatriating regulatory tasks from private bodies to national regulators, sharing national decisions that have direct cross-border impact on various EU Member States, deciding on which functions to perform centrally, etc. To achieve these objectives, incentives described above under the 'Coordination of national policies for competitiveness' would apply.

- **EU Competitiveness Priority 3**: Equip the EU's workforce with the skills needed by today and tomorrow's economy.

The **EU Education and Skills Action Plan** would translate the EU Priority into targets and objectives, such as: mapping skills needs, modernising and benchmarking curricula in formal education along the skills map (for instance, STEM curricula starting from primary school) and developing lifelong learning schemes with a quantified target in each Member State. To achieve these objectives, incentives described above under the 'Coordination of national policies for competitiveness' would apply.

- **EU Competitiveness Priority 4:** Boost digitalisation, as well as the development, deployment and adoption of advanced digital technologies in the EU – including AI – across key economic sectors.

The **EU Digital Action Plan** would translate the EU Priority into measurable objectives on advanced connectivity (e.g. fast broadband, including access to standalone 5G and 6G) and the related deployment of new infrastructure in the EU. The action plan would specify the use of the funding instruments listed above under 'Investment in EU public goods'. The action plan would also specify targets for cross-border industrial projects in advanced digital technologies, for example, providing a target for the construction of foundries for strategic semiconductor sectors or for the joint development of new vertical applications of AI across key areas, such as energy, transport, and pharmaceuticals. To achieve these objectives, the action plan would specify the use of tools and financial incentives described above under 'Launch multi-country industrial projects' – and rely also on the implementation of other action plans, for example those on skills and innovation. Experts or businesses could have a coordination role in some of these multi-country industrial projects developing new AI vertical use cases. Finally, the action plan would set objectives of a regulatory nature, such as the coordination of national digital policies and regulations with clear externalities, including spectrum policy. To achieve these objectives, incentives described above under the 'Coordination of national policies for competitiveness' would apply.

- **EU Competitiveness Priority 5:** Increase the EU's defence industrial capacity to meet Europe's security needs.

The **EU Defence Action Plan** would translate the EU Priority into targets and objectives. Based on the mapping of the sector's needs, one of the objectives could be the development of joint defence projects in new strategic industrial segments. These could focus on segments which require new interoperable cutting-edge technological capabilities and large investment (e.g. drones, hypersonic missiles, directed-energy weapons, defence artificial intelligence, seabed and space warfare, etc.). The action plan would specify the use of the funding instruments listed above under 'Launch of multi-country industrial projects'. The action plan would also define the role and involvement of relevant research entities and companies in pooling their respective capabilities.

Accelerating the work of the EU

The urgency of regaining Europe's competitive edge should also be reflected in an accelerated legislative procedure. The total average length of an ordinary legislative procedure was 19 months (from the Commission's proposal to the signing of the adopted act) during the first half of the 2019-2024 parliamentary term[i]. This calls for a clear acceleration of our collective work, even at the cost of opting for a model of 'concentric circles' as a first step to achieve broader integration among all 27 Member States. It also calls for simplification and the reduction of excessive bureaucracy, as recommended under 'Simplifying rules' below.

EXTENDED THE USE OF QUALIFIED MAJORITY VOTING IN THE COUNCIL OF THE EU

Council votes subject to QMV should be extended to more areas, or even generalised. So far, many efforts to deepen European integration between Member States have been hindered by unanimity voting in the Council of the European Union. This has been the case, in particular, in policy areas including taxation, justice and home affairs, as well as employment and social policies. A well-known example is the failure back in 2008 to introduce a new 'European Private Company' (Societas Privata Europaea) as a voluntary 28th rulebook for all Limited Liability Companies in the EU. This failure was due to Member States' long-standing vetoes. All possibilities offered by the EU Treaties should therefore be exploited to extend QMV. The so-called 'passerelle' clause could be leveraged to generalise voting by qualified majority in all policy areas in the Council. This step would require an upfront agreement, subject to unanimity at the level of the European Council and would have a positive impact on the pace at which key legislative initiatives are adopted at the EU level[10].

DIFFERENTIATED APPROACHES TO EU INTEGRATION

However, if action at the EU level is hindered or blocked by existing institutional procedures, a differentiated approach to integration should build on the smart use of existing instruments currently foreseen by the EU Treaties. The preferred option would be resorting to the **possibility of enhanced cooperation** foreseen by Articles 20 TEU and 329 TFEU where "the objectives of such cooperation cannot be attained within a reasonable period by the Union as a whole, and provided that at least nine Member States participate in it"[11]. Enhanced cooperation offers two important safeguards: the consent of the European Parliament and the judiciary oversight of the Court of Justice of the EU. It is also based on a Commission proposal. As an illustration, following the failure of the proposal to introduce a European Private Company, a voluntary 28th company rulebook harmonising key aspects of corporate law, insolvency, labour law and taxation could be explored under enhanced cooperation by willing Member States, as described in the chapter on innovation.

As a last resort and in the clear absence of the required conditions to fall back on enhanced cooperation, intergovernmental cooperation should be considered. However, acting outside of the Treaties creates parallel legal frameworks (the international and the community one), and implies the absence of judicial oversight of the European Court of Justice, of the democratic legitimacy of the European Parliament, and of the Commission's involvement in preparing the texts. It should, therefore, be accompanied by strong safeguards, including adequate incentives for other Member States to eventually join the coalition of the willing and to bring such cooperation back into the framework of the EU Treaties as soon as possible. A precedent is the Treaty on Stability, Coordination and Governance (TSCG), also known as the Fiscal Compact, which began as an intergovernmental treaty which entered into force in January 2013, but was subsequently integrated into EU law.

