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Digital Decade in 2024: Implementation and perspective

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This chapter of the Staff Working Document describes the main achievements and legacy of the EU as a global digital player and regulator, as well as recent efforts to go above and beyond with ambitious economic and industrial policies.

Since the beginning of its mandate, the Von der Leyen Commission has been working to make **Europe fit for the digital age**, strengthening the EU's digital sovereignty, and setting global standards, with a focus on getting the EU's digital infrastructures ready for tomorrow's world. In recent years, the EU has inspired other regions of the world to ensure that (i) digital technologies and services work for people and to promote a more open, democratic and sustainable society; and (ii) the digital economy remains both competitive and fair for both large and small players. However, the EU's stance shifted significantly in 2023 and 2024, and to a greater extent than in the first years of this mandate. The EU is moving beyond its role as a pioneering regulator to become an assertive global actor that is increasingly aware of the strategic importance of technology as an instrument of its sovereignty and competitiveness.

During this mandate, the Commission has overhauled the digital policy landscape, proposing and negotiating the adoption of 23 legislative files ([1]). In addition, about **116 EU laws** relevant to digitalisation have been or will be enacted in 2019-2024 ([2]), including some important legislative files that have been negotiated towards the end of the current mandate. Landmark legislation such as the **Digital Services Act (DSA)** and the **Digital Markets Act (DMA)** has filled significant regulatory gaps and created a safer digital space in which the fundamental rights of all users of digital services are protected and established a level playing field to promote innovation, growth and competitiveness, both in the EU and globally.

As we look ahead to the new political cycle, the co-legislators have adopted **the Artificial Intelligence Act (AI Act)** ([3]) to promote trustworthy AI in the EU and beyond by ensuring that AI systems respect fundamental rights, safety and ethical principles, and by addressing potential risks posed by very powerful and impactful AI models. In January 2024, the Commission also launched a package of measures to support EU start-ups and SMEs in the development of trustworthy AI([4]).

Since the 2016 adoption of the **General Data Protection Regulation** (GDPR) ([5]), the EU has been at the forefront of establishing a robust framework for the handling of personal data. As technology continues to evolve and data-driven innovations proliferate, the EU has continued to adapt its regulatory framework to address emerging challenges, upholding its commitment to safeguarding data protection, privacy and others fundamental rights.

([1]) See SWD 'Digital Decade in 2024: Implementation and perspective' with annexes, SWD(2024)260, https://digitalstrategy.ec.europa.eu/en/news-redirect/833325, Annex 1 List of relevant policy initiatives.
([2]) According to Bruegel's dataset on EU legislation for the digital world: https://www.bruegel.org/dataset/dataset-eu-legislation-digital-world.
([3]) European Parliament legislative resolution of 13 March 2024 on the proposal for a regulation of the European Parliament and of the Council on laying down harmonised rules on Artificial Intelligence (Artificial Intelligence Act) and amending certain Union Legislative Acts.
([4]) https://ec.europa.eu/commission/presscorner/detail/en/ip_24_383.
([5]) Regulation (EU) 2016/679 of the European Parliament and of the Council of 27 April 2016 on the protection of natural persons with regard to the processing of personal data and on the free movement of such data, and repealing Directive 95/14/EC (General Data Protection Regulation) (Commission consolidated text).

The **Data Governance Act** ([6]), the **Data Act** ([7]) and the forthcoming **European Health Data Space Regulation** ([8]) facilitate data sharing within and across sectors to promote innovation and economic growth, while also ensuring that data are protected and secure.

Cybersecurity is one of the Commission's top priorities and a cornerstone of a digital and connected Europe. The EU has since early in this mandate recognised the importance of strengthening the resilience of its critical infrastructure to address cyber threats with the setting-up of the **European Cybersecurity Competence Centre** (ECCC), which aims to increase Europe's cybersecurity capacities and competitiveness, working together with a Network of National Coordination Centres (NCCs) to build a strong cybersecurity Community. Within the policy framework of the 2020 **EU Cybersecurity Strategy** ([9]), the EU has delivered on the promise of ensuring an open, safe and secure cyberspace for citizens and businesses with the adoption of several initiatives: the **EU Cybersecurity Act** ([10]) to strengthen the EU Agency for cybersecurity (ENISA) and establish a cybersecurity certification framework for products and services; the update of the **Network and Information Systems Directive (NIS2 Directive)** ([11]) to increase the numbers of sectors covered and strengthening the security requirements; the set of comprehensive measures for an EU coordinated approach to secure 5G networks **(EU Toolbox on 5G cybersecurity)** ([12]); and the **Digital Operational Resilience Act (DORA)** ([13]) to strengthen the IT security of financial entities in the event of severe operational disruptions. This framework is complemented by the forthcoming **EU Cyber Resilience Act (CRA)** ([14]), which safeguards consumers and businesses, as well as operators of critical infrastructure that buy or use products or software with a digital component; and the forthcoming **EU Cyber Solidarity Act** ([15]), which enhances our capacity to detect, prepare for and respond to cybersecurity threats and attacks. In 2021-2024, a major investment under the **Digital Europe Programme** of a total EU contribution of EUR 100 million was made to set up national and cross-border Security Operation Centres (SOC also called cyber hubs). These will leverage state-of-the-art technology (including AI) to pool cyber threat intelligence across borders and make the EU's critical infrastructure more secure.

During this mandate, the EU has placed significant emphasis on **enhancing citizens' access to and use of trusted online services**. This commitment includes bolstering digital literacy and education overall, including through the adoption of a comprehensive digital

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([6]) Regulation (EU) 2022/868 of the European Parliament and of the Council of 30 May 2022 on European data governance and amending Regulation (EU) 2018/1724 (Data Governance Act), OJ L 152, 3.6.2022, p. 1.

([7]) Regulation (EU) 2023/2954 of the European Parliament and of the Council of 13 December 2023 on harmonised rules on fair access to and use of data and amending Regulation (EU) 2017/2394 and Directive (EU) 2020/1828 (Data Act), OJ L 2023/2854, 22.12.2023.

([8]) https://health.ec.europa.eu/ehealth-digital-health-and-care/european-health-data-space_en.

([9]) Joint Communication from the European Commission and the High Representative of the Union for Foreign Affairs and Security Policy of 16 December 2020 to the European Parliament and the Council on the EU's Cybersecurity Strategy for the Digital Decade, JOIN(2020) 18 final.

([10]) Regulation (EU) 2019/881 of the European Parliament and of the Council of 17 April 2019 on ENISA (the European Union Agency for Cybersecurity) and on information and communication technology cybersecurity certification and repealing Regulation (EU) No 526/2013 (Cybersecurity Act), OJ L 151, 7.6.2019, p. 15.

([11]) Directive (EU) 2022/2555 of the European Parliament and of the Council of 14 December 2022 on measures for a high common level of cybersecurity across the Union, amending Regulation (EU) No 910/2014 and Directive (EU) 2018/1972, and repealing Directive (EU) 2016/1148 (NIS 2 Directive), OJ L 133, 27.12.2022, p. 80 (consolidated version).

([12]) https://digital-strategy.ec.europa.eu/en/library/eu-toolbox-5g-security.

([13]) Regulation (EU) 2022/2554 of the European Parliament and of the Council of 14 December 2022 on digital operational resilience for the financial sector and amending Regulations (EC) No 1060/2009, (EU) No 648/2012, (EU) No 600/2014, (EU) No 909/2014 and (EU) 2016/1011.

([14]) https://digital-strategy.ec.europa.eu/en/library/cyber-resilience-act.

([15]) https://digital-strategy.ec.europa.eu/en/policies/cyber-solidarity.

skills and education package ([16]), alongside tackling specific challenges within digital services. One such endeavour is the enhancement of digital identification through initiatives like the **EU Digital Identity Wallet (EDIW)** ([17]), which entails a systemic transformation potential on the whole digital sector. Furthermore, the **Interoperable Europe Act** ([18]) is a pivotal measure to promote digitalised public services that provide all EU citizens with a seamless and efficient service.

As it has emerged from the challenges posed by the global COVID-19 pandemic, the EU has steered its economy away from the brink of a recession and set out on the path to recovery with **NextGenerationEU**. Central to this endeavour is the **Recovery and set Resilience Facility (RRF)**, which is, with its unprecedented investment of about EUR 648 billion, a landmark opportunity to fuel growth and catalyse digital transformation throughout the EU. Member States have surpassed the 20% investment target by allocating about 26% of their **Recovery and Resilience Plans** to digital-related measures (around EUR 150 billion). These investments support a wide range of measures – including the digitalisation of public services, the development of digital skills and the digitalisation of businesses. The **EU's unemployment rates** reached historically low levels of 6.4% in January 2024 ([19]).

The growing demand for digital products and services, compounded by the supply-chain disruptions during the COVID-19 pandemic, has increased awareness of strategic dependencies on essential products and materials. To address risky foreign dependencies, **the EU has taken a number of initiatives in critical sectors such as semiconductors.** The **European Chips Act** has already triggered EUR 100 billion of private and public investment in more than 65 industrial sites across the EU. New **Important Projects of Common European Interest (IPCEIs)** are being established to support breakthrough innovations or large-scale infrastructure projects in key sectors and technologies. In the past year alone, the **Second IPCEI on Microelectronics and Communication Technologies and the IPCEI on Next Generation Cloud Infrastructure and Services** have been approved and more IPCEIs in the field of digital and beyond are in the pipeline ([20]). IPCEIs have proven to be a useful tool to concentrate national funding on strategic priorities, but they remain rather inflexible, have a long investment lead time and are currently too narrowly targeted on highly innovative/disruptive first industrial deployment ([21]). Bringing together a range of stakeholders in an industry or value chain, **Industrial Alliances** remain a strong instrument for delivering on the strategic objectives of making the EU economy more resilient, ensuring the competitiveness of the EU industry and SMEs, and supporting the twin transition ([22]).

The past year has also seen concrete progress in the setting-up of the new instrument for the implementation of multi-country projects, the **European Digital Infrastructure Consortia (EDICs)**. To date, two EDICs have been formally established via a Commission

([16]) https://ec.europa.eu/commission/presscorner/detail/en/ip_23_2246.
([17]) https://ec.europa.eu/digital-building-blocks/sites/display/EUDIGITALIDENTITYWALLET/EU+Digital+Identity+Wallet+Home.
([18]) Regulation (EU) 2024/903 of the European Parliament and of the Council of 13 March 2024 laying down measures for a high level of public sector interoperability across the Union (Interoperable Europe Act) OJ L, 2024/903, 22.3.2024.
([19]) Eurostat, January 2024: https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Unemployment_statistics.
([20]) https://competition-policy.ec.europa.eu/state-aid/ipcei_en.
([21]) https://www.linkedin.com/pulse/successful-eu-competitiveness-industry-new-deal-thierry-breton-vxsve/?trackingId=SiBhD2SCQASFPY4k16atYg%3D%3D.
([22]) https://single-market-economy.ec.europa.eu/industry/strategy/industrial-alliances_en.

decision: the **Alliance for Language Technologies EDIC** and the **Local Digital Twins towards the CitiVERSE EDIC**. Nine more are under preparation. Several other initiatives whose objectives show alignment with the objectives of the Digital Decade are also under consideration for becoming EDICs in the future.

The Digital Europe Programme (DIGITAL) has, in partnership with other EU and national mechanisms, fostered a vibrant network of **European Digital and Innovation Hubs (EDIHs)** that serve as regional access points for digitalisation opportunities and as local bridges between academia and industry, with a mandate to accelerate the digital journey of private and public sectors. The network, which spans the EU and three associated countries, comprises over 200 hubs (including 151 co-funded by DIGITAL). This comprehensive network has a physical presence in 90% of EU regions but is extending its reach to cover the whole EU, ensuring broad accessibility to the services offered by EDIHs. The network has fully embarked on its mission to advance digitalisation in their regions. In its inaugural year (2023), the network conducted **over 2 200 digital maturity assessments (DMAs) to evaluate companies' digitalisation level; and provided tailored support to nearly 9 000 individual companies. The goal is to reach about 100 000 companies by 2027.**

The EU's policy and regulatory developments matched investment efforts reflect a concrete commitment to deliver on the objectives of the Digital Decade Policy Programme and **build a competitive, innovative and inclusive digital ecosystem, while always safeguarding citizens' rights, security and privacy**. In addition to EU funding programmes supporting R&I and deployment of digital technologies established under the current multiannual financial framework (MFF), the Commission proposed in June 2023 the establishment of the **Strategic Technologies for Europe Platform (STEP)**, an instrument to develop critical emerging technologies that are relevant to the green and digital transitions and to the EU's strategic sovereignty. The Platform aims to **boost manufacturing capacity in digital technologies and deep tech innovation, clean and resource-efficient technologies and biotechnologies**; strengthen value chains and address labour and skill shortages in these sectors.

Throughout this mandate, the EU has demonstrated an unwavering commitment to its digital agenda and has emerged as a frontrunner in the global digital landscape. Leveraging lessons from previous crises, **the EU has balanced the regulation imperative against the innovation imperative**. The EU will in future have to strengthen its position as a global digital leader in an ever-accelerating technology race and volatile geopolitical context. By upholding this commitment, the EU will continue to shape policies that foster technological innovation, drive competitiveness and economic growth, and ensure digital sovereignty.

2. KEY DRIVERS FOR THE STATE OF THE DIGITAL DECADE 2024

This chapter provides a picture of the recent and most salient trends and developments that have affected or will affect the EU's digital transformation, from the geopolitical level down to its local economic and societal fabric.

The rules-based international order is encountering significant challenges as it transitions into a phase characterised by a resurgence of power politics. The EU has traditionally been committed to principles such as multilateralism, free trade, and international cooperation, which have served as the cornerstone of its global governance and economic strategies. However, **wars and trade conflicts are increasingly undermining the principles of the international system**, posing significant threats to the very foundations upon which the EU has constructed its external relations and policies. The Russian war of aggression against Ukraine has caused a rupture, prompting a **defence paradigm shift in the EU**, as evidenced by the **Versailles Declaration** of March 2022 ([23]), by the **Granada Declaration** of October 2023 ([24]) and the **Commission's European Economic Security Strategy** ([25]).

Despite a solid legacy that makes it a major global economic and digital player, the EU continues to face a range of additional enduring challenges – both long-standing and more recent – related to climate change, technological acceleration, high energy prices, demographic changes such as lower birth rate and ageing population, labour and skills shortages, strategic dependencies, and unfair international competition ([26]) **which have a significant impact on its digital transformation.** The EU has long taken for granted inexpensive energy sourced from Russia, access to the vast Chinese market for its exports and security assurances provided by the US. However, historical trade relations are changing and are prompting the EU to reassess its scope of action, competences, and investment needs. Subdued productivity growth, shocks and economic uncertainty are causing the EU to place **competitiveness** at the very core of its policy and regulatory initiatives. In addition, the EU is increasingly faced with **pressing societal issues** and an intensifying political polarisation that makes policymaking increasingly more challenging**.** Climate change, extreme weather events, biodiversity loss and ecosystem collapse, pollution and natural resource shortages increase the list of challenges facing both the EU and the rest of the world.

2.1. A renewed focus on the EU's competitiveness

Russia's full-scale invasion of Ukraine has significantly impacted the competitiveness of businesses in the euro area, raising **electricity prices in the EU's industrial sector to nearly three times higher than those in the US and over twice as high as those in China** ([27]). The production of high energy-intensive goods is therefore at risk, which threatens the euro area's position in traditional industries. High carbon-intensive sectors

([23]) https://www.consilium.europa.eu/media/54773/20220311-versailles-declaration-en.pdf; https://www.consilium.europa.eu/en/press/press-releases/2023/10/06/granada-declaration/.
([24]) https://www.consilium.europa.eu/en/press/press-releases/2023/10/06/granada-declaration/.
([25]) Joint Communication from the European Commission and the High Representative of the Union for Foreign Affairs and Security Policy of 20 June 2023 to the European Parliament, the European Council and the Council on 'European economic security strategy', JOIN(2023) 20 final.
([26]) European Commission, The 2024 Annual Single Market and Competitiveness Report, SWD(2024) 77 final - SWD(2024) 78 final, https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52024DC0077.
([27]) Inaugural lecture of the EMU Lab by Isabel Schnabel, Executive Board of the ECB, at the European University Institute, 'From laggard to leader? Closing the euro area's technology gap', Florence, February 2024, https://www.ecb.europa.eu/press/key/date/2024/html/ecb.sp240216~df6f8d9c31.en.html.

such as mining, refineries and air transport have so far been on average more productive than greener ones, so the reallocation of production factors across sectors during the green transition will automatically reduce aggregate productivity over the short run. **Boosting technology adoption in less carbon-intensive sectors** could help offset some of these effects. Raising wages and reducing inflation could also secure public support for the green transition.

13 new Member States have joined the EU since 2004 and the EU has been able to ensure their convergence with older Member States without a negative impact on the EU's competitiveness. The EU has also been able to decouple economic growth from greenhouse gas (GHG) emissions much faster than the rest of the world.

However, various domestic factors are compounding the productivity challenges faced by the euro area, with three critical issues coming to the fore. The first is a **marked difficulty in bringing innovation to market**, especially in enabling the EU economy to capitalise on the efficiency gains brought about by information and communication technologies. This challenge is exacerbated by the EU's dependency on a few non-EU digital technology and service companies which have significant market concentration.

The two other factors are related to **demographic challenge and the link between productivity and monetary policy**. Demographic shifts are reducing the proportion of working-age individuals and the number of working hours per elderly person. Eurostat projects that the old-age dependency ratio ([28]) will increase from 37% to 57% in 2100 ([29]). This trend intensifies the need for higher productivity (measured as output per hour worked) to sustain a highly competitive social market economy.

Efforts have been made to restore price stability following significant inflationary shocks, but **low or negative productivity growth has magnified the effects of nominal wage increases and their transfer to unit labour costs for firms**. Firms are therefore facing heightened labour costs which in turn drive up prices for consumers ([30]). These economic challenges are accompanied by more frequent and severe commodity and technology supply-side disruptions and vulnerabilities.

In February 2024, the Commission revised **downwards its growth forecasts for 2024** for the third time since May 2023. It now predicts that the eurozone's growth rate will be 0.8% in 2024, half of the figure predicted in May 2023 ([31]). **Financing conditions tightened significantly in 2023**, creating a more challenging investment environment ([32]), including for digital companies. In the second quarter of 2023, foreign investors withdrew more money from their EU investments than they invested in the EU. However, EU investors invested a roughly equivalent amount outside the EU during the same quarter. Both **net inward and outward foreign direct investment in the EU declined sharply in the second quarter of 2023**, as deteriorating economic conditions in the EU led to a slowdown of investment ([33]).

([28]) The old-age dependency ratio is defined as the ratio of the number of older people (aged 65 and over) compared with the number of people of working-age (15-64 years).
([29]) https://ec.europa.eu/eurostat/web/products-eurostat-news/-/DDN-20200713-1.
([30]) https://www.ecb.europa.eu/press/key/date/2024/html/ecb.sp240216~df6f8d9c31.en.html.
([31]) https://www.mckinsey.com/mgi/our-research/accelerating-europe-competitiveness-for-a-new-era.
([32]) European Commission, The 2024 Annual Single Market and Competitiveness Report, SWD(2024) 77 final - SWD(2024) 78 final, https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52024DC0077.
([33]) https://www.statista.com/statistics/933294/eu-fdi-flows/.

In the meantime, the US economy is leading and expanding. China's downturn, as well as the ongoing conflicts in Ukraine and Israel, are playing a major role. With the rise of economies like Brazil, India, Mexico and Türkiye, the global economic power balance is set to change drastically ([34]). All major economies are now prioritising the needs of their own industries, including by subsidising them in some cases and by securing access to supply chains. For instance, in 2023, the US showed its capacity to act boldly with initiatives to support its industry, such as the **US Inflation Reduction Act (IRA) which enables simplified time-to-deployment**.

A new European Competitiveness Deal

In the face of a new geopolitical reality and increasingly complex challenges related to long-term productivity, technology and demography, the EU is committed to acting decisively to ensure its long-term competitiveness, prosperity and leadership on the global stage and to strengthen its strategic sovereignty. At the European Council of 17 and 18 April 2024 ([35]), EU leaders called for a **new European Competitiveness Deal** anchored in a fully integrated single market and inspired by the Letta report on the future of the single market ([36]). Further input will come from the former President of the European Central Bank Mario Draghi's forthcoming **report on competitiveness** ([37]). This report is expected to propose a radical change for the EU and immediate actions in the sectors most exposed to green, digital and security challenges.