10. The Commission has recently made a proposal on using the 'passerelle' clause in the field of CFSP. See: European Commission, Communication from the Commission to the European Parliament, the European Council and the Council on pre-enlargement reforms and policy reviews (COM(2024) 146), 2024. See: European Commission, Legal service, 70 years of EU law – A union for its citizens, Publications Office of the European Union, 2023.

11. The decision to use enhanced cooperation is adopted by QMV, including in areas which require unanimity. Only for enhanced cooperation in the area of CFSP is there the requirement for unanimity. Within enhanced cooperation, moreover, the voting rules provided for in the substantive legal basis apply (e.g. unanimity for enhanced cooperation in the field of taxation), unless the Member States interested in enhanced cooperation make use of the possibility to use QMV provided for in Article 333 TFEU.

EXTENDED USE OF A BETTER FRAMED ARTICLE 122

Finally, the increased successful use of Article 122 TFEU to underpin swift EU action in times of crisis suggests that the EU could extend its use and have it clarified through an Interinstitutional Pact. Article 122 TFEU has often allowed the Union to react and legitimately adopt necessary measures to deal with emergency situations (e.g. the COVID-19 pandemic or the energy crisis). Article 122 is subject to the scrutiny of the European Court of Justice, but not of the European Parliament. Recent practices have managed to ensure the involvement of the European Parliament to a certain degree[ii]. However, if the EU would have the ambition of accelerating its action using this article, it would be necessary to clarify the emergency procedure in EU law, ensuring full democratic legitimacy by involving the European Parliament at least in triggering a state of emergency, and entailing strict deadlines once set. To avoid Treaty changes, an Interinstitutional Pact at the beginning of each legislature would allow the codification of past successful practices, and the establishment in advance of clear 'rules of the game' to deal with emergency situations.

Simplifying rules

THE STARTING POINT

Excessive regulatory and administrative burden[12] can hinder the competitiveness of EU companies compared to other blocs. It negatively affects sectoral productivity, for instance by increasing companies' operation costs and raising barriers to entry for new companies, deterring competition. Moreover, it may lead to higher prices for consumers[iii]. Indicators based on surveys and perceptions, such as the World Bank's Doing Business database, suggest that the business environment in the EU is less favourable than in the US[13]. Moreover, 61% of participating companies in the 2023 EIB Investment Survey flagged regulation as an obstacle to long-term investment in the EU[14], and 83% of companies polled in 2023 by Business Europe across 21 Member States raised complexity and the duration of permitting as key obstacles to investing in Europe, compared to other regions.

Quantifications of the aggregate regulatory burden in the EU, especially compared to other blocks, are hindered by differing or piecemeal approaches. Comparable metrics of the aggregate regulatory burden across world regions could usefully guide policy-making, especially in areas where Europe is particularly exposed to international competition. However, attempts to obtain them are hindered by divergences in regulatory models, for instance between the EU's rights-driven approach and the US' innovation-driven one[iv]. As a result, only few international comparisons exist in specific sectors, such as banking[v]. Looking at the EU only, the Commission's Regulatory Fitness and Performance Programme (REFIT) used to include fitness checks of the regulatory burden of sectoral policy initiatives based on cumulative cost assessment models[15]. However, given their complexity, those quantitative exercises have remained rare and largely self-standing. In 2014, the Stoiber Group estimated the EU's administrative burden at EUR 150 billion, or 1.3% of GDP a year[vi]. When also considering other benefits – e.g. removing complex procedures, excessive national requirements, and unharmonised labelling standards – the opportunity cost of a lack of harmonisation reaches EUR 200 billion a year[16].

Quantitative estimates by the public sector mostly concern new policy initiatives in the form of impact assessments. Among the EU institutions, however, only the European Commission has developed a methodology (the Standard Cost Model) to calculate regulatory burden. Instead, the co-legislators (the European Parliament and Council) have no methodology in place to measure the impact of amendments proposed to draft EU legislation. Moreover, even the Commission's methodology is broad and accepts a variety of metrics to assess costs (for instance, different discount rates, price years and appraisal periods), making it harder to aggregate the costs of new regulation across sectors. Finally, there is no single methodology in place to assess the impact of EU legislation once transposed at the national level, with only a few Member States systematically measuring the impact of transposed EU law. In the absence of a single, coordinated approach by the public sector, estimates of regulatory burden are

12. Throughout this chapter, the definitions of regulatory and administrative burden are aligned with the Commission's Better Regulation Guidelines (SWD(2021)305) and Toolbox (in particular, Tool #56). Regulatory costs are deemed to include administrative burden (i.e. costs resulting from administrative requirements contained in legal acts, including reporting requirements), together with regulatory charges (e.g. fees, levies or taxes on certain stakeholders) and adjustment costs (incremental and the non-business-as-usual costs of complying with new requirements other than charges and administrative costs, such as direct labour costs, overheads, equipment costs, material costs, the cost of external services, etc.).

13. With a score of 84%, the US placed sixth worldwide in the 2020 ranking, well ahead of the EU (which scored 76.5%, ranking thirty-ninth worldwide). This is thanks to the US' better performance in three sub-components of regulation – the processing of construction permits, the registration of property, and paying taxes.
See: World Bank, Doing Business 2020: Region Profile European Union, 2020.