These workstreams reflect the growing perception that efforts are needed at both EU and Member State levels and across policy areas in order to close the growth, productivity and innovation gaps between the EU and its international partners and main competitors. To implement the new Competitiveness Deal, the EU's work will have to focus on a set of key drivers, including (i) the deepening and modernisation of the **single market**, with a focus on SMEs; (ii) advancing the work on measures to create truly integrated **European capital markets**; (iii) developing an effective **industrial policy** that decarbonises industry and develops the EU's competitive edge in digital and clean technologies, diversifies and secures strategic value chains and strengthens the EU's defence technological and industrial base; (iv) promoting a more innovation-friendly **R&I environment**, while increasing investments to meet the 3% GDP expenditure target[38]; (v) achieving an **energy** Union by securing the supply of abundant, affordable and clean energy, and increasing **circularity and resource efficiency**; (vi) supporting the **digital transformation** of business, government and society, and strengthening the EU's leadership in **global digital affairs**; (vii) encouraging the creation of high-quality jobs and talent mobility into and within the EU; and (viii) pursuing an ambitious **trade policy** that creates reciprocal market access opportunities, defends EU interests and supports the role of the WTO in the multilateral rule-based system.

([34]) https://www.forbes.com/sites/bernardmarr/2023/10/31/navigating-the-future-10-global-trends-that-will-define-2024/?sh=303c143142ba; https://desapublications.un.org/sites/default/files/publications/2024-01/WESP%202024_Executive%20Summary_0.pdf.
([35]) https://www.consilium.europa.eu/media/m5jlwe0p/euco-conclusions-20240417-18-en.pdf.
([36]) Letta Enrico, Much more than a market, April 2024: https://www.consilium.europa.eu/media/ny3j24sm/much-more-than-a-market-report-by-enrico-letta.pdf.
([37]) See the upcoming Draghi report, at the time of writing the report is not yet published.
([38]) Council Recommendation (EU) 2021/2122 of 26 November 2021 on a Pact for Research and Innovation in Europe, OJ L 431, 2.12.2021, p. 1–9.

Strengthening and modernising the single market

The single market is the EU's strongest asset and enables EU firms to keep pace with the technological frontier ([39]). This is particularly important in the service sectors, which account for 70% of the EU's GDP but are three times less likely than other sectors to provide their services in another EU/EEA country. However, without a full integration of the financial, energy and electronic communications markets, the EU's competitiveness will inevitably decline. In addition to progress in these sectors, the EU may also need to reconsider the very founding principles of the single market. The framework of the single market, which is built upon the four freedoms (free movement of people, goods, services, and capital) appears increasingly outdated in light of the evolving dynamics of a market shaped by digitalisation, innovation and climate change uncertainties.

Towards the end of his mandate as President of the Commission, Jacques Delors suggested the need to explore new dimensions for the single market. One potential avenue is the **introduction of a fifth freedom alongside the existing four, aimed at bolstering research, innovation, and education within the single market**. This fifth freedom would prioritise embedding research and innovation drivers at the core of the single market, fostering an environment where the diffusion of knowledge drives economic prosperity, societal progress and cultural enrichment ([40]).

In addition, the traditional fourfold categorisation fails to account for the blurring distinction between goods and services, the intangible aspects of the digital economy, and the opportunities and challenges posed by trends like the circular economy, which is seen as vital for environmental sustainability. Transitioning towards a circular economy requires robust competencies that are protected by intellectual property rights, and the ability to translate these competencies into innovation and a thriving industry. Furthermore, the concept of the four freedoms falls does not sufficiently address the transition from an ownership-based economy to one centred on access and sharing.

A primary goal of the new single market is to align the EU's industrial capacity with the aims of a just, green, and digital transition. To achieve this, the focus in the upcoming legislative period must be on **directing both public and private funds towards supporting these strategic objectives** to enable the transformation of the EU's production system. **Mobilising private investment** is an area where the EU is currently lagging behind. The EU holds a substantial EUR 33 trillion in private savings (mainly in currency and deposits) but is not fully harnessing this wealth to address its strategic objectives. Around EUR 300 billion of EU savings flow out of EU markets every year (primarily to the US) due to financial market fragmentation within the EU. This highlights a significant **inefficiency in utilising the EU's economic resources, which, if redirected internally, could greatly assist in meeting strategic goals.** To achieve this, the establishment of a **Savings and Investments Union** that builds upon the incomplete Capital Markets Union is desirable. By fully integrating financial services within the single market, **the Savings**

([39]) https://www.ecb.europa.eu/press/key/date/2024/html/ecb.sp240216~df6f8d9c31.en.html.

([40]) Letta Enrico, Much more than a market, April 2024: https://www.consilium.europa.eu/media/ny3j24sm/much-more-than-a-market-report-by-enrico-letta.pdf.

and Investments Union aims not only to retain EU private savings within the EU but also to attract additional resources from abroad ([41]).

A more competitive Digital Single Market

The Digital Single Market has in recent years evolved with a **twofold objective**: to ensure fair competition that puts an end to the leakage of our data (particularly industrial data); and to create the conditions for the emergence of major EU digital players. Moving forward, there will be a need for a major reform in order to advance the Digital Single Market for **telecoms and cloud** infrastructure to build the digital infrastructure needed for the digital transition. The Commission **White Paper 'How to master Europe's digital infrastructure needs?'** of 21 February 2024 ([42]) discusses possible scenarios for public policy action.

Securing our digital value chains through an **enhanced economic security approach** will be of the utmost importance in achieving a competitive Digital Single Market. Our competitiveness also relies on **access to talent** and a **skilled workforce**. The EU will need to step up education and training efforts, because hundreds of thousands of talented people are urgently needed in order to drive our green and digital transition. This is a competence of the Member States, but parallel efforts must also take place at the EU level. In addition, investing in digital literacy is vital so that everyone can fully participate in the digital economy and society, and access the labour market where digital skills are increasingly needed. Digitalisation, through the **uptake of digital technologies as drivers of productivity growth**, is an opportunity to be seized so that the EU can promote its economic prosperity.

The systemic and transformative power of AI in the EU's future competitiveness

The growing importance of AI to the future of the EU as a systemic source of growth throughout the economy reinforces the case for **putting digitalisation at the heart of EU's competitiveness strategy,** and the need to closely monitor and support the development of AI ecosystems in the EU.

AI, and in particular the innovative generative AI, has a **transformative potential for the economy and society** and is expected to benefit the economy by increasing productivity ([43]). This is particularly true when it comes to more developed countries, where a greater share of work is knowledge-based. Advocates for the technology highlight its potential to streamline a wide range of repetitive and tedious tasks in different industries, ranging from customer service to healthcare. **The rise of generative AI has reinforced the understanding that gaining a competitive edge and productivity requires the ability to master the entire technological value chain** on which the development of generative AI relies: the data that generative AI systems are built on; the researchers and specialists who develop them; the connectivity infrastructure that underpins them (e.g. data centres); the investment that supports their development thanks to a well-functioning capital market; and the cloud computing power and storage of trusted cloud providers. **Competitiveness**

([41]) Letta Enrico, Much more than a market, April 2024: https://www.consilium.europa.eu/media/ny3j24sm/much-more-than-a-market-report-by-enrico-letta.pdf.

([42]) European Commission, White Paper - How to master Europe's digital infrastructure needs?, February 2024, https://digital-strategy.ec.europa.eu/en/library/white-paper-how-master-europes-digital-infrastructure-needs.

([43]) https://www.mckinsey.com/capabilities/mckinsey-digital/our-insights/the-economic-potential-of-generative-ai-the-next-productivity-frontier.

is also generated by the application of critical frontier technologies, but the EU is leading in only two of them (next-gen materials and clean technologies), while lagging behind in areas such as AI, semiconductor production and quantum computing. The success and uptake of generative AI in the EU therefore depends on the availability and accessibility of these enabling technologies. In December 2023, the EU approved up to EUR 1.2 billion of support over 8 years for cloud computing-related R&D ([44]). This represents 4% of what Amazon Web Services invested in 2022 alone ([45]).

Consequences for the Digital Decade in 2024: Increasing evidence shows that the root of the EU's competitiveness problem ([46]) *is particularly linked to its weakness in digital technologies, and the need to reduce the regulatory burden, channel private and public investments into innovation-intensive uses and to secure its supply chain. There is a particular need to find solutions to the demographic challenge through greater productivity and to address future asymmetrical supply shocks. The EU's digital transformation is part of the solution on all these issues. The* ***Digital Decade is a key forum and opportunity to harness digital technologies in the single market****, accelerate the comprehensive diffusion of new technologies within the EU's economy, and prioritise investments in areas that foster growth, enhance productivity and limit those disruptions (e.g., digital technologies, infrastructures and skills).*

2.2. Keeping people on board

The global digital transformation provides unparalleled opportunities for societal progress but also poses significant societal challenges. As the world passes through the current period of transformation, it is imperative to empower and protect citizens in order to ensure an inclusive digital transformation that safeguards people's rights ([47]).

In the context of the deepening 'technologisation' of our lives, it is critical to ensure that people can access digital infrastructure, particularly broadband internet in areas that are currently under-served. Some progress has been made but persistent disparities in digital access, connectivity and digital literacy between EU Member States are hindering equal participation in the digital economy and society. The rise of extremist parties in electoral processes and surveys and societal discomfort can be seen on social media platforms. Some technologies are triggering both enthusiasm and resistance. AI is a case in point. **It is recognised as empowering, but people are growing more concerned by AI's impact** on jobs, its misuse for violations of human rights and a potential loss of privacy.

According to the results of the Special Eurobarometer 'Digital Decade 2024'[48], **five out of six EU citizens (84%) consider that is important for public authorities to build efficient and secure digital infrastructures** (including connectivity and data processing facilities); and **four out of five (78%) think that it is important to shape the**

([44]) https://digital-strategy.ec.europa.eu/en/news/commission-approves-eu12-billion-state-aid-seven-member-states-important-project-common-european.
([45]) https://www.mckinsey.com/mgi/our-research/accelerating-europe-competitiveness-for-a-new-era.
([46]) Communication 'State of the Digital Decade 2024' with annexes, COM(2024) 260: https://digital-strategy.ec.europa.eu/en/news-redirect/833324, Annex 1.
([47]) https://digital-strategy.ec.europa.eu/en/library/european-declaration-digital-rights-and-principles.
([48]) Special Eurobarometer 551 'The Digital Decade' 2024: https://digital-strategy.ec.europa.eu/en/news-redirect/833351.

development of AI and other digital technologies to ensure they respect our rights and values.

According to the Digital Decade Eurobarometer 2024 findings, **three out of four EU citizens consider that the digitalisation of daily public and private services is making their lives easier**. To ensure the successful digital transformation of the EU, it is critical to encourage a perception of digitalisation as a source of advantage rather than a source of complexity or challenge caused by a lack of skills or infrastructure. In this respect, the Digital Decade Eurobarometer 2024 highlighted the fact that **for 9 out of 10 EU citizens consider that it is important for public authorities to ensure that people receive proper human support to accompany them in the transformation brought by digital technologies and services in their lives**[49].

The growing importance of digital technologies at work means that uncertainty about the impact of the digital transformation on jobs is a growing concern for the public. A 2024 IMF report has suggested that the roll-out of AI technologies may have a massive impact on employees (affecting up to 60% of EU employees in the region, half of whom may be adversely affected by the technology). The report further warned of great uncertainty as to how and when AI would affect economic outcomes, mirroring the uncertainty that came with the introduction of general-purpose technologies in the past. The report also noted that, despite this grave forecast, about half of the workers who interact with AI in their jobs are likely to gain from the technology thanks to higher productivity and higher wages. The unlucky remainder will see 'lower demand for their labour and lower wages' ([50]).

*Consequences for the Digital Decade in 2024: The **'whole-of-government' approach, promoted by the Digital Decade** can help link people's perception with policy action, helping reduce boundaries between government agencies and facilitating the seamless exchange of data and information. The need to address people's concerns is also reinforcing the importance of some of the key focus areas of the Digital Decade: enabling the adoption of and access to solutions such as the **European Digital Identity** and achieving the targets of **digital skills and connectivity** will together also help maximise the benefits of the digital transformation and bring them closer to EU citizens and companies. **Enforcement of online digital rights and the development of trustworthy human-centric AI systems** will help enhance trust. More **synergies across different governance levels**, within EU institutions and with national, regional and local authorities will be needed in order to address calls for simplification.*

2.3. A year of elections worldwide and the risk of misuse of technology

Almost 80 countries, with a combined population of about four billion (including 365 million EU citizens in the 27 Member States) have or will cast a vote in 2024, the largest global election year until 2048 ([51]). This is happening in the context of the **18th year of**

([49]) Special Eurobarometer 551 'The Digital Decade' 2024: https://digital-strategy.ec.europa.eu/en/news-redirect/833351.

([50]) IMF Staff Discussion Note, *Gen-AI: Artificial Intelligence and the Future of Work*, 14 January 2024: https://www.imf.org/en/Publications/Staff-Discussion-Notes/Issues/2024/01/14/Gen-AI-Artificial-Intelligence-and-the-Future-of-Work-542379?cid=bl-com-SDNEA2024001.

([51]) European Parliamentary Research Service (EPRS), *Ten issues to watch in 2024*, January 2024: https://www.europarl.europa.eu/RegData/etudes/IDAN/2024/757592/EPRS_IDA(2024)757592_EN.pdf.

democratic decline, as **political rights and civil liberties have deteriorated** in 52 countries ([52]). Democracy is changing (not least in digital spaces) and becoming more fragile as it is exposed to disinformation operations. This has raised concerns that this can undermine trust in democratic processes and social cohesion ([53]). As the world is going through this **crucial election year** ([54]), the Digital Decade Eurobarometer 2024 shows that **45% of respondents identify fake news and disinformation as one of the online issues which have the biggest personal impact** on them. However, **74% consider that, by 2030, digital technologies will be important to engaging in democratic life** (e.g., voting, virtual citizen assemblies/town hall meetings, finding reliable information, etc.)[55].

Digital technologies have had a transformative impact on elections, in terms of both electoral process and outcomes. Firstly, electoral bodies around the world are using digital technologies to ensure transparency and more efficient voting processes with digitised voter rolls and electronic voting. Secondly, digital technologies and spaces are being used as sites of debate and political influence, where digital platforms are used by governments, political parties, movements, and citizens to influence election outcomes ([56]).

AI provides opportunities to improve the democratic processes in our societies. It can, for example, help citizens to gain a better understanding of politics and engage more easily in democratic debate. Likewise, politicians can get closer to citizens and ultimately represent them more effectively. Such an alignment between citizens and politicians could change the face of electoral campaigns and considerably improve the policymaking process, making it more accurate and efficient.

However, this emerging technology also poses multiple risks to democracies because it can also be a powerful tool for disinformation and misinformation, both of which can trigger polarisations and tensions that result in election-related disputes and even violence. There have been concerns over the use of AI in politics since the late 2010s, but concerns related to democracy and the election process have grown with the recent increase in false information generation.

The emergence of generative AI has reinforced existing concerns that the digital space could impact electoral integrity and decrease public trust. The growing proliferation of large language models used for generative AI in recent months is making it easier to produce false content (commonly known as 'deep fakes'), AI-manipulated images and falsified audio-recordings of public figures on a large scale, and at ease of dissemination, thus making it harder to distinguish real content from fabricated material. In an era where technology has succeeded in combining the triple elements of realism, efficiency, and ease of access, it has become **very difficult to verify content and combat disinformation.** New types of social media bots powered by large language models (LLMs) are spreading

([52]) Freedom House, *Freedom in the World 2024*, 2024: https://freedomhouse.org/report/freedom-world/2024/mounting-damage-flawed-elections-and-armed-conflict.

([53]) Bertelsmann Stiftung, *Disconcerted Public – super election year 2024: concerns about disinformation in Germany and the United States*, February 2024: https://www.bertelsmann-stiftung.de/en/publications/publication/did/disconcerted-public.

([54]) Munich Security Conference, Munich Security Report 2023, *Re:vision*: https://securityconference.org/en/publications/munich-security-report/.

[55] Special Eurobarometer 551 'The Digital Decade' 2024: https://digital-strategy.ec.europa.eu/en/news-redirect/833351.

([56]) Nighat Dad & Shmyla Khan, 'Reconstructing elections in a digital world', *South African Journal of International Affairs*, Vol. 30, 2023: https://www.tandfonline.com/doi/full/10.1080/10220461.2023.2265886.

political disinformation in ways that are difficult to detect ([57]). Creation tools from companies like OpenAI and Microsoft are being used to spread election-related disinformation, such as political deepfakes ([58]). Moreover, it can be difficult to track the origin of these harmful deepfakes because some of them may come from open-source systems or systems built by state actors and may be disseminated on end-to-end-encrypted platforms where they cannot be traced. The 'Portal Kombat' network, which the French authorities uncovered earlier this year, exerted foreign digital interference, targeting several EU countries and the US with the aim of legitimising the war in Ukraine ([59]).

Proper safeguards are therefore much needed in order to limit those risks. For example, **watermarking** can be used to clearly indicate that content has been generated by AI ([60]). **Proactive and collaborative initiatives** of online platforms (e.g., the AI Elections Accord of February 2024) are also helpful in combating the deceptive use of AI-generated content to influence elections by tracking it, raising awareness among the public and promoting technological fixes ([61]). These efforts, along with targeted policies, are to be welcomed as the acknowledgement of the urgent need for policymakers and the tech industry to address emerging threats.

*Consequences for the Digital Decade in 2024: The 2024 elections are testing the EU's capacity to **implement the regulatory framework** and the initiatives designed to manage systemic threats linked to the misuse of online platforms and AI technologies. All actors therefore need to be mobilised for this purpose. The guidelines published under the Digital Services Act (DSA) to mitigate systemic online risks in elections contain a set of measures and best practices that social media platforms can apply in order to safeguard the integrity of elections in 2024. In the long term, this challenge highlights the **importance of enhancing digital literacy and skills** in order to empower people, and of ensuring that all digital players act responsibly and safely. Such efforts will support people's **trust in the digital public space and their engagement in the democratic process** at all levels. Almost midway through the Digital Decade, ensuring that AI's potential is harnessed responsibly to maintain election integrity has become a paramount concern. Building more human-centricity and trustworthiness within AI systems will require more investment.*

2.4. Health and digitalisation

The **use of health data and advanced technologies** has a great potential to improve **access to health services** by citizens, in particular in rural and remote regions; increase the quality and efficiency of healthcare; develop **personalised approaches**; and support **research and innovation**. Digital Decade Eurobarometer 2024's findings indicate that four out of five

([57]) Zuckerman Ethan, Social Bots and the Frightening Unknowability of Social Media: https://www.kettering.org/news/social-bots-and-the-frightening-unknowability-of-social-media/.
([58]) Open AI, *How OpenAI is approaching 2024 worldwide elections*: https://openai.com/blog/how-openai-is-approaching-2024-worldwide-elections.
([59]) https://www.sgdsn.gouv.fr/publications/portal-kombat-un-reseau-structure-et-coordonne-de-propagande-prorusse.
([60]) Michael Adam, *Artificial intelligence, democracy and elections*, 19 September 2023: https://www.europarl.europa.eu/thinktank/en/document/EPRS_BRI(2023)751478.
([61]) *Technology industry to combat deceptive use of AI in 2024 elections:* https://www.aielectionsaccord.com/uploads/2024/02/Press-Release-AI-Elections-Accord-16-Feb-2024.pdf.

respondents consider digital technologies to be important by 2030 for accessing or receiving healthcare services (e.g., telemedicine and AI for diagnosing diseases)([62]).

The EU Digital COVID Certificate (EU DCC), which was developed in record time and became a global standard during the COVID-19 pandemic, was a notable example: more than 2.3 billion certificates were issued EU-wide and a total of 78 countries were connected to this EU solution, which significantly contributed to the global fight against the disease, protecting EU citizens' health and restoring their right of free movement. The December 2022 Council Recommendation on access to affordable, high-quality long-term care([63]) called for the rolling-out of accessible technology and digital solutions to support autonomy and independent living.

The recent finalisation of the negotiations on the European Health Data Space (EHDS) Regulation ([64]) will further change dynamics in the field of digital health. One of the rights for natural persons provided under the upcoming EHDS regulation is the right to access electronic health data through an online access service. This right will apply to six priority data categories. In addition, natural persons will have the right to authorise another person to access their health data. This is fully in line with the e-Health target under the Digital Decade Policy Programme 2030. The implementation of the EHDS Regulation will therefore support the implementation of the programme (and vice versa).

Recent **developments have highlighted the complex interlinkage of digital technologies with public health**. On the positive side, the development of AI tools for supporting health professionals in their work, increased digitalisation of health data and the use of telemedicine are opening up new opportunities. However, 2023 has also seen a stronger focus on more negative effects linked to the design of online interfaces, which can also affect mental health negatively (as exemplified in addictive behaviours, attention deficit or desensitisation to violence) ([65]).

The policy debate on these issues has gained attention in 2024. Regarding children, some analysis recently pointed to a significant shift in childhood experiences, where the rise of a 'phone-centric culture' is, together with overprotection offline and declining education standards, being accompanied by lower PISA maths scores, addiction that worsens mental health, and higher rates of depression, anxiety and self-harm (particularly among Gen Z) ([66]). Deepening the research in this area will be crucial.

Consequences for the Digital Decade in 2024: Rising mental health concerns linked to certain online interface designs call for heightened awareness and vigilant monitoring. The political focus generated by this issue must be acknowledged and addressed. In 2024, the EU and Member States have new tools to ensure the full respect of fundamental rights, including by means of the recently adopted Digital Services Act (DSA), the Better Internet for Kids Strategy and the draft child sexual abuse regulation (CSAM regulation). The DSA obliges the technology industry and specifically online platforms to ensure that their users

([62]) Special Eurobarometer 551 'The Digital Decade' 2024: https://digital-strategy.ec.europa.eu/en/news-redirect/833351.
([63]) Council Recommendation of 8 December 2022 on access to affordable high-quality long-term care, 2022/C 476/01.
([64]) https://ec.europa.eu/commission/presscorner/detail/en/IP_24_2250.
([65]) In December 2023, the European Parliament adopted an initiative report which stressed 'the significant impact of addictive design on all individuals, but especially on children and adolescents': https://ec.europa.eu/commission/presscorner/detail/en/ip_24_926.
([66]) PISA, *Insights and interpretations: how smart phones and tablets can impact learning*, December 2023.

are safe and secure in the online environment. Delivering these initiatives through thorough enforcement will be key to achieving the objectives of the Digital Decade (e.g., safety, security and empowerment of people, as well as the promotion of a human-centred, fundamental-rights-based, inclusive, transparent and open digital environment).

2.5. Race to talent and educational gaps

As President Von der Leyen stated in her State of the Union speech on 13 September 2023, the shortage in digital skills and talents is emerging as a key issue for the EU: *'Instead of millions of people looking for jobs, millions of jobs are looking for people. Labour and skills shortages are reaching record levels in Europe'* ([67]).

Automation and the net-zero transition are likely to trigger some of the largest labour market shifts in history. A major challenge for the EU will be to build and attract a strong and diverse workforce that has the right skills for the twin green and digital transition. **The EU's employment rates are historically high**, with a job vacancy rate in the eurozone of 3% in September 2023 ([68]).**74% of SMEs say they are struggling to find workers with the right skills** ([69]). Our economies are now in a race to upskill and retrain the labour market to meet tomorrow's needs. Furthermore, **large non-EU companies that offer high salaries and computing resources, are draining academia of top talent** ([70]) with potential negative implications for R&D in Europe. For example, one third of the AI talent in US universities comes from the EU ([71]). The contribution of EU researchers to the major AI LLMs remains limited: in 2022, 54% of the creators of AI models were American while only 3% came from Germany, the EU's top performer ([72]).

The 2023 PISA results ([73]) have shown an **unprecedented decline in student performance in the EU, particularly in sciences.** These results are setting an important challenge for the future of EU Member State. This will exacerbate current demographic trends. Reversing it will require bold and coordinated cooperation between the EU and the Member States. Rapid technological development, supported by a focus on investments and entrepreneurship, and a holistic restructuring of education and training will be vital in ensuring that the EU's human capital remains at the forefront of accelerating technological changes.

Consequences for the Digital Decade in 2024: Skills gaps are one of the biggest obstacles to the EU's progress in the digital transformation. ***Digital skills are essential for people*** *being able to participate in the labour market and in society at large, and to achieve social*

([67]) 2023 State of the Union Address by President von der Leyen: https://ec.europa.eu/commission/presscorner/detail/en/speech_23_4426.
([68]) Eurostat, September 2023: https://ec.europa.eu/eurostat/documents/2995521/17501484/3-14092023-AP-EN.pdf/ad3c84e2-fbbb-b3a8-b762-5e6996dfa08d?version=1.0&t=1694672174657.
([69]) 2023 State of the Union Address by President von der Leyen: https://ec.europa.eu/commission/presscorner/detail/en/speech_23_4426; https://europa.eu/eurobarometer/surveys/detail/2994.
([70]) https://www.washingtonpost.com/technology/2024/03/10/big-tech-companies-ai-research/?mc_cid=17070bf49e.
([71]) https://www.washingtonpost.com/technology/2024/03/10/big-tech-companies-ai-research/?mc_cid=17070bf49e; In 2023, nearly 70% of people with American doctorates in AI ended up in private industry (compared with 21% of graduates two decades earlier) according to the MIT Initiative on the Digital Economy (IDE): https://ide.mit.edu/wp-content/uploads/2023/03/0303PolicyForum_Ai_FF-2.pdf.
([72]) Artificial Intelligence Index Report 2023, p. 58: https://aiindex.stanford.edu/wp-content/uploads/2023/04/HAI_AI-Index-Report_2023.pdf; https://www.robert-schuman.eu/en/european-issues/728-artificial-intelligence-europe-needs-to-start-dreaming-again.
([73]) https://www.oecd.org/publication/pisa-2022-results/.

inclusion. They strengthen the EU's competitiveness and ensure technological sovereignty. However, the EU faces a critical shortage of digital experts (including in cybersecurity and data analysis) who drive the development of AI and other critical technologies. Shortages will probably increase with the projected decline in the EU's working age population from 265 million in 2022 to 258 million by 2030 ([74]).

2.6. A paradigm shift in security and defence

The EU's level of autonomy in security and defence is being reevaluated in the light of evolving global power dynamics, rapid technology innovation and rising cyber threats that require greater military expenditure, the setting-up of a robust defence industry, and enhanced synergies and cross-fertilisation between the EU's civil and military industries. Geopolitical developments now indicate a compelling **need for the EU to take increased strategic responsibility for its own security** ([75]). Imperatives include the **diversification of alliances** and the mitigation of the EU's **economic and technological dependencies** through 'de-risking', while at the same time maintaining the EU's **global commitment** to navigate the multipolar world effectively and reaffirming its commitment to **democratic principles.**

Before Russia's full-scale invasion of Ukraine in February 2022, the EU had recognised the imperative of increasing financial support for EU defence projects, with the setting-up of the **European Defence Fund (EDF)** ([76]). As the European continent continues to witness the **return of war onto its territory and an intensification of regional conflicts**, the need to strengthen the EU's defence capabilities has become more urgent ([77]). EU members of NATO have announced plans to spend significantly more on defence in the coming years ([78]). A new EU mechanism, the **European Peace Facility** ([79]), has been created to provide military assistance to other countries and has been used since 2022 to provide military aid to Ukraine. At the start of February 2024, the EU agreed a further EUR 50 billion package of support to Ukraine ([80]). Progress is continuing with new initiatives to increase cooperation on developing military capabilities in the EU (e.g., the **European Sky Shield Initiative (ESSI)**) ([81]).

The EU has historically relied on the US for security guarantees, NATO guidance and diplomatic leadership. Despite a solid transatlantic relationship between the US and the EU, the US has begun to encourage EU to be more self-reliant in terms of defence. Depending on the outcome of the next US presidential elections, the EU may have to prepare for the **possibility of a less supportive US administration**, with expectations of a possible decline in US support for NATO and a potential withdrawal from multilateral accords. A decrease in US military aid would require the EU to provide an unprecedented level of support to Ukraine.

([74]) https://op.europa.eu/en/publication-detail/-/publication/ea6b0987-dd66-11ee-b9d9-01aa75ed71a1.
([75]) European defence industrial strategy (EDIS), https://defence-industry-space.ec.europa.eu/document/download/3b4ec5fb-395c-49ea-abf2-fb54ca6dfd6c_en?filename=EDIS%20Joint%20Communication_0.pdf.
([76]) EDF I Developing tomorrow's defence capabilities: https://defence-industry-space.ec.europa.eu/eu-defence-industry/european-defence-fund-edf-official-webpage-european-commission_en.
([77]) Strategic Compass for Security and Defence, https://data.consilium.europa.eu/doc/document/ST-7371-2022-INIT/en/pdf.
([78]) https://www.nato.int/cps/en/natohq/news_222664.htm.
([79]) https://www.consilium.europa.eu/en/policies/european-peace-facility/.
([80]) https://ec.europa.eu/commission/presscorner/detail/en/ip_24_2244.
([81]) https://www.nato.int/cps/en/natohq/news_219119.htm.

In March 2024, the Commission and the High Representative of the Union for Foreign Affairs and Security Policy jointly announced the EU's first ever **European Defence Industrial Strategy (EDIS)** ([82]); and the Commission proposed a regulation to establish a new **European Defence Industry Programme (EDIP)** ([83]) to enhance the EU's readiness and security, and to reduce its reliance on the US. The strategy sets a goal of 40% of EU defence equipment being jointly procured by two or more EU Member States by 2030, with 50% of equipment being procured within the EU. In the short term and building on its armaments manufacturers, the EU will have to ramp up the production and procurement of material to support Ukraine. However, in the medium to longer term, the EU will still need to increase weapons and ammunition production in order to reconstitute EU armies' defence supplies; address shortfalls; improve training and logistics planning; build an EU fleet of critical strategic enablers like drones and satellites; and develop cyber and airlift capabilities.

Acknowledging the lack of suitable instruments to facilitate cross-fertilisation between civil and military R&D activities, the Commission adopted the **Action Plan on Synergies between the European civil, defence and space industries** in 2021 ([84]), with which it has kickstarted action to create opportunities for synergies between the different programmes and instruments that can reinforce innovation and exploit the disruptive potential of technologies in the interplay of the civil, defence and space industries. In the more recent **Joint Communication on the European Economic Security Strategy** of June 2023[85], the Commission has set itself the aims of building up the EU's economic security and making its economy more resilient, including by maintaining and growing the EU's technological edge over technologies that are critical to its economic security. The Commission has made a commitment to report on **options to secure support for R&D that involves technologies with dual-use potential**.

The EU has, under the policy framework of the **EU Cyber Defence Policy** and acknowledging that the lines between the civilian and military dimensions of cyberspace can be unclear, made a commitment to promote close military and civilian cooperation in cyberspace to enhance the ability to prevent, detect, defend against, recover from and deter cyberattacks against the EU and its Member States. The Policy also sets out the ambition for the EU and its Member States to step up investment in the development and deployment of full-spectrum cyber defence capabilities, including by leveraging investments in dual-use technologies and infrastructure.

Consequences for the Digital Decade in 2024: The increased attention to security and defence matters, the initiatives to enhance the cross-fertilisation between civil and military R&D, and the large dual-use potential of digital technologies together represent an opportunity to reinforce and improve the competitiveness and resilience of the EU's scientific and technological bases. This would boost start-ups and SMEs engaged in

([82]) A new European Defence Industrial Strategy: Achieving EU readiness through a responsive and resilient European Defence Industry, https://defence-industry-space.ec.europa.eu/document/download/643c4a00-0da9-4768-83cd-a5628f5c3063_en?filename=EDIS%20Joint%20Communication.pdf.

([83]) https://defence-industry-space.ec.europa.eu/document/download/6cd3b158-d11a-4ac4-8298-91491e5fa424_en?filename=EDIP%20Proposal%20for%20a%20Regulation.pdf

([84]) https://commission.europa.eu/strategy-and-policy/priorities-2019-2024/europe-fit-digital-age/european-industrial-strategy/creating-synergies-between-european-civil-defence-and-space-industries_en.

([85]) Joint Communication on a European Economic Security Strategy, JOIN(2023) 20 final, https://eur-lex.europa.eu/legal-content/EN/ALL/?uri=JOIN:2023:20:FIN.

technological innovation, because civil defence synergies can create new market opportunities for companies working in various industrial ecosystems and can bolster the wider economy. Many critical technologies with dual-use potential are in the digital sector, so geopolitical challenges will probably continue to frame the context in which digital policies are designed and undertaken ([86]).

2.7. Cybersecurity challenges to Europe's critical infrastructures and connectivity

Security now needs to be viewed from a much broader perspective than in the past. It might include industrial and supply chain resilience, vital infrastructure physical and cyber integrity, digital sovereignty, global trade routes and food supply, and climate change mitigation.

Ensuring the security of the EU's online space is a critical challenge today and will remain so in the years to come. In 2024, **threats to communication networks and infrastructure have intensified**, including ransomware, supply chain and physical attacks, and the sabotage of digital infrastructure ([87]). Cyberattacks and extorsion operations were on the rise in 2023 and into 2024. ENISA recorded more than 2 500 cyber incidents targeting at least one EU country between July 2022 and June 2023, with 220 specifically targeting two or more EU countries ([88]). Government, financial, healthcare and communications industries are particularly at risk.

Increased attention needs to be paid to the EU's potential **reliance on critical cables**, because **systemic and widespread disruptions of submarine cable communications** could have particularly serious consequences if they form part of a coordinated attack ([89]). The **sabotage of a submarine telecom cable in the Baltic Sea between Finland and Estonia in October 2023** caused concern after the Nord Stream 2 attacks, because submarine cables transmit 99% of global data traffic and are crucial to EU connectivity. Russian naval actions near Ireland pose a threat to transatlantic cables that transmit data between the US and Ireland. In early 2024, the FBI and Europol destroyed LockBit, one of the world's most dangerous cybercriminal groups, but the groups still managed to cause billions of dollars of damages to thousands of affected victims ([90]).

The connectivity infrastructure of the EU is facing critical challenges, including a lack of investment needed to match the growing demand in capacity and connectivity caused by technological development ([91]); critical dependency on high-risk suppliers in the 5G

([86]) European Commission, White Paper on options for enhancing support for research and development involving technologies with dual-use potential, 2024, https://research-and-innovation.ec.europa.eu/document/download/7ae11ca9-9ff5-4d0f-a097-86a719ed6892_en; European defence industrial strategy (EDIS), https://defence-industry-space.ec.europa.eu/document/download/3b4ec5fb-395c-49ea-abf2-fb54ca6dfd6c_en?filename=EDIS%20Joint%20Communication_0.pdf.

([87]) EU Member States, with the support of the European Commission and ENISA, the EU Agency for Cybersecurity, published the 'Cybersecurity and resiliency of Europe's communications infrastructures and networks' report on 21 February 2024, https://digital-strategy.ec.europa.eu/en/library/report-cybersecurity-and-resiliency-eu-communications-infrastructures-and-networks.

([88]) https://www.enisa.europa.eu/publications/enisa-threat-landscape-2023.

([89]) Commission Recommendation (EU) 2024/779 of 26 February 2024 on Secure and Resilient Submarine Cable Infrastructures, OJ L, 2024/779, 8.3.2024, http://data.europa.eu/eli/reco/2024/779/oj.

([90]) https://www.europol.europa.eu/media-press/newsroom/news/law-enforcement-disrupt-worlds-biggest-ransomware-operation.

([91]) https://digital-strategy.ec.europa.eu/en/library/investment-and-funding-needs-digital-decade-connectivity-targets.

infrastructure; and the need to strengthen the security and resilience of underwater infrastructure ([92]).

Generative AI is bringing a new level of sophistication and reach to cyberattacks by creating convincing text and other materials, thus enabling even low-skilled and less-funded or amateur cybercriminals to commit such acts. State-sponsored hackers have used generative AI systems in the creation of their cyberattacks, according to research released by OpenAI ([93]). This is expected to complicate efforts to identify various types of attacks, including spoof messages and social engineering tactics ([94]). The number of ransomware and other cyber threats is continuing to rise with AI ([95]), but it is still unclear how the technology will affect the severity of cyberattacks. What is more, 72% of Europeans are worried that **elections in the EU could be manipulated and disrupted through cyberattacks** ([96]).

The convergence of technologies adds to the complexity of this picture and to the vulnerability of our societies and economies. Blockchain, the Internet of Things (IoT), AI, quantum computing and other critical and emerging technologies, such as human-machine interfaces (e.g., a US company Neuralink project), are **forming or reshaping industries that will become ever more strategically important**; and are redefining problem-solving paradigms. This is the basis for an economic and a national security argument for maintaining EU competitiveness. The more these technologies converge and become interconnected, the more technical vulnerabilities will amplify existing threats.

*Consequences for the Digital Decade in 2024: Addressing these trends underlines the importance of reinforcing the **EU's collective effort in ensuring resilience and sovereignty in critical digital technologies and connectivity networks, including in terms of monitoring, as part of the Digital Decade.** This monitoring should also include an increased knowledge and risk-awareness of how and where our infrastructures are built.*

2.8. Climate change trends and implications for the 'twin' transition

Global warming concerns have grown in recent months and environmental hazards continue to dominate the risk landscape. Temperature records continued to be broken in 2023, confirming the extraordinary pace of climate change ([97]). Rising temperatures and the increasing frequency of extreme events contributed to numerous wildfires. By the end of July 2023, they had affected more than 182 000 hectares across the EU (40% above the 2003-2022 average). At the same time, unprecedented floods hit parts of the EU ([98]). Climate change, extreme weather events and critical changes to Earth systems, biodiversity loss and ecosystem collapse, pollution, and natural resource shortages will be among the world's biggest challenges in the next decade, according to the World Economic Forum's

([92]) European Commission, White Paper - How to master Europe's digital infrastructure needs?, February 2024, https://digital-strategy.ec.europa.eu/en/library/white-paper-how-master-europes-digital-infrastructure-needs.
([93]) https://openai.com/blog/disrupting-malicious-uses-of-ai-by-state-affiliated-threat-actors.
([94]) https://www.ncsc.gov.uk/collection/phishing-scams.
([95]) https://www.ncsc.gov.uk/news/global-ransomware-threat-expected-to-rise-with-ai.
([96]) https://op.europa.eu/en/publication-detail/-/publication/ea6b0987-dd66-11ee-b9d9-01aa75ed71a1.
([97]) Report from the Commission - EU Climate Action Progress 2023, COM(2023) 653 final, https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52023DC0653.
([98]) Report from the Commission - EU Climate Action Progress 2023, COM(2023) 653 final, https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52023DC0653.

2024 Global Risks Perception Survey (GRPS) and the Munich Security Report 2024 ([99]). They will continue to cause **worldwide material catastrophes** in the coming years. The EU is particularly exposed because it is the fastest warming continent in the world, with several regions such as southern Europe being hotspots for multiple climate risks ([100]). Global cooperation is needed to manage climate and ecological emergencies, but rising geopolitical and economic conflicts are making this more challenging.

Climate change concerns mean that assessing the environmental effect of technologies' growing proliferation and use has become of paramount importance. Challenges persist in measuring impacts and determining the assessments that should occur, but data robustly show that technologies' footprint on the environment is set to increase. Digitalisation is an energy-intensive process and, while some technologies are creating sustainability paths, the so-called 'twin green and digital transition' is not yet guaranteed in practice. **Thanks to existing climate and energy legislation, the EU's greenhouse-gas emissions have already fallen by 32.5% since 1990** ([101]). **However, the EU and its Member States need to significantly step up implementation efforts** in order to remain on track to achieve the EU's 2030 55% GHG reduction target and the EU's 2050 climate neutrality objective ([102]).

The ICT sector, and the digital transformation that it underpins, are gaining attention because they could impact global emissions both positively and negatively. Figures released by the International Energy Agency (IEA) suggest that global electricity demand rose considerably in 2023 and is expected to grow at a much faster pace in the next 2 years, in line with the global demand for internet services and AI ([103]). Electricity consumption by data centres, AI and the cryptocurrency sector could double in just 2 years. A large storage capacity and efficient processing techniques are required in order to be able to analyse and process the volumes of data that are feeding AI systems. However, today's data centres are not designed to support this, so greater energy and storage capacities will need to be built ([104]).

Consequences for the Digital Decade in 2024: ***There is a growing perception of the role that the digital transformation and the adoption of technologies are playing in the green transition*** *in various sectors, through productivity growth and efficiency gains for companies, as well as* ***breakthroughs in energy, net-zero and clean technologies****. This confirms the importance of ensuring that initiatives for the green and the digital transitions are consistent and complementary, fostering a smart greening of EU's economy and society.*

([99]) World Economic Forum, Global Risks Report 2024, https://www.weforum.org/publications/global-risks-report-2024;Bunde T., Eisentraut S., Schuette L.(eds.), Lose-Lose ? Munich Security Report 2024, https ://securityconference.org/assets/01_Bilder_Inhalte/03_Medien/02_Publikationen/2024/MSR_2024/MunichSecurityReport2024_Lose-lose.pdf, chapter 7.
([100]) https://www.eea.europa.eu/en/newsroom/news/europe-is-not-prepared-for.
([101]) https://commission.europa.eu/news/eu-2023-succeeding-amidst-challenging-times-2024-03-13_en.
([102]) https://climate.ec.europa.eu/eu-action/climate-strategies-targets/progress-made-cutting-emissions_en
([103]) https://www.iea.org/energy-system/buildings/data-centres-and-data-transmission-networks; https://www.iea.org/reports/electricity-2024.
([104]) https://www.reuters.com/technology/european-data-centres-grapple-with-ai-driven-demand-space-2024-02-27/.

2.9. Geopolitical technological competition

Technology has gone from being a driver of global prosperity to also becoming a pivotal element in geopolitical rivalries. Countries are more and more implementing de-risking strategies in their semiconductor supply chains, while simultaneously leveraging their choke points as tools of geopolitical influence.

The EU and US are investing heavily in domestic semiconductor manufacturing through the European Chips Act([105]) and the CHIPS and Science Act respectively. Taiwan, South Korea and Japan are investing even more heavily ([106]). The US is also providing significant support for the development of green technology in the US through measures like the Inflation Reduction Act (IRA). China is funding its home-grown technological development through Made in China 2025 and other measures.