14. A greater number of EU companies voice concerns about sectoral regulation and compliance with new rules, standards, and certifications as key obstacles to international trade. US companies, on the other hand, are more likely to flag business and labour market regulations among their top perceived barriers.
See: EIB, EIB Investment Survey 2023: European Union Overview, 2023.

15. An example is the 2019 fitness check of the most relevant chemicals legislation in the EU, which estimated regulatory costs of EUR 9.5 billion per year from 2004 to 2014, but large environmental and health benefits too. See: European Commission, Commission Staff Working Document – Fitness Check of the most relevant chemicals legislation (excluding REACH), as well as related aspects of legislation applied to downstream industries (SWD(2019) 199 final/2), 2019. In 2023, an analysis of 50 impact assessments by DG GROW showed that average annual compliance costs had nearly doubled compared to 2014. In particular, recurring average annual compliance costs for an SME in the chemical industry almost doubled from EUR 332,500 in 2014 to EUR 577,000 in 2023.

16. European Parliament Think Tank, Mapping the cost of non-Europe report: Theoretical foundations and practical considerations, 2023.

often left to the initiative of the private sector (e.g. consulting companies or sectoral associations)[17]. This contributes not only the heterogeneity of these estimates, even within the same sector, but also to private operators' perception of a high level of regulatory burden.

A larger 'regulatory flow' – defined as the number of new provisions passed in a dedicated time period – is among the factors making the EU's regulatory environment less favourable for conducting business compared to the US. While direct comparisons are prevented by different political and legal systems, around 3,500 pieces of legislation were enacted and around 2,000 resolutions were passed in the US at the federal level over the past three Congress mandates (2019-2024)[vii]. During the same period, around 13,000 acts have been passed by the EU, of which 515 ordinary legislative acts, 2,431 other legislative acts, 954 delegated acts, 5,713 implementing acts and 3,442 other acts[18]. This comes in addition to national legislation passed in each Member State. As an example, Dansk Industry found that due to developments in both EU and national legislation the number of applicable regulations in Denmark rose by 63% from 2001 to 2023. Other factors contributing to the perception of a less conducive business environment in the EU include a different constellation of veto points, with the US having a more federal structure and fewer authorities involved in approval processes[19]; and the fact that the benefits of regulation for society, individuals and the environment are more difficult to quantify and hardly considered in net cost assessments[viii].

Three examples from EU law – the sustainability reporting and due diligence framework, the General Data Protection Regulation (GDPR), and the EU's waste and packaging waste legislation – are analysed to highlight the following top three regulatory difficulties encountered by companies:

- Complying with the accumulation of EU legislation and its frequent changes over time, translating into regulatory overlap and inconsistencies.
- The extra burden added by national transposition and enforcement, including Member States 'gold-plating' EU legislation, as well as diverging implementing requirements and standards in different Member States[ix].
- The proportionally higher regulatory burden faced by SMEs and small mid-caps compared to larger companies.

The EU's sustainability reporting and due diligence framework[20] is a major source of regulatory burden, magnified by a lack of guidance to facilitate the application of complex rules and to clarify the interaction between various pieces of legislation. The goal of this framework is to strengthen rules concerning the social and environmental information that companies have to report. This entails a major compliance cost for companies in the EU[21], ranging from EUR 150,000 for non-listed undertakings to EUR 1 million for listed ones[22]. Moreover, risks of over-compliance (e.g. over-reporting) exist across the value chain. Reasons for this currently include unclear definitions

17. For instance, SIRA Consulting BV ('Regulatory pressure indicator on SMEs in six sectors', 2023) estimated that the overall cost of regulatory burden for an average Dutch SME varies between EUR 38,000 and EUR 250,000, depending on the size of the company and their business activity. The majority of these costs are due to horizontal legislation, including labour law, taxation, and sector-specific regulation.

18. EUR-LEX, Legal acts – statistics, retrieved on 19 August 2024. 2019 is included in the sum to allow a comparison with the US. If 2019 is excluded, the sum is around 11,000 new acts. The trend is increasing compared to the 2014-2019 mandate as regards legislative acts, as well as delegated and implementing acts.

19. For instance in areas, such as environmental legislation, subject to shared competences in the EU and largely managed by federal bodies like the Environmental Protection Agency in the US. See: Stevens-Finlayson, B., EU vs US. Comparing the EU and US Federal Systems, 2019.

20. EU legislation considered includes: i) the Corporate Sustainability Reporting Directive (CSRD); ii) the Taxonomy Regulation, notably with its 'do no significant harm' (DNSH) assessment; iii) the Sustainable Finance Disclosure Regulation; iv) the Corporate Sustainability Due Diligence Directive; v) the Eco-design for Sustainable Products Regulation (ESPR); vi) the Industrial Emissions Directive (IED); vii) the Emissions Trading System (ETS); and viii) REACH.

21. As of the financial year 2024, and with phase-in over the next three years, approximately 42,000 large companies and listed SMEs subject to the CSRD must prepare extensive sustainability statements based on the European Sustainability Reporting Standards (ESRS), adopted by the Commission based on a proposal by EFRAG. EFRAG, formerly known as the European Financial Reporting Advisory Group, is the independent technical advisory body on ESRS. The ESRS includes 1,052 quantitative or qualitative datapoints, of which 783 for mandatory disclosure (80% of them, i.e. 622 datapoints, are "subject to materiality" i.e. only to be disclosed if relevant to the company) and 269 for voluntary disclosure.