To offset consequences such as (economic) security risks, the EU has outlined in the Chips Act([107]) its approach under State aid law to allow Member States to match public funding available elsewhere by assessing a funding gap. The EU continues to promote an open approach to technological autonomy that is based on collaborations and partnering with like-minded countries ([108]). For example, through trade and technology councils (TTC) and digital partnerships with the US, India, Japan, South Korea, Singapore and Canada, the EU is cooperating on the development of emerging technologies such as AI, Quantum and 6G; and securing the resilience of key supply chains, including semiconductors. The EU is also unilaterally deploying its trade policy instruments more assertively to address unfair trading practices, such as launching (trade defence) investigation into electric vehicles, the public procurement market for medical devices, and foreign subsidies that distort the EU's single market.

This dynamic is further underscored by the **promotion of divergent visions for global technology governance** and the consequent **notable lack of unified global regulations to address emerging technology-related risks** ([109]). **Within the technology race, intense competition for supremacy in AI advancement coexists with the attempt to foster international cooperation in regulating AI technologies**. In the coming decades, the role of AI technology will shape geopolitical power dynamics significantly; and the capacities of contemporary machine-learning systems (a subset of AI) to swiftly process vast amounts of data could revolutionise military capabilities ([110]).

([105]) Regulation (EU) 2023/1781 of the European Parliament and of the Council of 13 September 2023 establishing a framework of measures for strengthening Europe's semiconductor ecosystem and amending Regulation (EU) 2021/694 (Chips Act), OJ L 229, 18.9.2023, p. 1–53.
([106]) https://worldpopulationreview.com/country-rankings/semiconductor-manufacturing-by-country.
([107]) Regulation (EU) 2023/1781 of the European Parliament and of the Council of 13 September 2023 establishing a framework of measures for strengthening Europe's semiconductor ecosystem and amending Regulation (EU) 2021/694 (Chips Act), OJ L 229, 18.9.2023, p. 1–53. .
([108]) Joint Communication from the European Commission and the High Representative of the Union for Foreign Affairs and Security Policy of 20 June 2023 to the European Parliament, the European Council and the Council on 'European economic security strategy', JOIN(2023) 20 final.
([109]) Bunde T., Eisentraut S., Schuette L.(eds.), Lose-Lose ? Munich Security Report 2024, https ://securityconference.org/assets/01_Bilder_Inhalte/03_Medien/02_Publikationen/2024/MSR_2024/MunichSecurityReport2024_Lose-lose.pdf, chapter 8.
([110]) Scharre P., *Four Battlegrounds: Power in the Age of Artificial Intelligence*, W.W. Norton & Company, Inc., New York, 2023, p. 310.

Recent months have witnessed a global surge in proposals for regulation. In 2024, the EU introduced the world's first dedicated AI law – the AI Act ([111]), which is a significant milestone in AI governance. The US has followed with an AI Executive Order ([112]).

AI operates globally, so there is a growing recognition of the need to establish a cohesive international framework for AI governance. Such a framework will have to harness the immense potential of AI technology while mitigating potential societal harms. **International collaboration on AI has made progress,** especially on governance and ethics issues, with global and regional AI summits, and the release of proposed frameworks such as the UN General Assembly's Resolution on AI([113]), Global Digital Compact([114]), G7's International Guiding Principles for Organizations Developing Advanced AI Systems ([115]), the Council of Europe Framework Convention on Artificial Intelligence and Human Rights, Democracy and the Rule of Law[116], and the UN High Level AI Advisory Body's report.([117]) The EU has been closely involved in many of these listed initiatives. In particular, AI is now integral to the international development agenda and regional collaboration strategies in Latin American and African countries ([118]).

Another dimension of the geopolitical technological competition is represented by the **confrontation between democratic and autocratic visions of digital governance, where a 'battle of offers' combined with offers towards third countries is increasingly noticeable**. In this context, there is an opportunity for the EU to share its human-centric approach on digital transformation as set out in the European Declaration on Digital Rights and Principles([119]) (and through reports such as the Berlin Declaration on Digital Society and Value-Based Digital Government[120], as well as policy instruments such as the Digital Services Act([121]), AI Act, and the 5G Toolbox([122]) with partner countries. In addition, and in order to provide convincing aid packages, it is important to support partner countries in achieving their digital transformation goals by providing investment and regulatory support for secure and resilient connectivity and digital infrastructure roll-outs under the Global Gateway Strategy.

Notwithstanding this battle of offers, countries around the world are being prompted to **identify areas where cooperative efforts are required and to come forward with a minimum set of global guardrails, even in the current context of geopolitical tensions**. Embracing a mindset of seeking positive-sum outcomes in areas such as protecting human

([111]) https://digital-strategy.ec.europa.eu/en/policies/regulatory-framework-ai.
([112]) https://www.whitehouse.gov/briefing-room/statements-releases/2023/10/30/fact-sheet-president-biden-issues-executive-order-on-safe-secure-and-trustworthy-artificial-intelligence/.
([113])https://undocs.org/Home/Mobile?FinalSymbol=A%2F78%2FL.49&Language=E&DeviceType=Desktop&LangRequested=False.
([114]) https://www.un.org/techenvoy/global-digital-compact.
([115]) https://digital-strategy.ec.europa.eu/en/library/hiroshima-process-international-guiding-principles-advanced-ai-system.
([116]) https://rm.coe.int/1680afae3c.
([117]) https://www.un.org/en/ai-advisory-body.
([118]) https://oxfordinsights.com/ai-readiness/ai-readiness-index/.
([119]) https://digital-strategy.ec.europa.eu/en/library/european-declaration-digital-rights-and-principles.
([120]) https://digital-strategy.ec.europa.eu/en/news/berlin-declaration-digital-society-and-value-based-digital-government
([121]) Regulation (EU) 2022/2065 of the European Parliament and of the Council of 19 October 2022 on a Single Market For Digital Services and amending Directive 2000/31/EC (Digital Services Act), OJ L 277, 27.10.2022, p.1-102.
([122]) https://digital-strategy.ec.europa.eu/en/library/eu-toolbox-5g-security.

rights online is becoming crucial to navigating the complexities of our interconnected digital world ([123]).

Consequences for the Digital Decade in 2024: Global technological competition is prompting the EU to (i) strengthen its technological leadership and digital sovereignty, as well as its digital diplomacy actions to increase its cooperation with like-minded countries to increase our mutual economy security; and (ii) further promote a digital transformation that puts people and their human rights at the centre, as enshrined in the European Declaration on Digital Rights and Principles ([124]).

([123]) Bunde T., Eisentraut S., Schuette L.(eds.), Lose-Lose ? Munich Security Report 2024, https ://securityconference.org/assets/01_Bilder_Inhalte/03_Medien/02_Publikationen/2024/MSR_2024/MunichSecurityReport2024_Lose-lose.pdf.

([124]) https://digital-strategy.ec.europa.eu/en/library/european-declaration-digital-rights-and-principles.

3. A COMPETITIVE, SOVEREIGN AND RESILIENT EU BASED ON TECHNOLOGICAL LEADERSHIP

Technological leadership is essential for a prosperous, sustainable and human-centred digital future in the EU. It can fuel innovation and competitiveness, creating new jobs and opportunities for EU businesses. It also ensures security, resilience and sovereignty, thus enabling the development of technologies that uphold the EU's values, rules and standards, and ultimately empowering the EU to influence global standards.

The rapid advancements in key technologies, increasing digitalisation and intensified geopolitical tensions have accelerated the global tech race. The EU's performance has lagged behind, however, with global revenue share of EU GDP in the ICT market decreasing by 10.5% between 2013 and 2022. Global competitors have intensified their efforts at the same time, and China in particular has emerged as a technology leader. The digital sector itself continues to grow in economic importance and some of the largest tech companies have revenues that exceed the GDP of many EU Member States.

Regaining technological leadership requires sustained and coordinated action across the EU to ensure that the EU has:

- the ability to **innovate, develop and bring to market digital technologies and services** without being bound by design choices made elsewhere and that do not reflect EU values.
- the capacity to **deploy secure, sovereign and accessible digital infrastructures**, as a precondition for the potential of the data economy to develop and to counter disruptive innovations.
- a **strong manufacturing digital sector** that has strategic know-how and builds synergies between the different stages of production, as well as concrete means to ensure the resilience of the EU's digital supply chains.
- a **policy and regulatory framework that supports the long-term competitiveness** of the EU's industry and economy, ensuring **broad access to global markets** and a level playing field with international competitors.

Over the past 5 years, the EU has responded by building on a robust technological innovation ecosystem, enhancing its digital infrastructure and investing in R&D. **Significantly increased levels of funding and vigorous regulatory action** have been committed not only to developing and rolling out technologies, but also to tackling security concerns, dependencies and other vulnerabilities.

Efforts are starting to bear fruit. For instance, intensive EU action (including investment) in recent years has resulted in the EU becoming a leader in **supercomputing**, with three of the five most powerful supercomputers in the world being based in the EU. Since 2023, there has been a **modest 0.5 percentage point increase in the EU's share of the global ICT market**. However, the EU is still lagging behind when it comes to the adoption of critical technologies (particularly AI and data analytics) and the manufacturing of semiconductors. For example, according to an EIB survey, **EU enterprises trail their US counterparts in terms of digital technology adoption** in the manufacturing sector by

66% to 78% ([125]). As **adoption can lead to large productivity gains and competitiveness dividends, so the EU's slower pace of digitalisation poses a risk** to efforts to narrow the gap with the US in these areas, unless it capitalises on opportunities presented by autonomation, AI and other technologies. In addition, the EU still relies on imports of high-tech products and raw materials, which are essential for the EU's technological development and innovation. This chapter provides an overview of the EU's current position in the global technology race, focusing in particular on innovation. It summarises the efforts made over the past 5 years to support innovation and critical technologies, reduce risks to economic security and cybersecurity and strengthen the single market. Furthermore, it presents the progress achieved in 2023 towards infrastructure and technology targets, the digitalisation of business and the scaling-up of innovative companies.

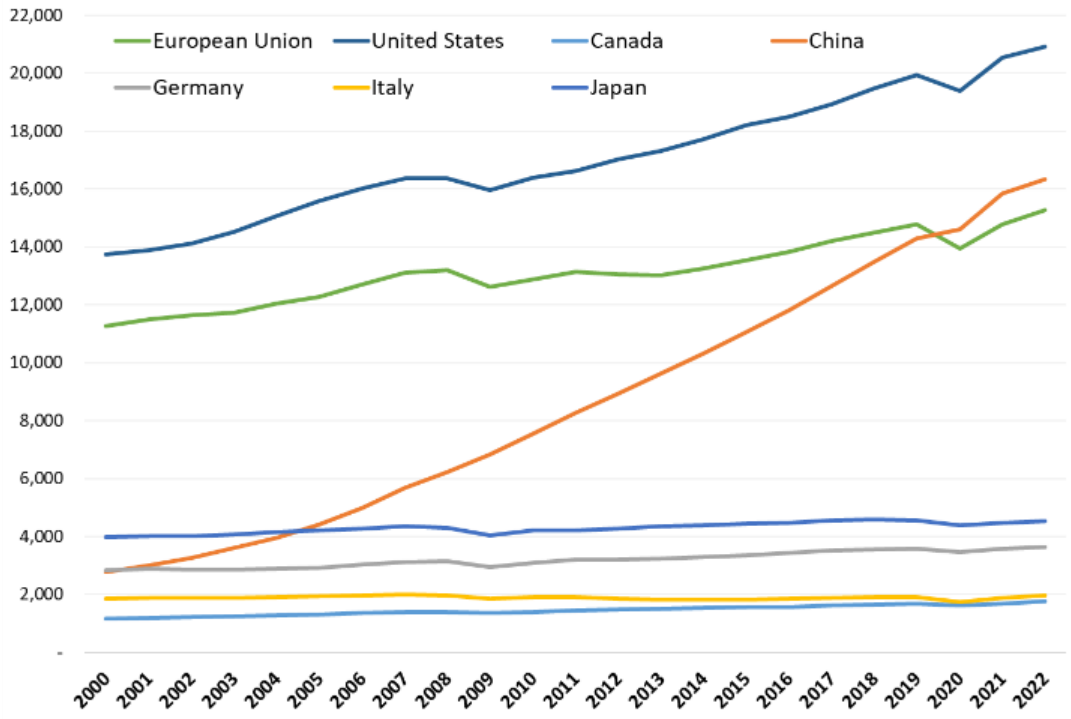
3.1. The global technology race: ensuring research and economic security and a level playing field for EU businesses

3.1.1. The EU's position in the global technology race

In recent years, **the EU's competitiveness has been challenged** by high inflation, labour shortages, supply chain disruptions, rising interest rates and spikes in energy prices. The **competitiveness** paradigm now needs to be reconciled with contemporary challenges, including economic security, decarbonisation, constrained fiscal capacities and the resurgence of economic nationalism. However, **the EU has proven its resilience.** The deepest EU recession since World War II has been followed by the strongest recovery since the post-war boom ([126]). Both the EU and the US economies have shown sustained growth over the last two decades. However, China's GDP grew fivefold between 2000 and 2022, and **since 2020 China has replaced the EU as the world's second economy**.

([121])https://www.eib.org/en/publications-research/economics/surveys-data/eibis-digitalisation-report.htm.
([126]) https://commission.europa.eu/document/download/37fb50d6-73e1-426c-bd4a-87c44c8763d9_en?filename=Keeping-our-promise-to-Europe_brochure.pdf.

Figure 1. GDP in current values – G7 countries & China (USD billions)



Source: World Bank

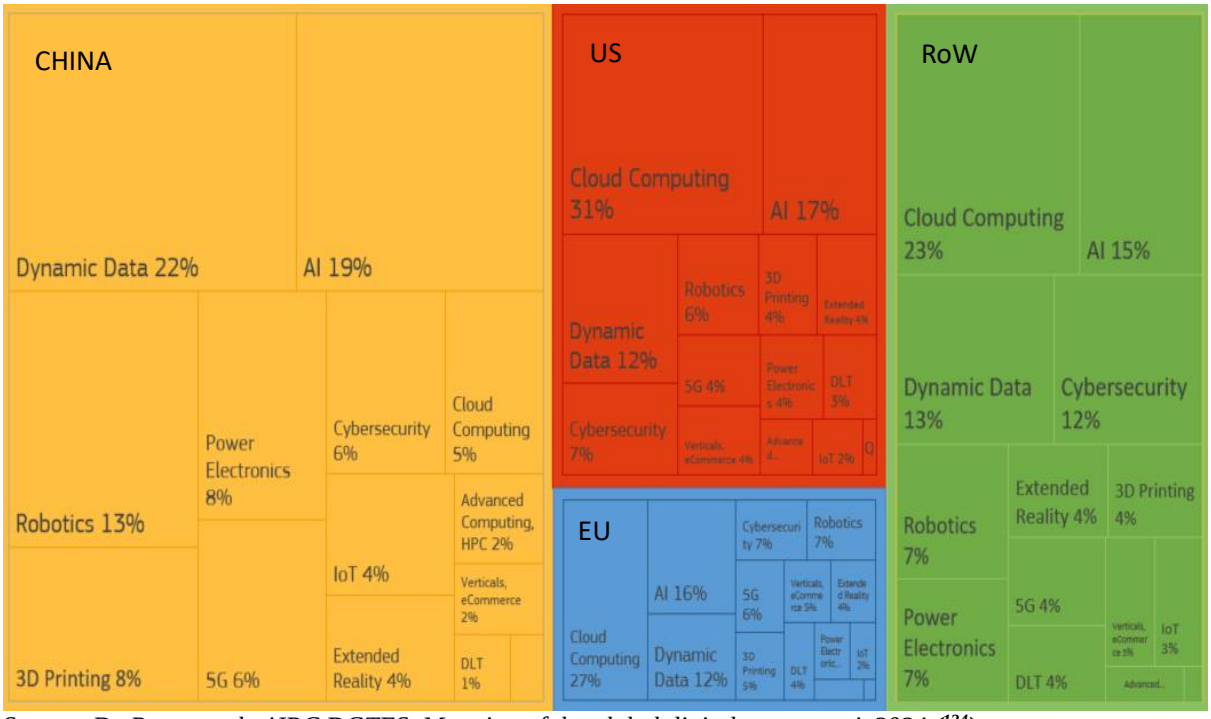
In this context, **the technology race has been rapidly accelerating**. The EU is leading in certain technology niches but is also lagging behind in several critical technologies (e.g., AI, connectivity, semiconductors and green technologies) that are essential for the ongoing economic transformation and is to a large extent dependent on imports of high-tech products. In addition, **the EU is not and will not be self-sufficient in many of the raw materials that are critical for the digital and green transitions** ([127]) and will have to continue relying on imports for most of its consumption ([128]).

According to Digital Decade Eurobarometer 2024 findings, 82% of citizens consider that it is important for public authorities to ensure that EU companies can grow and become EU champions able to compete globally([129]). **Digitalisation has played a vital role in the EU's recovery**, contributing to its competitiveness by driving growth and modernising the economy, opening new business opportunities and helping the EU gain a competitive advantage in global markets. **It is therefore important that the EU secures its position as a leader in transformative technology areas to be able to ensure its competitiveness in the long term**. In fact, achieving technological leadership is essential for the EU so that it cannot only chart its own path in the digital transformation and promote sustainable technological development across the EU; but also enhance its open strategic autonomy and resilience and strengthen its economy and industrial base, while also upholding the commitment to a fair, open and values-based global digital market, and protecting EU citizens' and companies' sensitive data ([130]).

([127]) Examples include lithium, cobalt, low-grade gallium, tungsten, magnesium and silicon.
([128]) https://ec.europa.eu/commission/presscorner/api/files/document/print/en/ip_23_1661/IP_23_1661_EN.pdf.
([129]) Special Eurobarometer 551 'The Digital Decade' 2024: https://digital-strategy.ec.europa.eu/en/news-redirect/833351.
([130]) https://www.consilium.europa.eu/media/54773/20220311-versailles-declaration-en.pdf.

As highlighted in the first 2023 State of the Digital Decade Report ([131]), **the EU is severely lagging behind in the ICT race**, with most of the technologies needed for the EU's digital transformation being designed and manufactured in non-EU countries. Despite the essential nature of the ICT industry for our sovereignty and competitiveness, and its role in addressing economic and societal challenges, **the global revenue share of EU GDP in the ICT market dramatically decreased by 10.5% in the decade between 2013 and 2022**. By contrast, the global share of US GDP in the ICT market increased from 26.8% to 35.7% during the same period. However, since last year, there has been a **marginal 0.5 percentage point increase in EU's share** ([132]) ([133]).It may be early to interpret this as a shift in trend, but this could be an **encouraging sign that sustained, continuous and coordinated efforts to strengthen the EU's digital technological leadership have started to bring results**.

Figure 2. Composition of activities by digital area in selected geographical areas (2009-2023)



Source: De Prato et al., 'JRC DGTES. Mapping of the global digital ecosystem', 2024 ***([134])***

Technological leadership often goes hand in hand with geopolitical influence. A dominant position in key technologies could enhance a non-EU country's global influence and challenge the EU's interests and values, particularly in areas such as human rights, cybersecurity and data privacy. In particular, the emergence of China as a technological leader presents such risks for the EU due to its potential ability to shape global standards and norms for emerging technologies. If the EU does not step up and play a significant role as a global standard setter, it may find itself having to conform to Chinese-led standards.

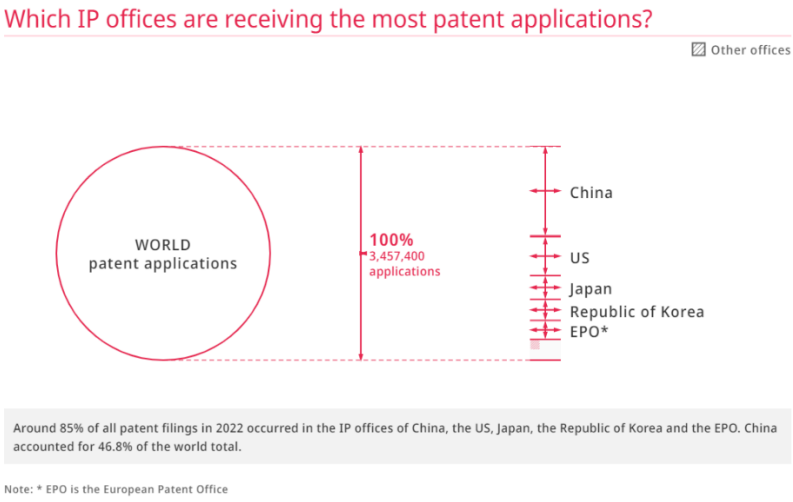
([131]) https://digital-strategy.ec.europa.eu/en/library/2023-report-state-digital-decade.
([132]) https://www.statista.com/statistics/263801/global-market-share-held-by-selected-countries-in-the-ict-market/.
([133]) For comparison, the US' share of global revenue is 35.7%, the Chinese share is 11.7% and the Japanese share is 5.7% (2023 data).
([134]) De Prato, G., Calza, E., Fabiani, J., Soguero Escuer, J., Kostić, U., Mitton, I., Moraschini, M., Cira, P., DGTES mapping of the global digital ecosystem, Publications Office of the European Union, Luxembourg, 2023 (2024, forthcoming).

This could significantly hinder the EU's technological development and regulatory autonomy.

3.1.2. EU performance in research and innovation

Looking in particular at innovation ([135]), which serves as a vital catalyst for economic growth, **the EU continues to stand out as a significant contributor to global scientific advancements**, generating approximately 20% of the world's scientific output ([136]) despite comprising just 6% of the world's population. **However, China became the new frontrunner in 2022**, with about 22% of global publications. When one examines specialised publications, China leads in applied and natural sciences, particularly in areas such as engineering, enabling and strategic technologies and ICT. By contrast, EU publications focus on humanities and US publications centre around health technologies ([137]). In 2022, innovators from around the world submitted a record-breaking 3.46 million patent applications – the highest number of filings ever recorded. Since 2015, the National Intellectual Property Administration of the People's Republic of China (CNIPA) has consistently received over 1 million applications annually. **In 2022, CNIPA received 46.8% of global patent applications**, equivalent to approximately 1.6 million. The United States Patent and Trademark Office (USPTO) ranked second with 594 340 applications, followed by the Japan Patent Office (JPO) (289 530), the South Korean Intellectual Property Office (KIPO) (237 633) and **the European Patent Office (EPO) with 193 610** ([138]).

Figure 3. Patent applications across the world



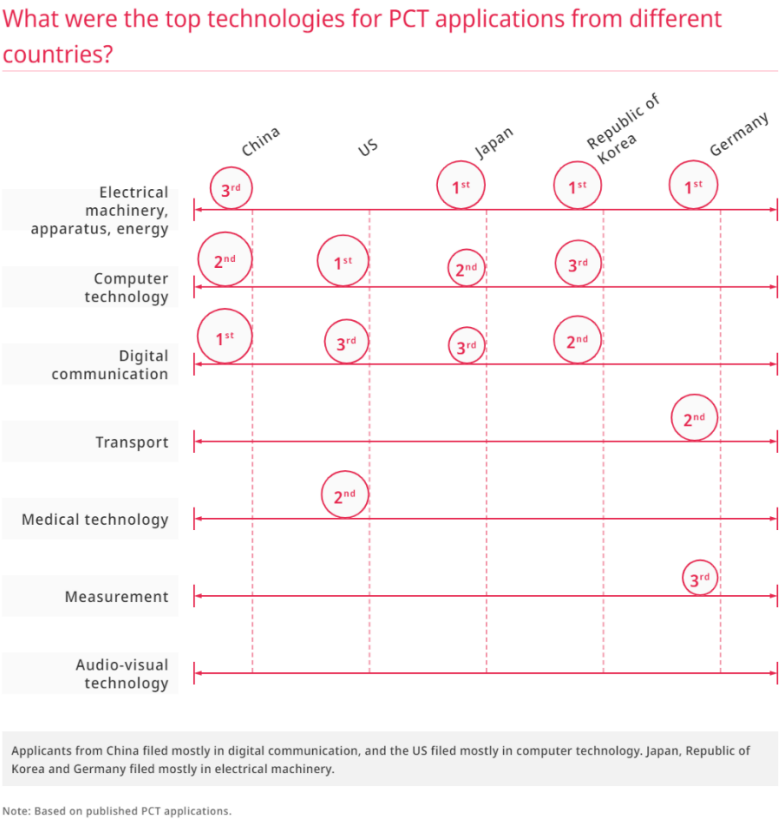
Source: WIPO Statistics Database, March 2024

Available quantitative data indicate that China is also leading in international patent filings ([139]), as captured by the World Intellectual Property Organisation's (WIPO) ranking

([135]) Innovation is often assessed through proxies such as academic publications and the use of patents, both of which reflect the extent and impact of R&D activities within a region or country.
([136]) China produced 22% of publications, having around 17.7% of the world population.
([137]) https://op.europa.eu/en/publication-detail/-/publication/b3baec75-fdd0-11ed-a05c-01aa75ed71a1/language-en/format-PDF/source-287596143, pp. 52-55.
([138]) https://www.wipo.int/edocs/pubdocs/en/wipo-pub-941-2023-en-world-intellectual-property-indicators-2023.pdf, p. 10.
([139]) International patent applications or filings are the first step in ensuring that a company gets exclusive rights to its inventions in countries around the world.

of firms leading the filing of international patent applications under the PCT ([140]). In 2023, Huawei Technologies (China) led as a top filer with almost 6 500 applications. It was followed by Samsung Electronics (South Korea) with 3 924 applications, Qualcomm (US), Mitsubishi Electric (Japan), BOE Technology Group (China) and LG Electronics (South Korea). It is worth noting that 8 of the top 10 users were located in north-east Asia. **Ericsson (Sweden) is the only EU-based company among the top 10 filers of international patent applications**. Applicants from China filed mostly in digital communications. US applicants filed mostly in computer technology ([141]).

Figure 4. Top technologies for PCT applications across the world



Source: WIPO Statistics Database, March 2024

It is important to recognise that, the greater number of patent applications in China does not necessarily reflect superior quality and impact. In spite of high patenting, China is only 12th in the WIPO Global Innovation Index 2023 [142]. On patenting intensity, China has incentives and targets in place, which most likely artificially inflate the patent production.

Ongoing efforts to develop quality-adjusted analyses are shedding light on critical aspects of China's technological landscape and industrial strategies. China lags behind the EU in critical areas such as quantum technology and faces significant challenges in AI development. In particular, the nature of AI (particularly GenAI) presents inherent challenges within China's regulatory framework. For instance, officials are incentivised to

([140]) The Patent Cooperation Treaty (PCT) is an international patent law treaty, concluded in 1970. It provides a unified procedure for filing patent applications to protect inventions in each of its contracting states. A patent application filed under the PCT is called an international application or PCT application. The PCT regulates patent protection for inventions in multiple countries: https://www.wipo.int/pct/en/.

([141]) https://www.wipo.int/en/ipfactsandfigures/patents.

([142]) https://www.wipo.int/edocs/pubdocs/en/wipo-pub-2000-2023-section1-en-gii-2023-at-a-glance-global-innovation-index-2023.pdf.

meet targets for pushing companies to deploy robots, but the utility of deployment is often limited[143].

China's dominance remains unbeatable in areas where economies of scale come into play. However, it is struggling to transition towards innovation and broader competitiveness. Against a general understanding of the China's industrial landscape, **the role of direct State subsidies is minimal, while state-owned funds, primarily targeting second-tier companies, play a significant role**. Disparities between national and regional levels, as well as deviations from official plans, underscore the complexity and fluidity of such landscape.

The EU's total (public and private) R&I investments still represent only 2.2% of the EU's GDP (2022) – well below the target of 3% – and are unevenly distributed across regions and Member States ([144]). The EU investment level remains below that of the US (3.4% of US GDP) and China (1.8% of China GDP), especially due to the **huge gap in private sector R&I** and stagnant public investments, as shown in Figure 5 and Figure 6 below ([145]).

Figure 5. US and China: Contextual data

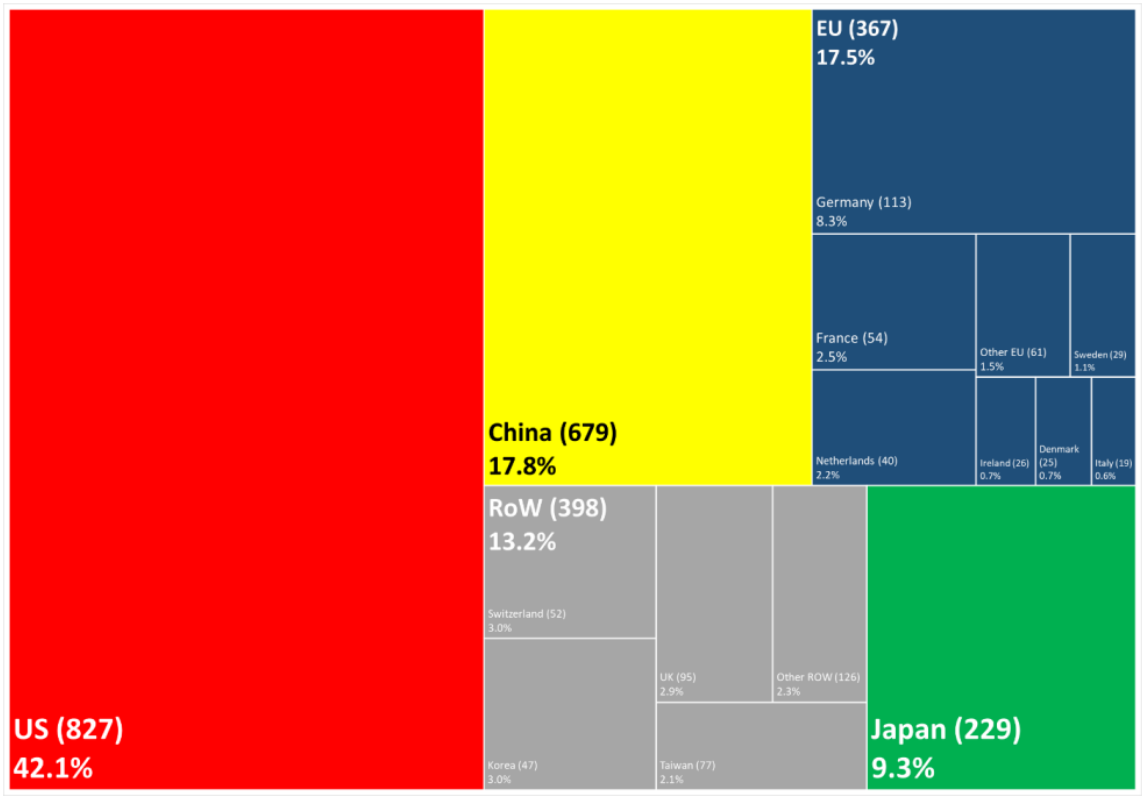
	US	EU		US	EU
Population (million)	333.3	446.7	Human Development Index (score 0-1)	0.92	0.90
GDP ($ billion)	$25,462	$16,641	R&D expenditure (% of GDP)	3.4%	2.3%
GDP per capita ($, PPP)	$76,398	$54,248	ICT service exports (% of service exports)	7.1%	16.8%

	China	EU		China	EU
Population (million)	1,412.2	446.7	Human Development Index (score 0-1)	0.77	0.90
GDP ($ billion)	$17,963	$16,641	R&D expenditure (% of GDP)	1.8%	2.3%
GDP per capita ($, PPP)	$21,476	$54,248	ICT service exports (% of service exports)	10.1%	16.8%

Source: International benchmarking of the digital transformation, Visionary Analytics, March 2024

([143]) https://www.economist.com/china/2023/12/20/chinas-quest-to-become-a-robot-superpower.
([144]) https://commission.europa.eu/document/af444130-5a3e-44f2-bea6-5b9ddcb46012_en.
([145]) For additional details, see the 2023 EU Industrial R&D Investment Scoreboard, European Commission, Joint Research Centre, Publications Office of the European Union, 2023, https://data.europa.eu/doi/10.2760/506189.

Figure 6. Share of R&D investment per region/country worldwide



Note: Figures in brackets show the number of companies per region/country; the percentage share refers to the regions'/country's share in total Scoreboard R&D.

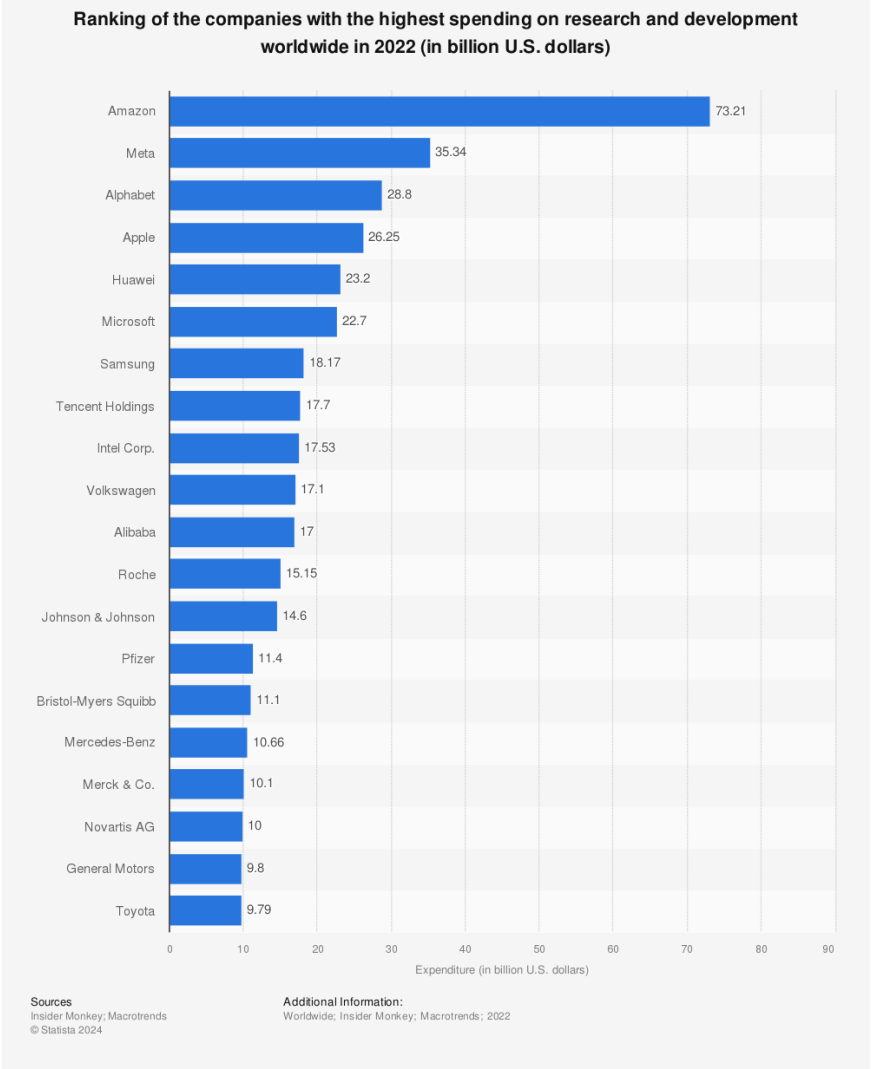
Source: The 2023 EU industrial R&D investment scoreboard – Publications Office of the EU (europa.eu), *p. 13.*

The lower rate of R&D investment in the EU business sector than in the US is partly due to structural differences in R&D business investment sector profiles. In addition, many euro area countries set higher administrative requirements for start-ups than other advanced economies ([146]). High barriers to entry protect the profits of incumbents, reduce technology diffusion and constrain the entry of younger innovative firms ([147]) ([148]).

As Figure 5 and Figure 6 show, both **US and Chinese companies invest particularly heavily in R&D in high-growth areas. Such investments include ICT and related services** as well as health-related areas (particularly the US). By contrast, the EU leads in R&D investments in the automotive sector and has a broader industrial portfolio of R&D investment, including in industries that develop and apply green technologies for decarbonisation as well as for the circular economy. **The EU is a global leader in the development of technologies that combine digital and green innovations**, with a large share of EU patenting activities concentrated in climate change technology ([149]).

([146]) OECD, *Indicators of Product Market Regulation*, 2018.
([147]) Aghion et al. (2004), 'Entry and Productivity Growth: Evidence from Microlevel Panel Data', *Journal of the European Economic Association*, Vol. 2, No 2/3, Papers and Proceedings of the Eighteenth Annual Congress of the European Economic Association, pp. 265-276.
([148]) https://www.ecb.europa.eu/press/key/date/2024/html/ecb.sp240216~df6f8d9c31.en.html.
([149]) https://www.eib.org/en/publications/online/all/eib-investment-survey-2023.

Figure 7. Ranking of companies with the highest spending on R&D worldwide in 2022 (in billions of USD)



Source: *Companies with highest R&D spending worldwide 2022 | Statista*

This situation underscores the pressing need for the EU to pursue strategies to promote innovation, enhance its own technological capabilities, strengthen regulatory frameworks, diversify supply chains and collaborate with the widest range of partners to promote open and fair competition in the global tech landscape.

EU and Member State measures

Supporting EU R&I by addressing research security risks

As outlined in the **European Economic Security Strategy** ([150]) adopted on 20 June 2023, a global increase in geopolitical tensions and hostile economic actions, cyber and critical infrastructure attacks, foreign interference and disinformation has revealed threats to and vulnerabilities in our societies, economies and companies. It has become clear that the EU should be better prepared to respond to evolving, new and emerging risks that have arisen in this more challenging geopolitical context.

([150]) Joint Communication from the European Commission and the High Representative of the Union for Foreign Affairs and Security Policy of 20 June 2023 to the European Parliament, the European Council and the Council on 'European economic security strategy', JOIN(2023) 20 final.

The recent Digital Decade Eurobarometer 2024 shows that **five out of six EU citizens think it is important for public authorities to increase research and innovation in more secure and stronger digital technologies**[151].

Given the pivotal role of technology for political, economic and military pre-eminence, some of the EU's competitors are seeking global primacy in emerging and disruptive technologies in order to enhance their military and intelligence capabilities and are also actively pursuing civil-military fusion strategies. **This may result in EU R&I being affected by malign influences and being misused in ways that affect our security or infringe our ethical norms**. EU researchers and academics are increasingly confronted with risks when cooperating internationally.

The EU is one of the world's biggest research funders, with EUR 95 billion funded from Horizon Europe. **About 33% of the Horizon Europe budget has been committed to the digital transition** ([152])([153]) **and there is a legal obligation to earmark at least EUR 13 billion for core digital (general-purpose) technologies** ([154])([155]). Openness, international cooperation and academic freedom are at the core of the EU's world-class research and innovation. However, to better protect the EU's strategic assets, interests, autonomy and security, the Commission has introduced safeguards under the Horizon Europe Regulation ([156]). Concretely, 31 actions under the Horizon Europe 2023-2024 work programme (3.5% of the total) are subject to restricted eligibility under Article 22(5) of the Regulation. This means that **entities based in, owned or controlled from certain non-EU countries may not participate in such actions**. In addition, **cooperation with entities based in China has been excluded for innovation actions** under Article 22(6) of the Regulation. The participation of legal entities from Russia and Belarus in any Horizon Europe topics has been excluded in line with the EU's sanctions regime ([157]).

The Commission has also reinforced its monitoring system for cases of **transfer of ownership of results of EU-funded research projects to non-associated non-EU countries** (Article 40). In addition, the Commission has introduced **investment safeguards via the European Innovation Council**. The scope of these safeguards includes investments in SMEs and start-ups that are developing technologies and innovations that may pose risks to economic security if they are acquired by non-associated non-EU countries.

([151]) Special Eurobarometer 551 'The Digital Decade' 2024: https://digital-strategy.ec.europa.eu/en/news-redirect/833351.

([152]) https://commission.europa.eu/strategy-and-policy/eu-budget/performance-and-reporting/programme-performance-statements/horizon-europe-performance_en#contribution-to-horizontal-priorities.

([153]) For comparison, climate represents 34% of the Horizon Europe budget.

([154]) 7.925 billion.

([155]) Communication from the Commission to the European Parliament, the European Council and the Council of 14 February 2018, 'A new, modern Multiannual Financial Framework for a European Union that deliver efficiently on its priorities post-2020', COM(2018) 98 final, identifies EUR 13 billion that has been spent on the main digital activities under the Research and Innovation Framework Programme Horizon 2020.

([156]) Regulation (EU) 2021/695 of the European Parliament and of the Council of 28 April 2021 establishing Horizon Europe – the Framework Programme for Research and Innovation, laying down its rules for participation and dissemination, and repealing Regulations (EU) No 1290/2013 and (EU) No 1291/2013, OJ L 170, 12.5.2021, p. 1.

([157]) Council Regulation (EU) No 833/2014 of 31 July 2014 and Council Regulation (EU) 2021/1986 of 15 November 2021.

In a proposal for a Council Recommendation on enhancing research security of 24 January 2024 ([158]), **the Commission has called for the need to address research security risks in the R&I sector across the EU** with an approach that remains strongly anchored in academic freedom and institutional autonomy. Currently, awareness of these risks is not evenly spread across the EU. An increasing number of Member States and R&I actors are developing and introducing dedicated safeguarding measures, but others still seem largely unaware and are thus creating vulnerabilities that could easily be exploited. National governments are best placed to support the R&I sector. However, there is a need to take appropriate steps to raise awareness and build resilience, EU-level cooperation and coordination ([159]) in order to ensure the proper functioning of the EU research area and to reduce disparities caused by differences in national research security measures.

In 2021, the EU also adopted **guidelines for research involving dual-use items**, to ensure that risks are effectively identified, managed and mitigated by authorities and research organisations ([160]). With the adoption of the Economic Security Package on 24 January 2024 ([161]), the Commission launched a **public consultation on EU-level R&D support involving technologies with dual-use potential** ([162]). In this regard, it is reviewing the current relevant EU funding programmes and assessing whether this support is still adequate and strategic in the face of the existing and emerging geopolitical challenges outlined in the European Economic Security Strategy. It has also suggested options for the future in an open way as a basis for debate during the public consultation.