22. See: EFRAG, Cost-Benefit Analysis of the First Set of Draft ESRS, November 2022. Consistently, the Danish government estimates average one-off costs of EUR 365,000 and recurring costs of EUR 310,000 a year for a company in Denmark to comply with the CSRD and Article 8 of the Taxonomy Regulation. This is based on a survey of 2,200 companies falling under the CSRD and is, therefore, a floor not including additional costs for SMEs having to report to parent companies across the supply chain.

and requirements, for instance concerning the application of the 'do no significant harm' principle within the EU taxonomy and its alignment with the related assessment for the EU budget; burdensome and potentially overlapping methodologies for emissions accounting between the eco-design for sustainable products regulation, the ETS and the product environmental footprint[23]; and unharmonised timelines for different but related reporting requirements. Further changes in this framework, including sector-specific reporting standards required by the CSRD, may raise compliance costs.

'Gold-plating' by Member States of the GDPR and a lack of consistency in its enforcement adds to EU companies' administrative burden. The GDPR, which entered into force in 2016 and is directly applicable in all Member States, aims to offer a harmonised EU approach to privacy enforcement. However, it gives Member States the possibility to define privacy rules in 15 areas, leading to fragmentation and legal uncertainty stemming from the widespread use of specification clauses, 'gold-plating' [Box 1] and inconsistent enforcement by national Data Protection Authorities (DPAs), and the fact that some Member States have several DPAs doing so (e.g. 16 in Germany). This could hinder cross-border entrepreneurship and innovation, including the development and deployment of new technologies and cybersecurity solutions. As an example, divergence in the age of consent across Member States creates uncertainty in the application of data protection rights for children in the Single Market[24]. Estimates point to high GDPR compliance costs, up to EUR 500,000 for SMEs[x] and up to EUR 10 million for large organisations[25]. Furthermore, due to these compliance costs, EU companies decreased data storage by 26% and data processing by 15% in relation to comparable US companies[26]. However, in December 2023, Member States in the Justice and Home Affairs Council formation resisted further harmonisation[27].

23. For instance, ESPR includes information requirements already to be reported via the Digital Product Passport when a product is placed on the EU market.

24. The age of consent is 13 in Belgium, Denmark, Estonia, Finland, Latvia, Malta, Portugal, Sweden; 14 in Austria, Bulgaria, Cyprus, Spain, Italy, Lithuania; 15 in the Czech Republic, Greece, France; 16 in Germany, Hungary, Croatia, Ireland, Luxembourg, the Netherlands, Poland, Romania, and Slovakia. See: European Commission, Communication from the Commission to the European Parliament and the Council – Data protection as a pillar of citizens' empowerment and the EU's approach to the digital transition – two years of application of the General Data Protection Regulation (COM(2020) 264), 2020.

25. 68% of the large companies surveyed by PwC planned to spend between GBP 1 million and GBP 10 million to meet the GDPR requirements. See: The Privacy Compliance Hub, How much? The cost of getting privacy right, 2023. The average cost of GDPR compliance for a mid-sized company with 500 employees is found to be around EUR 1.3 million. See: UK Insight, Organizations Worldwide Fear GDPR Non-Compliance Could Put Them Out of Business, 2017. As reported by the Financial Times (Companies face high cost to meet new EU data protection rules, November 2017, accessed on 17 June 2024), the International Association of Privacy Professionals, and Ernst & Young also estimate that the average cost for large EU-based companies to achieve GDPR compliance could be in the order of EUR 1.3 million per company, with ongoing annual costs of EUR 1.1 million for maintenance.

26. For data-intensive industries, such as software, the cost increase due to GDPR compliance can be as high as 24%. Other sectors, like manufacturing and services, experience an average cost increase of 18%. See: Demirer, M., Jiménez Hernández, D. J., Li, D., and Peng, S., Data, Privacy Laws and Firm Production: evidence from the GDPR, February 2024.

27. "Justifying a certain degree of fragmentation, especially in processing activities where Member States have their own jurisdiction or in areas where national legislation lays down specific conditions for processing of personal data, such as in an employment context". Position and findings adopted at the Justice and Home Affairs Council, December 2023. See: European Commission, Communication from the Commission to the European Parliament and the Council – Second Report on the application of the General Data Protection Regulation (COM(2024) 357), 2024.

BOX 1

Gold-plating

The European Commission describes gold-plating as the process by which a Member State, which has to transpose EU legislation into national law or implement EU legislation, imposes additional requirements, obligations or standards in its national law that go beyond the requirements or standards of EU law – thereby imposing additional and avoidable regulatory costs[xi]. This can happen throughout the policy cycle, from the transposition of primary law to the implementation via delegated or implementing acts, to national enforcement of regulation. The main reasons why Member States gold-plate include the following:

(i) **EU directives may just set policy goals to be achieved by the Member States but leave up to each country the exact measures to be put in place to achieve them.** This requires the transposition of each directive into national law through domestic legal acts. So-called super-equivalence happens when the national implementation of a directive goes beyond the minimum necessary to comply with it – for example, Member States may remove derogations or extensions present in the original act; retain national standards which are more stringent or higher; apply the directive earlier than the stated deadline; or transpose with a wider scope than the EU directive[xii].