The importance of, and need to explore, ways to enhance **support for R&D involving technologies with dual-use potential** ([163]) have been previously discussed (e.g., in the context of the negotiations of the Horizon Europe Regulation and the European Defence Fund Regulation). However, the conclusions led to a political choice by the co-legislators to treat civil and defence R&D as separate fields that target different stakeholder communities, which each have their different rules, purposes and market applications. Acknowledging the lack of suitable instruments to facilitate cross-fertilisation between civil and defence R&D activities, the Commission has launched several actions since 2021 to improve synergies between EU programmes and promote an EU-wide approach for critical technologies by making best use of EU R&D programmes ([164]).

Beyond research security: addressing economic security risks

The EU benefits from being open and integrated in global value chains through cost reduction, economies of scale, risk reduction and access to foreign input. **Integration into global value chains enhances resilience but also creates risks that could affect**

([158]) Proposal for a Council Recommendation on enhancing research security, COM(2024) 24 final: https://research-and-innovation.ec.europa.eu/system/files/2024-01/ec_rtd_council-recommendation-research-security.pdf.

([159]) To this end, the Commission has announced the establishment of a European Centre of Expertise on Research Security.

([160]) Commission Recommendation (EU) 2021/1700 of 15 September 2021 on internal compliance programmes for controls of research involving dual-use items under Regulation (EU) 2021/821 of the European Parliament and of the Council setting up a Union regime for the control of exports, brokering, technical assistance, transit and transfer of dual-use items, OJ L 338, 23.9.2021, p. 1.

([161]) https://europa.eu/newsroom/ecpc-failover/pdf/ip-24-363_en.pdf.

([162]) https://ec.europa.eu/info/law/better-regulation/have-your-say/initiatives/14060-RD-on-dual-use-technologies-options-for-support_en.

([163]) 'Dual-use items' are items, including software and technology, which can be used for both civil and military purposes.

([164]) https://research-and-innovation.ec.europa.eu/system/files/2024-01/ec_rtd_white-paper-dual-use-potential.pdf.

essential inputs and products for society and the economy. The COVID-19 pandemic, Russia's full-scale invasion of Ukraine, the energy crisis and rising geopolitical tensions have exposed dependencies on strategic areas. Countries all over the world and the EU have therefore started to address challenges in relation to their economic security.

The **European Economic Security Strategy** ([165]) follows a three-pillar approach:

- **promoting** the EU's competitiveness, by strengthening the single market, supporting a strong and resilient economy, investing in skills and fostering the EU's research, technological and industrial base.
- **protecting** the EU's economic security through a range of existing policies and tools, and consideration of new ones to address possible gaps. This would be done in a proportionate and precise way that limits any negative unintended spill-over effects on the EU and global economy.
- **partnering** with the widest possible range of partners to strengthen economic security, including through furthering and finalising trade agreements, reinforcing other partnerships, strengthening the international rules-based economic order and multilateral institutions (such as the World Trade Organization) and investing in sustainable development through the Global Gateway ([166]).

The aim of the Economic Security Strategy is to provide a framework for a robust assessment and management of risks to economic security at the EU, national and business levels, while preserving and increasing its economic dynamism. In particular, the Strategy states that there will be coordinated assessments of four categories of risks: (i) **risks to the resilience of supply chains**; (ii) **risks to the physical and cybersecurity of critical infrastructure**; (iii) **risks to technology security and security-relevant technology leakage**; and (iv) **risks of weaponisation of economic dependencies or economic coercion**.

Critical technologies and dual-use technologies are the centre of the Strategy. They are crucial to the EU's prosperity and security but are also the subject of intensifying geopolitical competition and can be used to threaten international peace, security or human rights. A Commission Recommendation of 3 October 2023 on critical technology areas for the EU's economic security for further risk assessment with Member States ([167]) identified 10 critical technology areas for economic security ([168]) based on three criteria: (i) their **enabling and transformative nature**; (ii) the **risk of civil and military fusion**; and (iii) the **risk that the technologies could be used to violate human rights**.

After adopting the Recommendation, the Commission immediately launched **joint risk assessments in four critical technology areas that pose the most sensitive and**

([165]) Joint Communication from the European Commission and the High Representative of the Union for Foreign Affairs and Security Policy of 20 June 2023 to the European Parliament, the European Council and the Council on 'European economic security strategy', JOIN(2023) 20 final.

([166]) https://commission.europa.eu/strategy-and-policy/priorities-2019-2024/stronger-europe-world/global-gateway_en.

([167]) Commission Regulation (EU) 2023/2113 of 3 October 2023 on critical technology areas for the EU's economic security for further risk assessment for further risk assessment with Member States.

([168]) (1) Advanced semiconductor technologies; (2) AI technologies; (3) quantum technologies; (4) biotechnologies; (5) advanced connectivity, navigation and digital technologies; (6) advanced sensing technologies; (7) space and propulsion technologies; (8) energy technologies; (9) robotics and autonomous systems; (10) advanced materials, manufacturing and recycling technologies.

immediate risks to technology security ([169]) **and of technology leakage** ([170]) together with the Member States: (i) advanced semiconductor technologies; (ii) AI technologies; (ii) quantum technologies; and (iv) biotechnologies. **By assessing risks in these four technology areas, the Commission and Member States will ensure that the EU remains at the forefront of technological innovation, safeguards its economic security and maintains strong partnerships**.

As regards **the assessment of risks to the resilience of supply chains**, already as a follow-up to the reviewed Industrial Strategy of May 2021, the Commission has proposed a bottom-up data-driven assessment of **product dependencies across sensitive industrial ecosystems** ([171]). This assessment was updated recently to reflect the latest data developments ([172]). The latest update exercise detected 204 products among a set of 5 400 goods which the EU trades with non-EU countries and on which the EU is dependent ([173]). Of those products, 64 come from China, 38 from US and 15 from Russia. In import values, **China is the main source of the EU's dependencies**. Examples of such dependent goods in the digital and electronics ecosystem are **cell phones and laptops** from China. Once these products have been identified, a deeper analysis is conducted to detect **strategic dependencies subject to single points of failure or choke points**, because their production is highly **concentrated** at the world level in a single country and that country's production is central to many other countries in an international trade network. Such products **risk being weaponised for geopolitical purposes** given their particularly limited potential for diversification. The Commission's analysis cross-checked the 204 dependent goods against choke points and found that approximately 30% of these dependent goods are subject to a relatively high risk of facing choke points (China is the EU's main source for products such as permanent magnets, magnesium, manganese, solar PV cells and cell phones).

Furthermore, the forthcoming **EU Cyber Resilience Act (CRA)**, on which the co-legislators reached an agreement in December 2023, which the European Parliament approved in March 2024, will significantly increase the security of the whole supply chain. The CRA is the first comprehensive piece of product security legislation in the world. It introduces mandatory cybersecurity requirements for all hardware and software products on the EU market. This will also help critical infrastructures and other organisations to meet their supply chain security obligations and thus shield them from cyber espionage and ransomware attacks.

As regards **the physical and digital security of critical infrastructure, the Critical Entities Resilience Directive** which entered into force on 16 January 2023 provides for Member States to carry out **risk assessments on essential services** by 17 January 2026.

([169]) Technology security risks are economic security risks linked to the ability to develop or access trusted and secure critical technologies in the EU.

([170]) Technology leakage risks are economic security risks related to the undesirable transfer of critical technology to certain non-EU destinations where they could be misused for human right violations or to undermine peace and security.

([171]) Commission Staff Working Document on strategy dependencies and capacities, SWD(2021) 352 final.

([172]) Arjona et al. (2023): https://single-market-economy.ec.europa.eu/publications/enhanced-methodology-monitor-eus-strategic-dependencies-and-vulnerabilities_en.

([173]) A product is considered as foreign-dependent in a given year if it fulfils three criteria: (i) non-EU imports originate in fewer than three foreign countries; (ii) non-EU imports are at least half of the total EU imports; and (iii) non-EU imports are higher than total EU exports. NB: the data take into account the issue of re-exports.

The Network and Information Security Directive (NIS 2 Directive) ([174]) provides the framework for coordinated risk assessment on the cybersecurity of critical infrastructure.

Furthermore, in accordance with the recently agreed **Cyber Solidarity Act** (CSA), the Cyber Emergency Mechanism should support the coordinated preparedness testing of entities operating in highly critical sectors (see further details in Section 3.4). As a follow-up to the Nevers Call of 9 March 2022, **a risk assessment on communications infrastructures and networks was conducted by the NIS Cooperation Group**, with the support of the Commission and the EU Agency for Cybersecurity (ENISA). In addition, work is currently in progress on a **cybersecurity risk assessment for telecommunications and energy (including gas to the extent that it generates electricity)** in response to the Council Conclusions of 23 May 2022 on the EU's cyber posture. The **Commission Recommendation of 26 February 2024 on Secure and Resilient Submarine Cable Infrastructures** aims to ensure that the Member States and the Commission work together to implement a coordinated and robust approach to the assessment, deployment and upgrade of such critical infrastructures.

For 5G, the EU already has a **Toolbox on 5G cybersecurity** in place (see further details in Section 3.4). The Commission is taking measures to avoid any exposure of its corporate communications to mobile networks that use Huawei and ZTE, which have been assessed as high-risk suppliers. Procurement will exclude new connectivity services that rely on equipment from those suppliers, and they are being progressively phased out from the existing connectivity services of Commission sites. The Commission is also applying this decision in relevant EU funding programmes and instruments, in full compliance with EU law.

Finally, the Commission is also working with Member States to **assess risk levels and areas of potential weaponisation of economic dependencies or economic coercion**. This assessment looks at potential impacts and the likelihood of such practices being directed against the EU. The scope of this assessment includes various actions that could interfere with the legitimate sovereign choices of the EU and its Member States or could otherwise weaponise economic dependencies in relations with the EU.

Supporting the manufacturing of critical emerging technologies

To further enhance the EU's strategic sovereignty and support its technological leadership, the Commission has recently started to take a more structural approach to the significant investment needs of EU industries. In June 2023, the Commission presented the mid-term revision of the EU's multiannual financial framework (MFF) for 2021-2027. As a part of the package, it proposed the establishment of the **Strategic Technologies for Europe Platform (STEP), an instrument to develop critical emerging technologies that are relevant to the green and digital transitions and to the EU's strategic sovereignty**. The STEP Regulation, which entered into force on 1 March 2024, requires STEP during the current MFF to redirect funds under existing EU funding programmes as well as to use additional EUR 1.5 billion to reinforce the European Defence Fund.

([174]) Directive (EU) 2022/2555 of the European Parliament and of the Council of 14 December 2022 on measures for a high common level of cybersecurity across the Union, amending Regulation (EU) No 910/2014 and Directive (EU) 2018/1972, and repealing Directive (EU) 2016/1148 (NIS 2 Directive), OJ L 133, 27.12.2022, p. 80 (consolidated version).

The STEP Platform will boost manufacturing capacity in digital technologies and deep tech innovation, clean and resource-efficient technologies and biotechnologies, and will strengthen value chains and address labour and skill shortages in these sectors. The scope of the STEP Regulation may evolve in accordance with technological changes and/or geopolitical and international trade developments. However, with respect to the area of digital technologies, the Commission has provided that the Platform will support the manufacturing of digital technology innovations ([175]) that fall within the areas defined in the Commission Recommendation of 3 October 2023 on critical technologies for the EU's economic security.

Building technological leadership in national Digital Decade strategic roadmaps ([176])

The Decision establishing the Digital Decade ([177]) and the related Commission Guidance ([178]) specify that national Digital Decade strategic roadmaps should also encompass the general objectives of the Digital Decade. The national roadmaps, however, focus to a large extent on the Digital Decade targets and related trajectories. The measures to achieve the targets are also expected to cover and contribute to achieving the general objectives, but the link is often indirect, and it is more difficult to establish coverage of the general objectives.

Building technological leadership is a theme in many national roadmaps. Member States refer to technological leadership when describing their national contexts, ambitions and strategies. This corresponds to the objectives of the Digital Decade Policy Programme of building technological leadership, sovereignty and resilience. However, the number of measures reported as being intended to explicitly contribute to achieve these objectives is rather limited. Member States most often describe their contribution to technological leadership by referring to measures that address the related targets for digital infrastructures and technologies and their related trajectories. Indeed, the largest number of the measures that are attributed directly to the objectives of building technological leadership, sovereignty and resilience focus on developing and deploying sovereign and resilient digital infrastructure and technologies, including via multi-country projects and other cross-country initiatives (e.g., in the areas of high-performance computing, blockchain and security operation centres). Furthermore, the roadmaps report measures supporting R&D in technologies, networks and infrastructure (including via competence centres and innovation clusters).

Concluding remarks and future challenges

In times of intense competition for technological leadership, the EU must strengthen its efforts to maintain its technological edge. In particular, it will be important to boost support for the R&I sector and to put into place the right framework for promoting innovation. Faced with increased geopolitical competition, the EU will have to identify and address

([175]) Deep technology innovations should be understood as those which have the potential to deliver transformative solutions, rooted in cutting-edge science, technology, and engineering, including innovation combining advances in the physical, biological, and digital spheres.

([176]) This analysis only takes account of elements reported by the Member States in their national roadmaps. The measures reported by the Member States were grouped into categories to provide a better overview of the types of measures taken.

([177]) Article 7 of Decision (EU) 2022/2481 of the European Parliament and of the Council of 14 December 2022 establishing the Digital Decade Policy Programme, OJ L 323, 19.12.2022, p. 4.

([178]) Communication from the Commission: guidance to the Member States on the preparation of the national Digital Decade strategic roadmaps, COM(2023) 4025 final, OJ C 230, 30.6.2023, p. 4.

risks to research security, (including raising awareness) and build resilience in the European research area. In order to ensure that risks identified in the Economic Security Strategy are adequately and proportionately mitigated, it will be important for the Member States and the private sector to be engaged in the process.

3.1.3. A functioning Digital Single Market as an enabler of competitiveness

Ensuring the necessary level playing field and supporting EU-wide digital ecosystems (particularly innovative enterprises) in scaling up are among the major objectives of the Digital Decade policy programme.

By securing a **level playing field** for all EU businesses, the **digital single market is one of the key enablers that allow companies to grow and achieve the necessary scale to compete at EU level**, while also guaranteeing that digital technologies and services work for people (i.e., they are in line with EU standards and values).

The Digital Single Market allows digital providers to offer their services throughout the EU, thus allowing the scaling-up of business and fostering the digital economy. The Digital Single Market also increases consumer choice, thus removing artificial barriers within the EU.

The Commission has taken an active role in promoting the Digital Single Market, by monitoring the implementation of existing EU law, as well as proposing and then implementing new EU initiatives in the field of online services.

The past 5 years have been marked by intensive legislative activity to bringing the single market into line with the need for a human-centric digital transition and a competitive digital economy. The Digital Services Act (DSA) will, inter alia, ensure that online businesses can operate throughout the EU on the basis of a single set of directly applicable rules. The Digital Markets Act (DMA) will ensure fair and contestable markets in the digital sector, so that undertakings providing prominent core platform services (large online platforms) cannot misuse their gatekeeper position in the single market. Harmonised rules in areas such as audiovisual media and copyright, support fair remuneration for creators, cultural diversity and media pluralism in the digital context. The Data Governance Act and the Data Act have built a genuine single market for data. The forthcoming Cyber Resilience Act will create a single market of cybersecurity, including cybersecurity requirements for any connectable product, software or hardware.

Particular attention is being paid to online platforms, because they are often key drivers of innovation in the digital world and their success is closely tied to the success of a range of businesses that use online platforms to reach customers. Online platforms allow smaller businesses in particular to expand their operations beyond their home state, catering for consumers across the entire single market. SMEs and start-ups are reliant on large digital platforms. For instance, over 1 million EU businesses sold goods or digital services via online platforms in 2023.

Online platforms also raise new challenges relating to fairness, transparency, contestability and possible market distortions. Unfair practices and lack of contestability lead to inefficient outcomes in the digital sector in terms of higher prices, lower quality, and less choice and innovation. Large digital companies have become increasingly dominant in certain services (e.g., through network effects, data accumulation advantages, economies

of scale and scope, or the combination of user data from different services). In such situations, a new service may not be able to overcome these barriers and gain traction, even if it is innovative and of high quality.

EU and Member State measures

The **e-Commerce Directive** (Directive 2000/31/EC, ECD) is the foundational legal framework for online services in the EU. It aims to remove obstacles to cross-border online services. One of its key principles is the single market clause. It ensures that providers of online services are subject to the law of the Member State in which they are established and not the law of the Member States where the service is accessible. The Commission has been monitoring the implementation of this clause by Member States in the context of notifications received from Member States pursuant to the e-Commerce Directive on the measures that they intend to take against providers. The Court of Justice of the European Union has recently issued a reminder as to the limits to Member States' ability to deviate from the single market clause (C-376/22, C-662/22 and C-667/22).

The Commission has also continued monitoring the implementation of sector-specific legislation aimed at further deepening the single market, such as the **Geo-blocking Regulation** and the **Platform to Business Regulation** ('P2B Regulation').

To keep up with fast-evolving digital markets and to address market distortions associated with large online platforms, the **Digital Markets Act** (DMA) was adopted with the purpose of to ensuring contestability and fairness for markets in the digital sector. It was proposed by the Commission in December 2020 and agreed by the European Parliament and the Council in record-time, in March 2022. It came into force since November 2022 and began to be applied since May 2023.

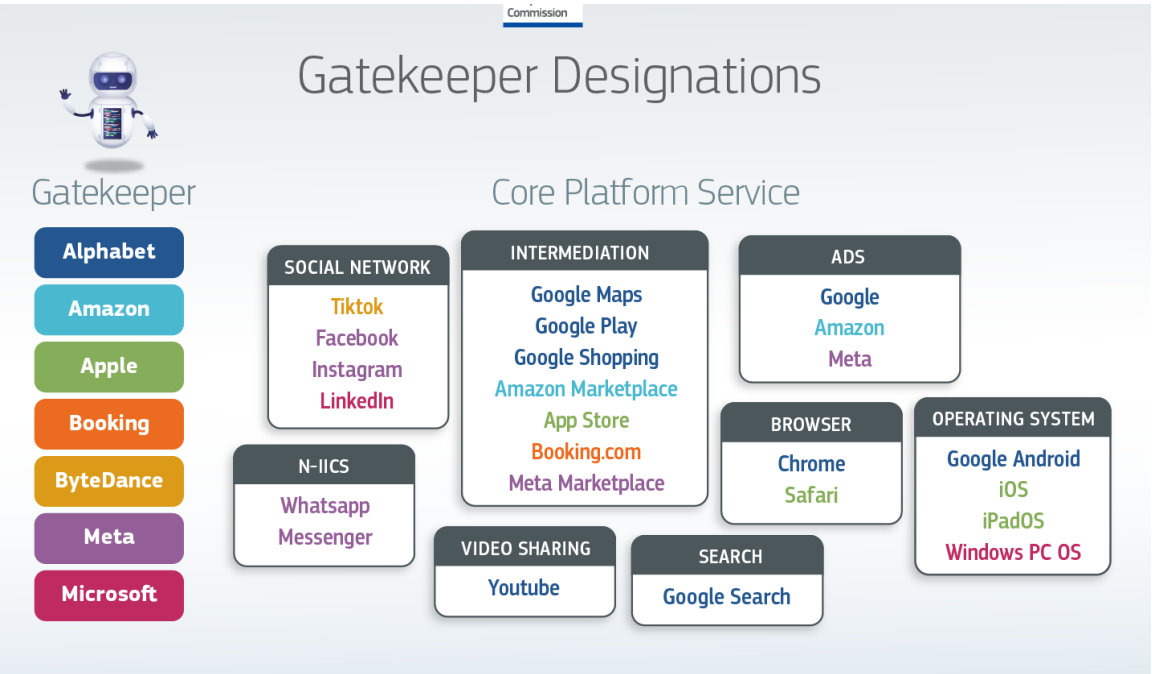
The DMA is an *ex ante* sector-specific regulation based on the years of experience the Commission has gained by enforcing competition policy and applying other EU law in the digital area. The DMA has introduced rules for platforms that act as 'gatekeepers' in the digital sector (i.e., platforms that have a significant impact on the single market and that serve as an important gateway for business users to reach their end users). The DMA aims to prevent gatekeepers from imposing unfair conditions on businesses and end users, and to ensure that digital markets are open and fair. It is therefore expected to open up possibilities for smaller companies to contest markets and innovate. For example:

- business users will no longer face unfair ranking practices whereby gatekeepers prioritise their own services and products over those offered by other businesses on the same platform.
- gatekeepers will not be allowed to use any non-public data that is provided by business users in competition with those business users.
- gatekeepers will need to ensure that business users can access performance data about advertising campaigns and advertisement pricing information.
- large platforms will allow developers to use alternative in-app payment systems and provide interoperability options for messenger systems.

Gatekeepers will allow business users to promote their offers and conclude contracts with their customers outside the gatekeeper's platform.