(ii) **EU legislation may deliberately leave flexibility in the level of harmonisation or Member States' practice.** While some matters are fully harmonised at EU level – with the EU legislator setting both a 'floor' (i.e., a baseline) and a 'ceiling', without any room for adding requirements at national level, some matters are the object of minimum EU harmonisation, for instance in areas such as consumer protection. This leaves room for Member States to set standards or requirements at national level above the identified baseline, where justified and proportionate to pursue legitimate public interests. This may lead to different rules across the single market, translating into additional regulatory or administrative burden for businesses, with a larger impact on SMEs, and making it more difficult for consumers to understand the scope of their protection[xiii].

(iii) **Double-banking.** The effects of domestic politics and national legislative processes tend to be another prominent reason for gold-plating. Member States may – by mistake or deliberately – leave national legislation in place on matters regulated by EU law, creating a dual regulatory regime, which can be burdensome. For example, where an EU act is deregulatory in an area of national sensitivity (e.g. tax or financial stability), national parliaments may introduce or keep in place requirements and restrictions that prevent the effective implementation of the EU acquis on the ground[xiv].

(iv) **Lack of adequate enforcement of measures to tackle Member States' gold-plating**. Additional national requirements, even within the legal rules, must be justified by overriding reasons of public interest, be non-discriminatory, proportionate, easy to understand and compliant with harmonized minimum rules – with differences kept to a minimum to safeguard the objectives of the Single Market. Under the Treaty, the European Commission has the power to bring infringement procedures and assist Member States in improving compliance with EU law pursuing the common objective of a well-functioning Single Market. However, both the use of redress mechanisms and soft cooperation between the Commission and the Member States could be strengthened to ensure efficient implementation and enforcement of Single Market legislation[xv].

The waste and packaging waste legislation[28] has been repeatedly identified as a major source of regulatory cost for SMEs due to overlapping horizontal and sectoral requirements. It sets out principles for waste and packaging waste management and emphasises the need for companies to adhere to strict requirements on waste handling, disposal and recycling not to endanger human health or the environment. However, in the absence of EU-level criteria, Member States and even EU regions currently apply deeply diverging rules and reporting categories[29]. A lack of common rules or interpretation causes uncertainty for EU operators and recyclers, requiring producers to manage a superset of data fields to satisfy all national reporting obligations[30]. Moreover, regulatory overlaps within and across product, chemical and waste legislation create unnecessary costs for businesses and administrations due to the duplication of compliance checks, legal uncertainty and the risk of sanctions[31]. With regard specifically to permitting, a gap analysis of 13 pieces of EU law, including the Waste Framework Directive, flagged duplication across 169 requirements, including differences (29%) and outright inconsistencies (11%)[xvi]. Finally, provisions may be duplicated or economic activities covered both by general framework legislation and sector-specific rules. While in principle sectoral legislation has priority over framework legislation in case of conflict (by virtue of the lex specialis principle and by being generally more recent), this is not automatic, but left to a case-by-case judicial assessment, to the detriment of legal certainty.

All three examples also point to the need to better consider the size of companies affected by regulation, using appropriate mitigation measures in line with the proportionality principle. SMEs tend to perceive the cost of complying with EU law as greater, also because they are less likely to survive long enough to reap the full benefits of regulation. In 2023, 55% of SMEs flagged regulatory obstacles and administrative burden as their greatest challenge. This was also the second most quoted challenge for start-ups (52%, after access to finance) and the third most frequently cited for mid-caps (36%, after difficulties in finding employees and supply chain disruptions)[xvii]. Overall, while SMEs are often exempted from the scope of EU laws or benefit from other 'mitigating measures', all the analysed case studies suggest that these measures do not go far enough in addressing the challenges faced by smaller companies. Namely:

- Due to value chain effects, the sustainability reporting and due diligence framework does not adequately differentiate SMEs from larger companies[32]. Moreover, the CSRD is flagged as an example of the lacking proportionality of the EU acquis vis-à-vis mid-caps, as compliance costs represent up to 12.5% of mid-caps' investment volumes[33].
- Within the waste and packaging waste framework, EPR reporting obligations mostly apply to all producers equally, without considering their scale or environmental impact[34].

28. Including the Waste Framework Directive and linked legislation, such as the recently amended Waste Shipment Regulation. Namely, the 'polluter pays' principle and extended producer responsibility (EPR) make producers responsible for all waste generated by their products and require that they put in place robust waste management.

29. Except for three product groups: iron, steel, and aluminium; copper scrap; and glass cullet. This concerns, for instance, the end of waste (i.e. when waste ceases to be waste and becomes a secondary raw material), leading to a fragmented Single Market and high administrative costs for businesses.

30. For instance, there are 27 ways to report on packaging because of different definitions and templates, as well as diverging rules on what enters the hazardous waste classification. End-of-life lithium-ion batteries and intermediates of recycling, such as battery production waste and black mass, might be classified differently across Member States in the absence of EU rules on their classification as hazardous or non-hazardous waste.

31. As an example of the overlap between product and waste legislation, the provisions dealing with EPR in the Packaging and Packaging Waste Directive are based on the Waste Framework Directive, which are applicable to all EPR schemes, while sectoral rules for packaging have been introduced. Moreover, specific EPR rules for textiles are foreseen within the same act setting out general provisions on EPR.

32. For instance, while the CSRD only applies to large companies and listed SMEs (with the latter also benefitting from a longer transition period for transposition, ending on 1 January 2026 and with the possibility of a further two-year opt-out), micro-enterprises and non-listed SMEs are impacted by trickle-down effects along the supply chain. More proportionate standards for use by listed SMEs to meet their reporting requirements under the CSRD as well as simplified standard for voluntary use by non-listed SMEs are still in the making.

33. EIB and EPC, Hidden Champions, Missed Opportunities – Mid-caps' crucial roles in Europe's economic transition, 2024. The General Secretariat of European Entrepreneurs (CEA-PME) estimates the average initial cost for a mid-cap to comply with the CSRD to be EUR 800,000 over two years – based on a survey of French mid-caps.

34. In the textiles sector, the Commission has proposed excluding micro-enterprises from these obligations, which entail reporting costs of at least EUR 540 per operator a year. Similarly, the packaging and packaging waste proposal would exempt certain operators, such as micro-companies, from the obligation to meet packaging re-use targets.

- The GDPR does not exempt SMEs, except in a few cases[35].

Systematic quantitative evidence of the cumulative burden of EU legislation on SMEs and small mid-caps is key to designing appropriate remedies and mitigation measures. This is one area in which the Commission is weak. About 80% of Commission Work Programme items are relevant to SMEs[xviii]. Nonetheless, only around half (54% in 2020 and 45% in 2021) of impact assessments substantially assessed the impacts of legislation on SMEs, and almost one-third of Regulatory Supervisory Board opinions asked for improvement in this regard. Moreover, the 2022 SME Test Benchmark pointed to a majority of analysed impact assessments not being of sufficient quality[xix]. The picture is bleaker when small mid-caps are considered, in particular given the lack of a commonly agreed European definition and of readily available statistical data. This has resulted in small mid-caps being largely absent from EU policy-making, as well as from related impact assessments. Unleashing the full potential of small mid-caps for EU competitiveness will require a sustained and systematic effort at the Member State and EU level across the board concerning both regulation and industrial policy[xx].

OBJECTIVES

- **Simplify the existing EU acquis and filter new proposals.**
- **Better enforce Single Market legislation.**
- **Apply a proportionate regime for SMEs and small mid-caps in the existing and future legislation.**
- **Promote innovation.**

To achieve these objectives, three overarching principles guide the proposals below:

- Identify in advance the rationale and objectives of EU law and strike the right balance between the principle of precaution and the principle of innovation. For instance, it should be identified when minimum or full harmonisation should be pursued.
- Choose the best legislative instrument (regulation, directive, decision, recommendation, delegated act or implementing act) meeting the identified rationale, while reducing the costs of regulatory compliance, transposition and reporting as far as possible.
- Manage the EU acquis effectively by ensuring the availability of all information needed to pass effective legislation. This includes early systematic, and cost-efficient stakeholder consultation on legislation to enhance its quality. Withdraw obsolete legislation, identify and address overlaps and contradictions, and focus on improving implementation and enforcement in Member States.

The ultimate goal should be to make EU and national regulation a consistent single corpus representing a competitive strength for the EU.

35. For instance, SMEs that are not primarily engaged in data processing and do not pose a specific threat to individuals' rights and freedoms are exempt from appointing a Data Protection Officer. Moreover, companies with less than 250 employees do not need to maintain data records, unless they regularly process personal data, pose risks or handle sensitive information.

PROPOSALS

1. Streamline the EU acquis under a new Vice-President for Simplification.

- At the start of each Commission mandate, before adopting new legislation, a fixed period of at least six months should be devoted to an 'evaluation bank' systematically assessing and stress-testing all existing regulation by sector of economic activity.
- On the basis of this stress-test, a second phase should focus on pursuing the codification and consolidation of EU legislation by policy area. This should include simplifying and removing overlap and inconsistencies across the whole 'legislative chain', with priority given to those economic sectors where Europe is particularly exposed to international competition (for instance, clean technologies). Digital tools could also help [Box 2].
- This exercise should be run by all members of the College of Commissioners, with each Commissioner taking responsibility for stress-testing and the subsequent simplification of EU legislation in the respective competence areas, under the coordination of a Vice-President for Simplification. The Vice-President would also be in charge of interinstitutional relations to build the consensus needed with co-legislators on legislative codification and streamlining.
- At the same time, a lex specialis principle should be clarified as a general horizontal rule, whereby, in case of conflict among EU laws, sectoral or more specific rules would automatically prevail, to the benefit of legal certainty[36].

BOX 2

Digital tools, and especially AI, to reduce the compliance burden

The evaluation bank [proposal 1], could be supported by the use of digital tools and especially AI (in particular, large language models) to rapidly analyse large volumes of legal documents and identify areas for consolidation, simplification and the removal of overlaps and inconsistencies[37].

Digital tools should also be used to fully enforce the 'once only' and 'digital by design' principles in EU legislation – including fully digitalising business-to-authority reporting not only at the EU level, but also in Member States. In parallel, full cross-border interoperability solutions among public sector bodies should be ensured through ambitious implementation of the Interoperable Europe Act.

While the obligation to share information remains with businesses, administrations should adopt a stronger role in organising and streamlining reporting, including through the use of cutting-edge digital technologies, such as AI[38], commonly agreed and harmonised reporting templates to automate the generation of required documentation[39], de minimis reporting thresholds, and centralised reporting requirements using one multilingual interface.