On 6 September 2023, the Commission designated six gatekeepers (Alphabet, Amazon, Apple, ByteDance, Meta and Microsoft) under the DMA. In total, 22 core platform services (CPSs) provided by gatekeepers have been designated. Some CPSs like Amazon and Meta marketplaces, Apple's App store or Google Play are vital gateways for businesses to reach their consumers. Since 7 March 2024, these six designated gatekeepers have been required to ensure full compliance with the DMA obligations for each of their designated CPSs. On 29 April 2024, the Commission designated Apple's iPadOS, its operating system for tablets, as a gatekeeper under the DMA. On 13 May 2024, the Commission designated Booking as a gatekeeper for its online intermediation service Booking.com The Commission continuously monitors if gatekeepers effectively comply with the DMA. Indeed, soon after the first compliance deadline (on 25 March 2024), the Commission opened non-compliance investigations against Alphabet, Apple and Meta because of concerns that the measures put in place by these gatekeepers fall short of effective compliance. Moreover, on 24 June, the Commission also opened new non-compliance investigation into Apple's new contractual terms for developers. The Commission's monitoring of effective compliance by gatekeepers is ongoing.

Figure 8. List of designated gatekeepers and their core platform services



Source: Commission services (May 2024)

During the pre-compliance discussions the Commission worked with the designated gatekeepers, and stakeholders and gatekeepers presented their compliance solutions in the compliance ([179]) reports submitted on 6 March 2024. Some changes which will already benefit companies in the EU are as follows:

Opening ecosystems

Apple's ecosystem will become more open:

([179]) https://digital-markets-act-cases.ec.europa.eu/reports/compliance-reports.

- rivals will be able to set up new app stores on iOS to compete with Apple's own native App Store.
- developers using Apple's App Store will be able to use alternative in-app payment providers and ID services.
- iOS features will be unlocked – developers can now start developing innovative services using APIs which had been private.

Interoperability of messaging services

- Meta's landmark service WhatsApp will become interoperable. If and when requested, Meta will ensure that WhatsApp is interoperable with competing third-party messaging services.

Data portability and access

- Alphabet, Amazon, Apple, Meta, Microsoft and ByteDance have rolled out new APIs and enhanced existing APIs, which will enable end users to authorise the direct recurrent transfer of their data to other competing platforms or to companies using the data to offer innovative services.
- Alphabet, Amazon, Apple, Meta, Microsoft and ByteDance have made more data available to business users about their use of the gatekeepers' platforms and engagement of their users on these platforms.

Competitiveness and resilience in national Digital Decade strategic roadmaps ([180])

Supporting competitive digital ecosystems and innovative businesses appear as objectives in many national Digital Decade strategic roadmaps. This corresponds to the objectives of the Digital Decade Policy Programme of ensuring strong digital ecosystems and resilient supply chains. However, the number of measures reported in order to explicitly contribute to achieving these objectives is rather limited. Member States most often describe their contribution to competitiveness and resilience by referring to measures that address the related targets for digital technologies and digitalisation of business. The largest part of these measures focuses on supporting digital ecosystems and scaling up innovative businesses.

A small number of measures include regulatory action for standard-setting, interoperability and fair competition for users, businesses and regions (e.g., Bulgaria, Greece, Croatia, Cyprus Luxembourg and Sweden), addressing dependencies for critical technologies supply (e.g., Denmark, Germany, Spain, France and the Netherlands) as well as initiatives in relation to international exchange (e.g., Lithuania and Sweden).

Concluding remarks and future challenges

The Commission priorities regarding the DMA are now to enforce the rules and to monitor effective compliance with the relevant obligations. On 25 March 2024, the Commission opened non-compliance investigations against Alphabet, Apple and Meta because of concerns that the measures these gatekeepers had put in place fell short of effective compliance with the relevant obligations under the DMA. In addition, the Commission

([180]) This analysis only takes account of elements reported by the Member States in their national roadmaps. The measures reported by the Member States were grouped into categories in order to provide a better overview of the types of measures taken.

will continue to assess the notifications of new gatekeepers or for new CPSs from already designated gatekeepers; revise at least every 3 years the status of designated gatekeeper; and assess the need to qualitatively designate gatekeepers that do not meet the quantitative thresholds. In this respect in the first semester of 2024 the Commission designated one additional gatekeeper (booking.com) and an additional CPS for Apple (iPadOS). Booking.com and Apple for its iPadOS CPS will have to comply with the DMA rules six months after designation.

The Commission will continue to monitor the evolution of the digital markets and to adapt its enforcement actions to the new challenges. Tools like the DMA include a number of future-proof provisions that enable the Commission to adapt its interventions.

Beyond this, a truly functional single market will be critical for a successful digital transformation and competitiveness. This will, inter alia, ensure the availability of fast, reliable and secure digital connectivity (including cloud, edge and other computing infrastructure throughout the EU) in order to provide functional data spaces for critical sectors where EU rules on privacy and data protection are fully respected; to stimulate a competitive data market; and to stimulate software and chips that meet all the sustainability and security standards (as discussed in the following paragraphs).

3.2. Developing and deploying sovereign and resilient digital infrastructures capabilities

DD cardinal points and targets: digital infrastructure (semiconductors, edge nodes, quantum computing, gigabit & 5G).

DD objectives: Research and Innovation (Create opportunities for growth and jobs through research, development and innovation; Promoting research and innovation to foster sustainable, resilient and energy and resource efficient digital infrastructure and technologies); **Digital infrastructure** (Secure and accessible digital and data infrastructures enabling technological developments, supporting competitiveness, resilience and sustainability, in particular of SMEs and fostering the start-up ecosystem; Competitive, secure and sustainable data cloud infrastructure in place, with high security and privacy standards); **Sovereignty** (Ensuring the Union's digital sovereignty).

Digital Rights and Principles: Solidarity and Inclusion (Connectivity: 'Everyone, everywhere in the EU, should have access to affordable and high-speed digital connectivity').

Faced with increased competitive pressure and the need to regain technological leadership and resilience, the EU has massively increased its efforts to develop and deploy sovereign digital infrastructures and technologies. The Digital Decade sets ambitious goals for gigabit and 5G connectivity, the production of semiconductors, quantum computing capabilities, and the deployment of edge nodes.

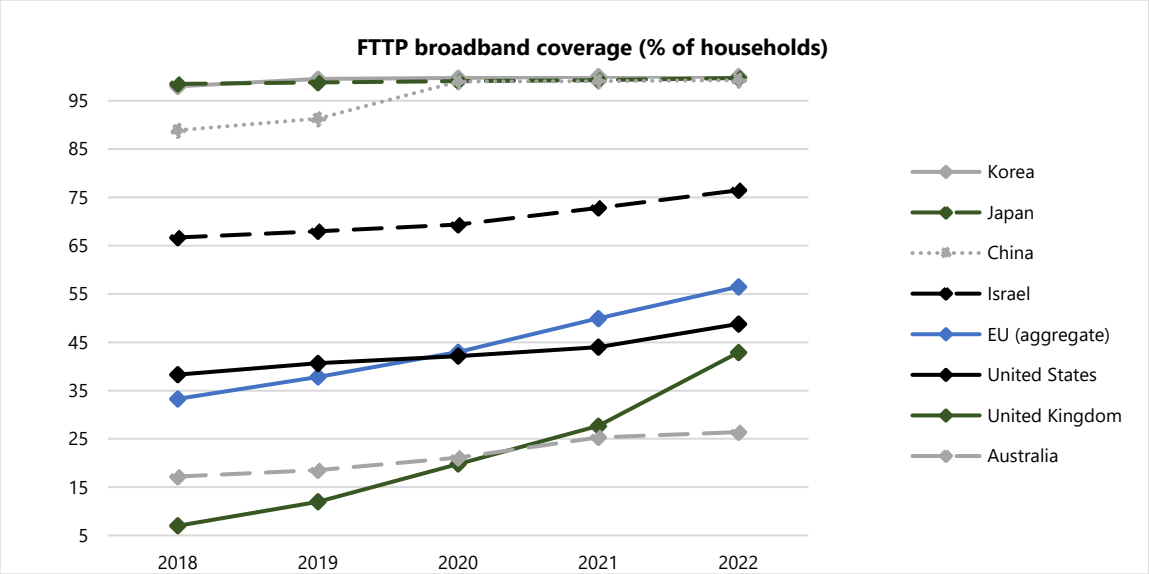
3.2.1. Connectivity infrastructure

Connectivity infrastructure is the foundation for a flourishing digital economy and society. Advanced connectivity and computing infrastructures enable applications to make citizens' lives easier, businesses more innovative and public administrations more efficient. Many sources agree that there is a strong link between the increased deployment of fixed and

mobile broadband and economic development: advanced digital network infrastructures and services generate a global GDP growth between EUR 1 and 2 trillion ([181]) and are essential enablers for the digital and green transition of our society and economy. Demand for connectivity is essential in order to stimulate the economy. Higher speeds and new generations of mobile networks have a positive impact on GDP ([182]).

Recent efforts have paid off in terms of catching up with global competitors ([183]). The EU now scores better in fibre subscriptions and fibre-to-the-premises (FTTP) coverage, but still lower than Asian countries and Israel. One may also note that the US in particular ranks relatively low in fibre-focused indicators due to the technology mix used for broadband roll-out.

Figure 9. FTTP coverage – international comparison



Source: International benchmarking of the digital transformation, Visionary Analytics, March 2024

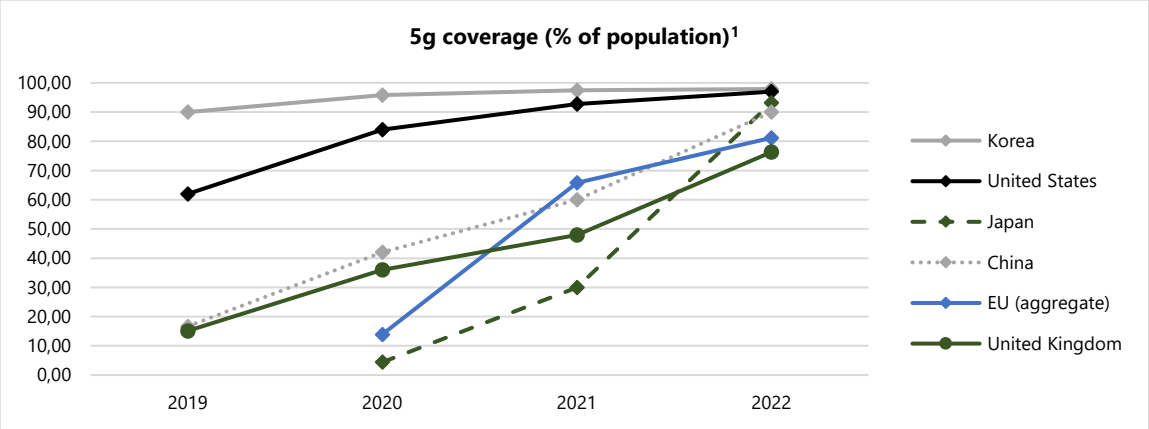
As regards the roll-out of 5G networks, the EU, is after a late start, also closing the gap with leading countries such as South Korea and the US. However, there are issues regarding the quality of 5G networks as well as major discrepancies within the EU, with 5G coverage rates ranging between 20% and 100%.

([181]) Connected World: An evolution in connectivity beyond the 5G evolution, McKinsey 2020 available at: https://www.mckinsey.com/industries/technology-media-and-telecommunications/our-insights/connected-world-an-evolution-in-connectivity-beyond-the-5g-revolution.

([182]) In particular, mobile telecommunication's baseline connectivity impact increases by about 15% when connections are upgraded to 3G. The impact increases by approximately 25%, when connections are upgraded from 2G to 4G. Source: mobile technology: two decades driving economic growth (gsmaintelligence.com).

([183]) Visionary Analytics, *International benchmarking of the digital transformation*, March 2014.

Figure 10. 5G coverage – international comparison



Source: International benchmarking of the digital transformation, Visionary Analytics, March 2024

The Commission's February 2024 white paper 'How to master Europe's digital infrastructure needs?' has highlighted the point that the EU's connectivity infrastructure is not sufficient to address the current and future challenges of the data-driven society and economy and the future needs of all end users.

Among other challenges, the sector is faced with the need to transform itself in a context of converging connectivity infrastructure with cloud and edge computing capabilities and digital services in key economic sectors, such as the Industrial Internet of Things and AI applications. This has important implications for investments, with the need for adequate scale and a level playing field across the entire value chain being highlighted as an important enabler. The sector also needs to deliver on the Digital Decade objectives of providing a secure sustainable digital infrastructure across the EU, thereby also closing the digital divide that has resulted from access to infrastructure.

State of play and progress towards the Digital Decade target

The Digital Decade policy programme sets ambitious connectivity targets: 100% coverage of all areas across the EU with gigabit network, and 100% coverage of all populated areas with next-generation wireless high-speed networks with performance at least equivalent to that of 5G. Reaching these targets can only be possible with full commitment from all Member States. These are full-coverage targets, so it is only possible if all Member States adopt the EU target at national level: only 100% at national level will deliver 100% at EU level.

Gigabit connectivity

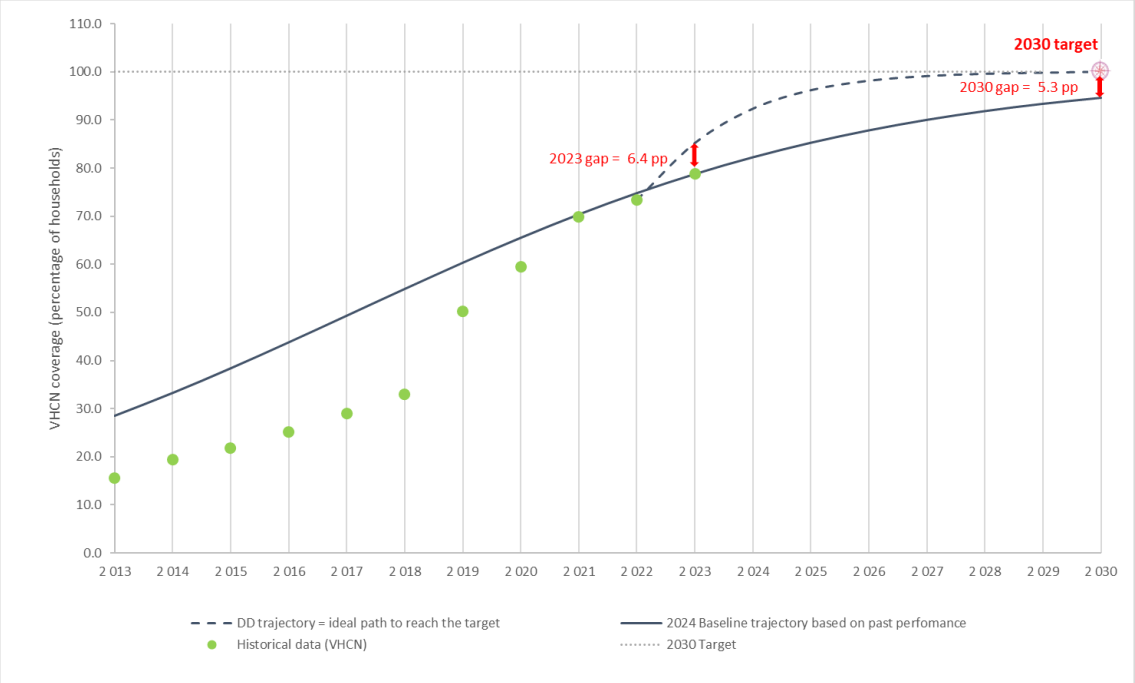
In recent years, significant efforts have been made across all Member States, showing important increases in coverage. Coverage with very high-capacity networks (VHCN) was 78.8% in 2023 (an increase of 7.4% on the 73.4% coverage in 2022)[184].

Based on the current VHCN definition and available data, fixed VHCN capable of providing gigabit connectivity is expected to reach 94.7% by the end of the projection period. The recent development of this KPI has been driven by the deployment of optical

([184]) For the purposes of this report, VHCN includes FTTP and DOCSIS 3.1 networks, cf. Decision C(2023)4288 Implementing Act setting out Key Performance Indicators to measure the progress towards the digital targets established by Article 4(1) of Decision (EU) 2022/2481 of the European Parliament and of the Council.

fibre networks (FTTP), for which an additional trajectory is presented below. The remaining 21% of households still not covered by VHCN will be reached mainly through further FTTP deployments. This will require sustained efforts because households not yet covered by the network are likely to be located in more cost-intensive suburban, semi-rural and rural areas, in particular areas where market viability is not ensured and for which public investment may not be available.

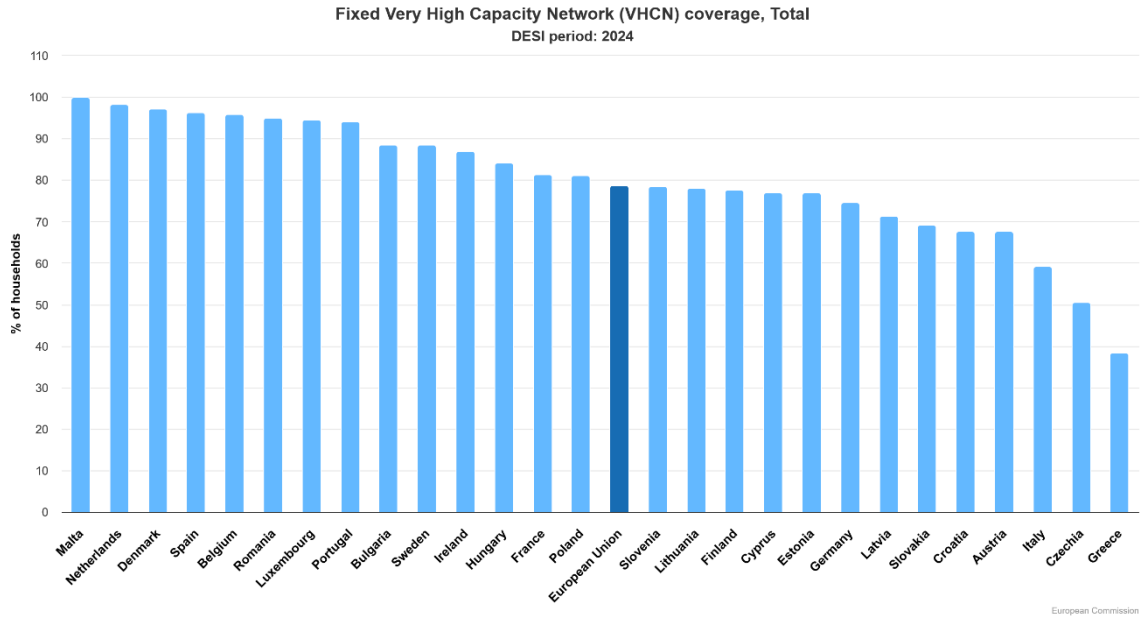
Figure 11. Fixed VHCN coverage in the EU. Historical data, Digital Decade (DD) trajectory and revised baseline trajectory towards 2030



Source: European Commission

Furthermore, VHCN coverage differs greatly between Member States. Countries like Malta, Netherlands, Denmark, Spain and Belgium are at over 95%, while Slovakia, Croatia, Austria, Italy, Czechia and Greece have rates below 70%. This is partly due to the existence of upgraded HFC networks in some Member States.

Figure 12. Fixed VHCN coverage in the EU

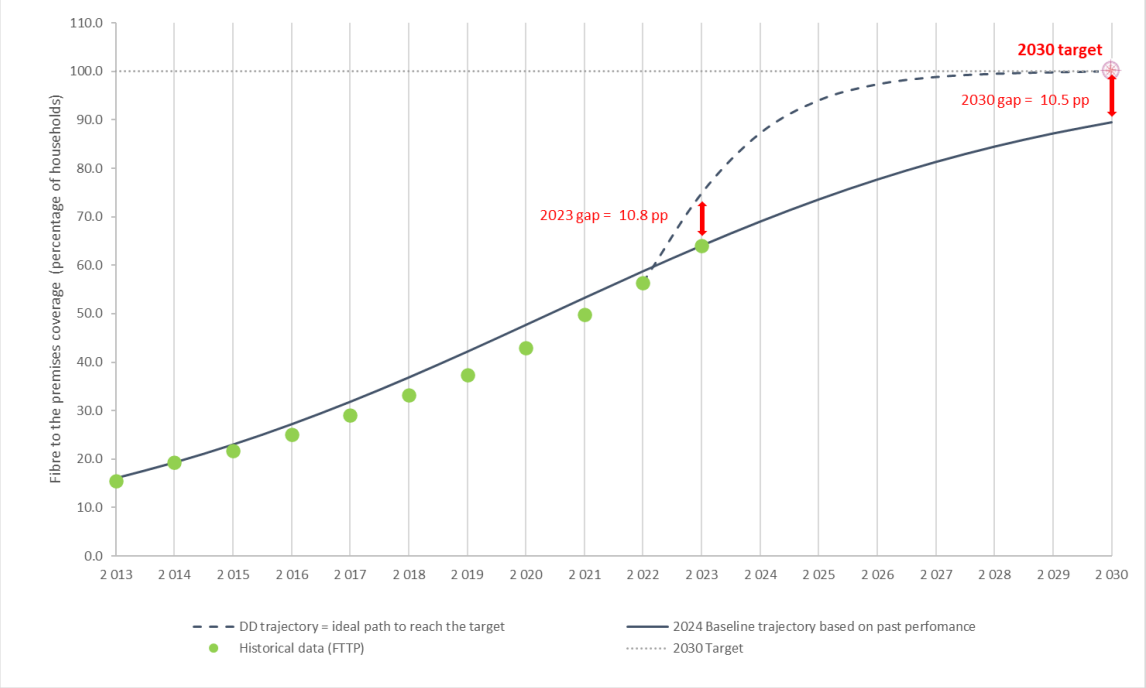


Source: European Commission

To track the progress of FTTP coverage, as outlined in the 'KPI Implementing Decision' ([185]) and to better interpret VHCN coverage data, an EU-level trajectory is also established and monitored for this indicator (Figure 13). Coverage with FTTP networks grew strongly by 13.5% from 56.4% in 2022 to 64.0%. The trajectory below shows that the fibre coverage is expected to reach 89.5% by 2030. This represents a gap with respect to the ideal Digital Decade trajectory of 10.5 percentage points if no additional investments are implemented.