Finally, national permitting procedures should be fully digitised, made interoperable and better coordinated at the EU level to reduce related costs and boost entrepreneurship. While safeguarding environmental credentials, the environmental impact assessment could be reviewed, introducing a time limit across the EU for

36. Currently, lex specialis is a recognised principle within EU law. There is no overarching rule that a horizontal principle of lex specialis applies automatically to all EU regulations. Its application, therefore, depends on the specific legislative context and interpretation by the EU's courts.

37. Recently, a one-off exercise of this kind has been carried out to streamline reporting obligations, particularly for SMEs.

38. AI applications (in particular, large language models) could be used to rapidly analyse large volumes of regulatory documents and to identify potential conflicts and redundancies, as well as areas for consolidation and streamlining. Machine learning could also help to simulate the impact of new proposed legislation, helping policy-makers to make more informed decisions. Finally, AI-powered software and virtual assistants could provide real-time or even predictive feedback on possible compliance issues and offer automated guidance on meeting regulatory requirements, including translating complex legal provisions into understandable language.

39. As an example, the Fit4Future Platform proposed a fully automated approach to sustainability reporting under the CSRD. Moreover, a revision of the Waste Framework Directive could be an opportunity for digitalising and streamlining reporting obligations concerning the circular economy, adopting a holistic approach across waste, product, and chemical legislation.

national administrations to respond in digital format. Once this time period has expired, companies would be able to proceed with their projects under the condition that operators would be responsible for restoring the status quo in case of a final negative assessment.

2. Use a single, clear methodology to quantify the cost of new legislation for EU institutions and Member States. This methodology should be adopted by the Commission when making a proposal, by co-legislators when amending legislation, as well as by Member States when transposing it.

- A single methodology should be developed and consistently applied within the Commission across its impact assessments, to control (and reduce where needed) the cost of new legislation for all operators – while taking into account national spillovers. The single methodology would pay special attention to the costs for SMEs and small mid-caps.
- The Commission should regularly make these figures on new regulatory and administrative burden across sectors publicly available, indicating the Commissioner(s) and department(s) responsible for legislation and its streamlining.
- An Interinstitutional Deal should ensure that the Council and the European Parliament take full responsibility for assessing (using the same methodology as the Commission) the impact of substantial amendments proposed during legislative negotiations.
- Finally, Member States should be encouraged to adopt the same methodology to measure the cost of transposition for concerned parties [see proposal 3].

3. Minimise the cost of Member State transposition and enhance enforcement of Single Market legislation.

- Strengthen the role of the Single Market Enforcement Taskforce (SMET) in assessing how Member States implement Single Market rules. This should include evaluating and addressing instances of incorrect transposition and transposition which exceeds the requirements of EU directives – with possible recourse by the European Commission to the European Court of Justice as needed to redress them.
- Add a new standard requirement in the article on the transposition of directives requiring Member States to systematically assess, using the same methodology as the EU institutions, the impact of their transposition measures on concerned parties (including instances of 'gold-plating'). The results of this assessment should be made public to improve transparency and discourage 'gold-plating'.
- Implementation and enforcement authorities in all Member States should work closer together and be streamlined and merged. Examples are the approaches taken by the Federal Network Agency (BNETZA) in Germany or the US Federal Trade Commission's (FTC) joint enforcement on data protection, competition, and consumer protection. Deepening cooperation and enhancing streamlining would ensure more systematic and consistent implementation. Compliance costs for companies arising from transposed legislation would also be reduced, as businesses would benefit from interactions with a single point of contact and from clearer information.
- Finally, national courts should be encouraged to exchange in the framework of an EU-wide peer review forum, with the final objective to attain a good degree of coordination and harmonisation in the judicial enforcement of EU law across Member States.

4. Uphold proportionality for SMEs and small mid-caps in EU law, including by extending mitigation measures to small mid-caps.

- The Commission should urgently define the baseline upon which to calculate the already announced cut by 25% in the cost of reporting obligations and fully implement it, while committing to further reducing it for SMEs (up to 50%). The proposed stress-testing of the EU acquis under the 'evaluation bank' [proposal 1] could support such reduction.

- The Commission should also postpone initiatives which are found to be particularly problematic from a competitiveness or innovation standpoint or with a disproportionate impact on SMEs and suggest the introduction of adequate mitigating measures [Box 3].

BOX 3

A revamped competitiveness test

Upholding proportionality for SMEs and small mid-caps in EU law [proposal 4] could be supported by a revamped competitiveness test, merging the existing competitiveness test and SME test and based on a clear, strong methodology to measure the cumulative impact (including both compliance costs and administrative burden) of all new proposals up for adoption on SMEs.

This test should be performed by involving committees of industrial operators supporting the Commission in assessing the impact of all acts. Moreover, co-legislators, Member States and consultative committees should be involved to progressively ensure a mandatory assessment of all additional impacts on SMEs introduced through delegated and implementing acts, as well as national transposition.

On this basis, the Commission should assess and identify relevant mitigation measures for SMEs that could be extended to further companies, including small mid-caps, particularly where existing regulation applying to large companies is deemed burdensome, disproportionate or as a hinderance to their competitive development[40].

This should be based on a more systematic, EU-wide data collection focused on mid-caps, allowing to expand the revamped competitiveness test to include small mid-caps too.

In the short term, raising the current SMEs definition thresholds could provide a likely competitiveness boost due to the extension of existing mitigation measures to small mid-caps. However, this should go hand-in-hand with a medium-term effort towards building a dedicated industrial policy for mid-caps, starting from their systematic identification across sectors, as well as of their needs and the specific challenges they face compared to SMEs – such as scaling up across borders and obtaining financing.

A voluntary 28th regime for innovative SMEs and mid-caps, as proposed in the chapter on innovation, should be regarded as part of this broader policy effort focused on mid-caps.

5. Review the Commission's system of Expert Groups.

- There are currently over 1000 groups which are consulted by the Commission for law and policy-making purposes – namely, 650 Expert Groups and 450 Sub-Groups, in addition to hundreds of bodies not governed by the rules on Expert Groups, such as comitology committees, social dialogue committees and 'Special Groups'. In most of them, Member States are represented, joined by stakeholders, associations, or experts[41]. Despite such an extensive consultation system, stakeholders still call on the Commission to better consider their views.

- There is a need to revise the process of stakeholder consultation, including streamlining the number of Expert Groups and their overlap with other consultative fora, for the sake of both better policy advocacy and better policy-making, It will also improve the optimal use of resources for all stakeholders involved.

40. For instance, the use of the simplified CSRD reporting standard for listed SMEs currently under development by EFRAG could be extended to cover small mid-caps to reduce their reporting costs. In addition, the frequency of assurance could be reduced for small mid-caps (from every year to every three years).

41. For instance, the Expert Group on the Competitiveness of the Rail Supply Industry (E03536) gathers representatives from 13 Member States and 37 organisations, including major companies or groups active in the sector, trade associations, trade unions and NGOs.

6. Create 'EU innovation hubs' to support Member States' efforts to define sandboxes and promote their use across countries, by offering centralised information to EU businesses.

- EU Representations in all Member States should become 'EU innovation hubs', facilitating the coordination among Member States with national sandboxes or other innovation facilitations in place, as well as providing centralised information to innovative companies in the EU on existing sandboxes to promote their use also in other Member States. Particularly when national sandboxes are established in key economic sectors for EU competitiveness, such as digital technologies [see Box on AI in the chapter on digital and advanced technologies], such 'federated' sectoral sandboxes and their wider use across borders would increase national incentives to policy experimentation in line with sectoral specificities, while enhancing EU-wide spill-overs and innovation.
- In parallel, a more innovation-prone regulatory framework should be achieved via a more systematic use of other flexibility instruments such as experimentation clauses[42], sunset clauses in legislative acts and enhanced cooperation – to ensure the agility needed to keep pace with rapid technological advances.

42. Experimentation clauses (often the legal basis for regulatory sandboxes) are defined as legal provisions which enable authorities tasked with implementing and enforcing legislation to exercise a degree of flexibility on a case-by-case basis concerning the testing of innovative technologies, products, services or approaches. At the same time, a 'one-size-fits-all approach', such as general experimentation clauses at the EU level, may be too general and unsuitable to address the specificity of emerging challenges across sectors or policy areas.

ENDNOTES

i European Parliament, Mid-term Activity Report – Developments and Trends of the Ordinary Legislative Procedure 1 July 2019 - 31 December 2021 (9th parliamentary term), 2021.

ii Calleja, D., et al., EU EMERGENCY - CALL 122? On the possibilities and limits of using Article 122 TFEU to respond to situations of crisis, (forthcoming).

iii Davies, A., Regulation and Productivity, 2014. Ferris, A., Garbaccio, R., Marten, A., and Wolverton, A., The Impacts of Environmental Regulation on the U.S. Economy, 2017. Yang, G., Ding, Z., and Wang, H., 'Can environmental regulation improve firm total factor productivity? The mediating effects of credit resource allocation', Environment, Development and Sustainability, Volume 25, 2023, p. 6799–6827.

iv Bradford, A., Digital Empires: The Global Battle to Regulate Technology, 2023.

v Wyman, O., The EU Banking Regulatory Framework and its Impact on Banks and the Economy: Reference study, 2023.

vi European Parliament, 'Stoiber Group on administrative burdens in EU law', At a Glance: Better-Law Marking in Action, 2014.

vii Govtrack.us, Statistics and Historical Comparison, data retrieved on 17 June 2024.

viii European Commission, Study on the cumulative health and environmental benefits of chemical legislation: Final Report, 2017.

ix European Commission, Cost of the Cumulative Effects of Compliance with EU Law for SMEs: Final Report, 2015.

x Statista, GDPR compliance spending in small businesses 2019, 2024.

xi European Commission, Commission Staff Working Document: Better Regulation Guidelines, 2021.

xii K. Mickute, How to identify and avoid gold-plating EU regulations, 2020.

xiii European Commission, Identifying and addressing barriers to the Single Market, COM(2020) 93 final.

xiv European Parliament, Challenges in the implementation of EU Law at national level, 2018.

xv European Commission, The 2024 Annual Single Market and Competitiveness Report, 2024.

xvi Business Europe, License To Transform: SWOT Analysis of industrial permitting in Europe, 2024.

xvii European Commission, Report on the Survey of EU Start-ups and the COVID-19 Pandemic, 2023.

xviii Results of the 'SME filter' exercise carried out by the SME Envoy's Group.

xix Business Europe, Eurochambres and SME united, SME Test Benchmark 2022 Report, 2022.

xx EIB and EPC, Hidden Champions, Missed Opportunities – Mid-caps' crucial roles in Europe's economic transition, 2024.