([185]) Commission Implementing Decision (EU) 2023/4288 of 30 June 2023 setting out key performance indicators to measure the progress towards the digital targets established by Article 4(1) of Decision (EU) 2022/2481 of the European Parliament and of the Council.

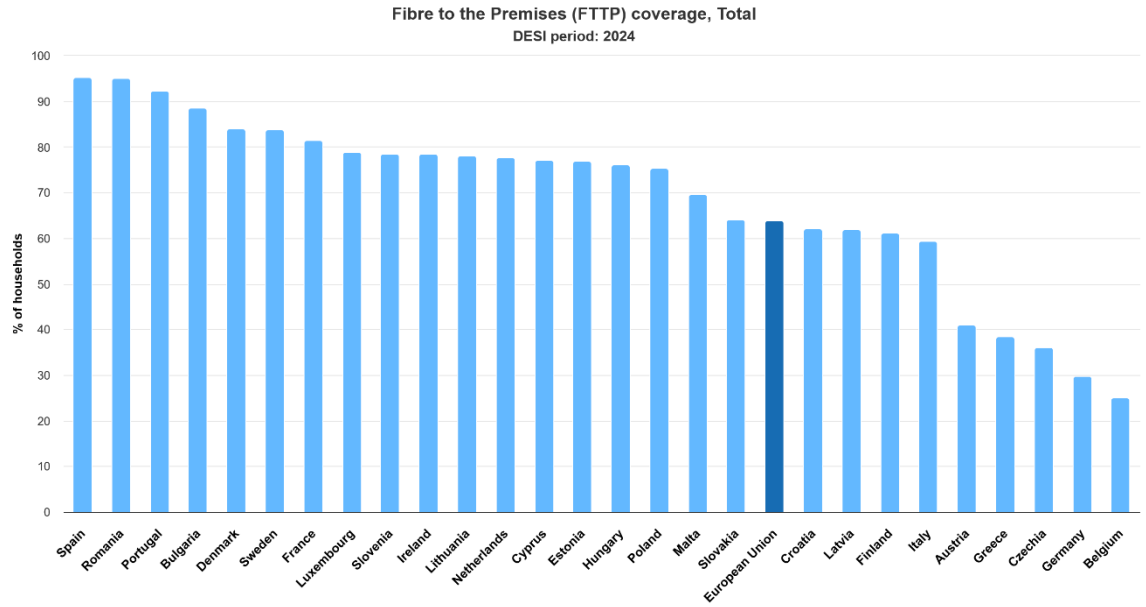
Figure 13. FTTP coverage in the EU. Historical data, Digital Decade (DD) trajectory and revised baseline trajectory towards 2030



Source: European Commission

The discrepancies between Member States in terms of FTTP coverage are even greater than for VHCN coverage. Rates range from over 90% in Spain, Romania and Portugal to less than 40% in Czechia, Germany and Belgium. Greece nevertheless achieved a significant increase in its FTTP coverage by 37.9% between 2022 and 2023, reaching 38.4% of the households.

Figure 14. FTTP coverage in the EU

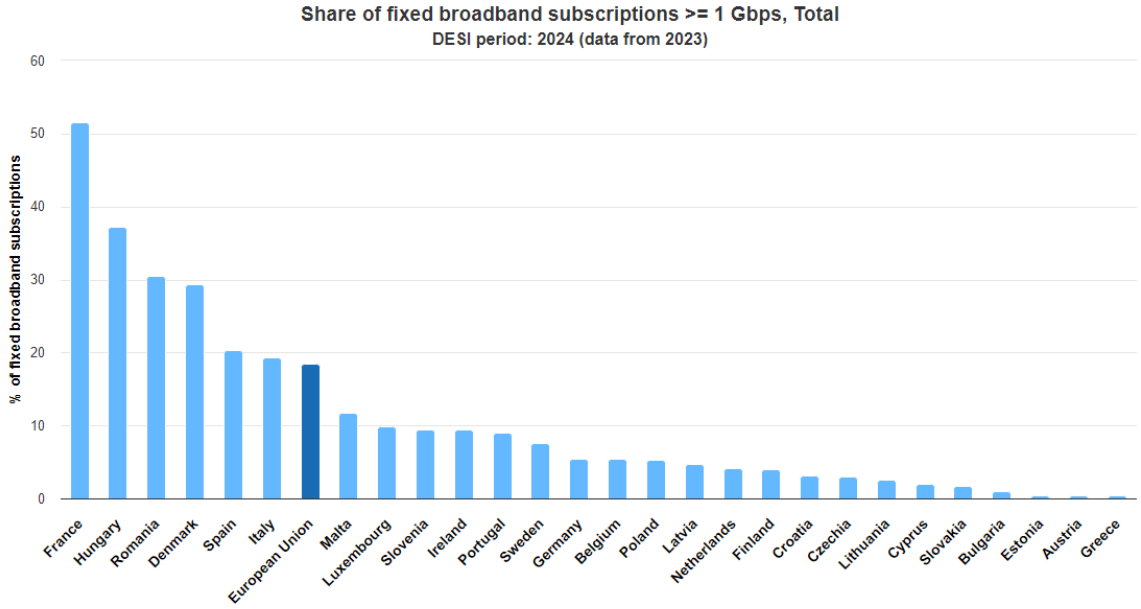


Source: European Commission

Steady progress was also registered in terms of closing the rural urban divides. Rural VHCN coverage reached 55.6% in 2023, while rural FTTP coverage was just over half, at 52.7%.

In terms of take-up, the share of broadband subscriptions with speeds of 1Gbps or above grew from 14.9% in 2022 to 18.5% in 2023. Member States' figures range from around 30 to 52% for France, Hungary, Romania and Denmark to less than 1% in Estonia, Austria, and Greece. Over the same period, the share of broadband subscriptions of 100Mbps or above grew from 60 to 66% across the EU as a whole.

Figure 15. Share of fixed broadband subscriptions



Source: European Commission

A study performed on behalf of the Commission (Study on National Broadband Plan in the EU-27[186]) assessed the likelihood of reaching the Gigabit Society 2025 and Digital Decade 2030 connectivity objectives at national level in the light of the latest developments in terms of connectivity policies, regulations and investments, at EU and national levels. The study noted that the Member States' national broadband plans (NBPs) differ greatly as regards their structure and approach. It concluded that most Member States have made good progress towards reaching the connectivity targets in the recent years, but that the planned public and private investments for the next years are quite ambitious. However, achieving the objectives might become challenging for some of them, especially in relation to the 2025 target of download speeds of 100 Mbps upgradable to 1 Gbps for all. The probability of achieving the Digital Decade 2030 connectivity target is assessed as high for 16 Member States. 9 Member States (Czechia, Germany, Croatia, Italy, Cyprus, Austria, Poland, Slovakia and Finland) have a medium probability of reaching the 2030 target. 2 Member States (Belgium and Greece) have a low estimated probability. The many factors that may be slowing down progress in achieving Digital Decade's gigabit for all targets include low FTTP coverage; low levels of digital skills; low subscription rates for gigabit speeds; difficult topography; challenging and cost-intensive roll-out in rural and remote areas; barriers to investment (legal, administrative, financial and technical); high broadband prices; insufficiently extensive investment plans; high DOCSIS 3.1. coverage; market share; low population density; and a high number of mobile-broadband-only users.

All Member States have an overall strategic approach for the deployment of broadband networks that is being implemented and delivered in practice. A variety of factors influence

([186]) https://digital-strategy.ec.europa.eu/en/library/updated-study-national-broadband-plans-eu27.

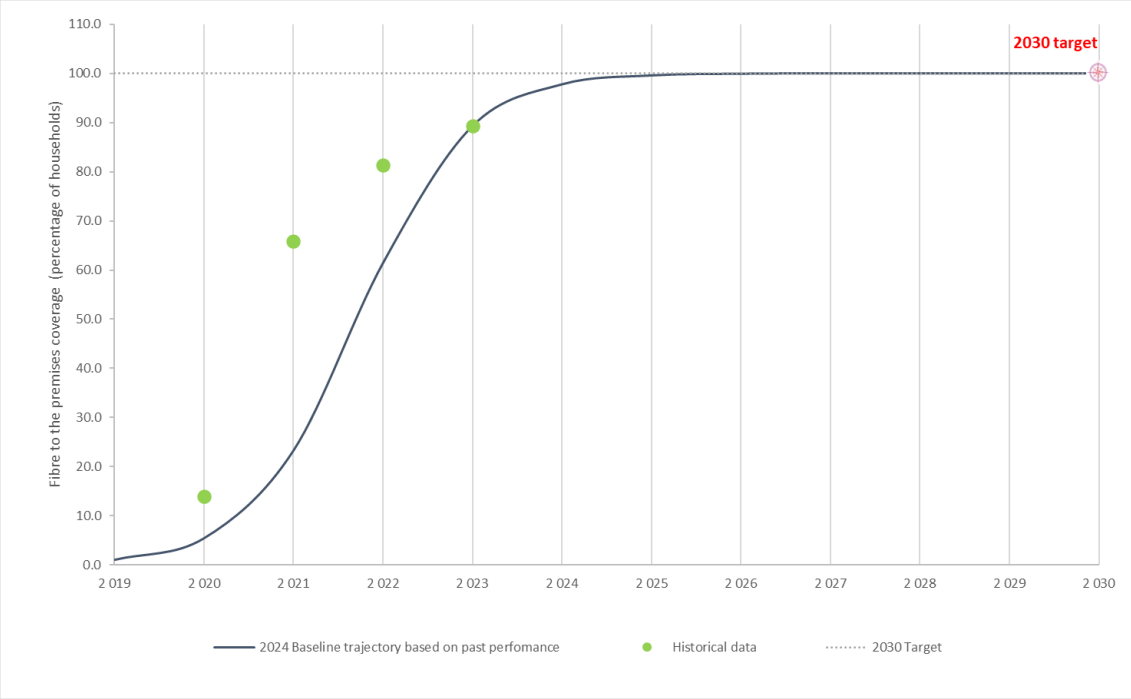
the success of broadband roll-out in a given country. Successful ones assess their individual starting positions and take concrete measures that take advantage of their individual strengths and mitigate their weaknesses. The Member States' NBPs usually focus on measures that target demand, supply, regulation, organisation and transparency. There is no one-size-fits-all solution for broadband strategies in the EU.

5G connectivity

The mobile network connectivity target set out in Article 4(1), point (2)(a) of the Implementing Decision for the Digital Decade ([187]) is intended to ensure that all populated areas are covered by a next-generation wireless high-speed network with at least 5G equivalent performance, in accordance with the principle of technology neutrality. The corresponding KPI included in the 'KPI Implementing Decision' measures the percentage of populated areas covered by at least one 5G network, regardless of the spectrum band used (overall 5G coverage).

Based on available data, overall 5G coverage increased in the EU from 81.3% in 2022 to 89.3% in 2023. Four Member States reached 100% and a few others came very close to it. The forecast along the revised baseline trajectory predicts that almost 100% of populated areas in the EU will be covered by at least one 5G network by 2025.

Figure 16. 5G roll-out in the EU, historical data and revised baseline trajectory towards 2030

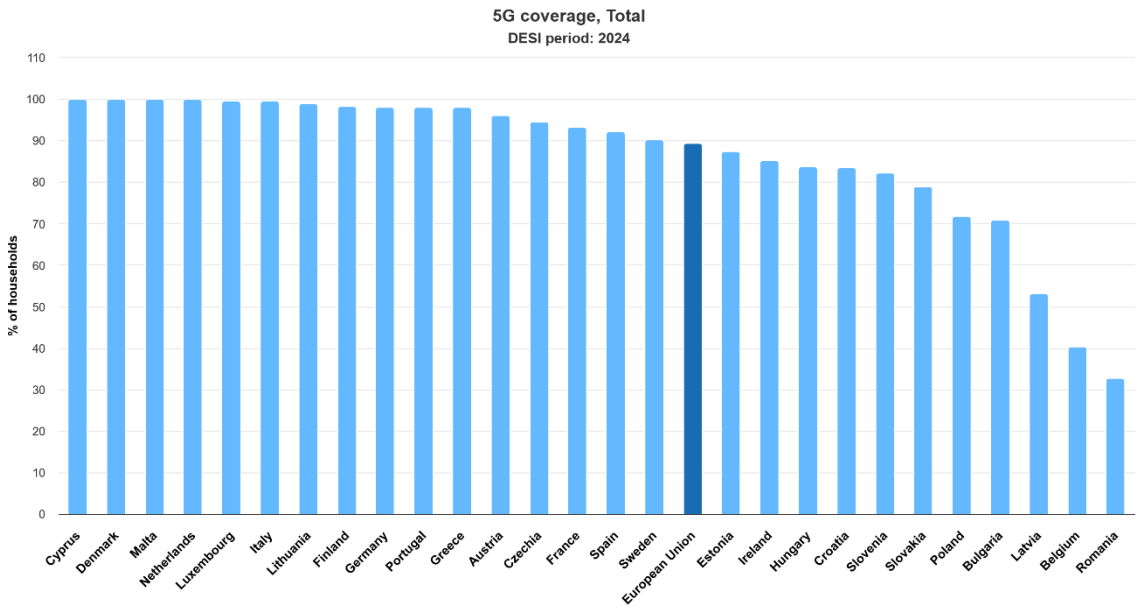


Source: European Commission

It should nevertheless be noted that 5G coverage differs greatly between Member States: Cyprus, Denmark, Malta, the Netherlands, Luxembourg and Italy have above 99% coverage. The coverage in Belgium and Romania remains below 50%. Growth has been extremely rapid in some Member States (e.g., Sweden, where 5G coverage went from 20% to 90%).

([187]) https://digital-strategy.ec.europa.eu/en/library/updated-study-national-broadband-plans-eu27.

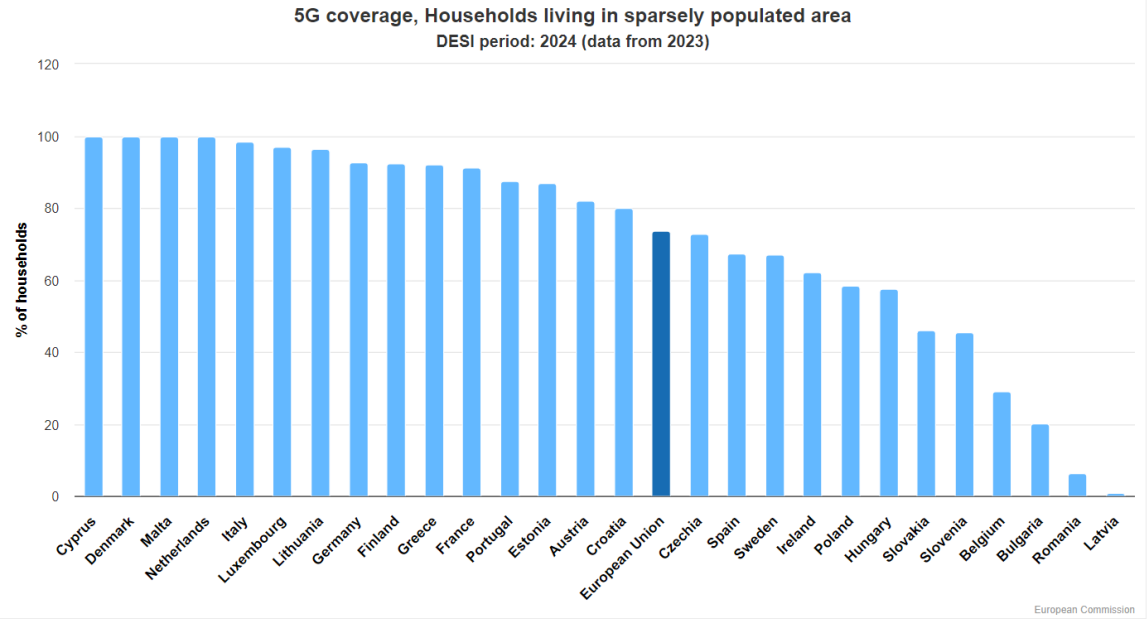
Figure 17. 5G coverage in the EU



Source: European Commission

5G coverage in rural areas also grew from 51.0% in 2022 to 73.7% in 2023. However, large discrepancies exist between Member States. Cyprus, Denmark, Malta and the Netherlands having achieved 100% rural average, but it was only 6.3% in Romania and 0% in Latvia.

Figure 18. 5G coverage in the EU's rural areas

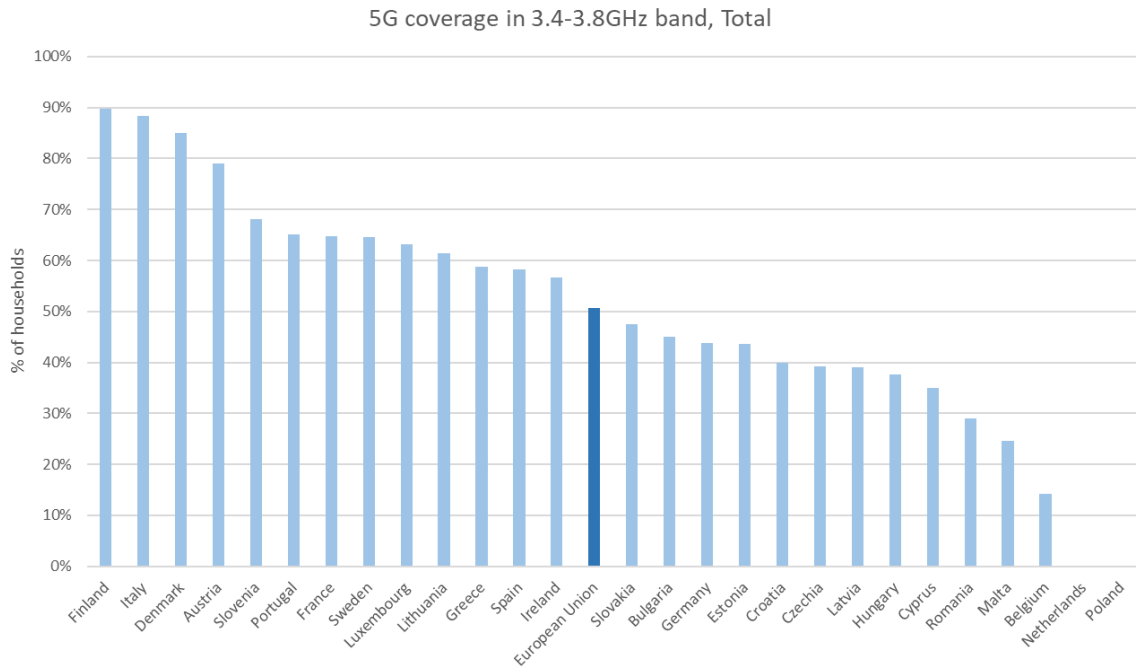


Moreover, according to the same study on NBPs in the EU-27, while 5G commercial services are now available (to a variable extent) in all 27 Member States and the perspectives are good in most Member States in terms of probability of achieving the 5G general coverage target, ensuring uninterrupted service along major roads and railways remains a challenge for some several Member States.

More importantly, most of the current 5G deployment can be categorised as 'basic 5G', and a higher quality of service and additional functionalities are still needed in order to meet the demand for more advanced 5G services and to achieve the computing continuum

that includes connectivity, cloud/AI [188] and the Internet of Things (IoT). This performance limitation is mainly because current network deployments do not yet make use of the full spectrum possibilities offered by all three 5G pioneer bands (700 MHz, 3.6 GHz and 26 GHz) and this limits the performance of 5G connectivity. In fact, 5G coverage in the 3.4-3.8 GHz band (the '3.6 GHz band') – which is considered the primary pioneer band for 5G in the EU and the only available large-scale mid-band that offers the possibility of large contiguous spectrum portions of 80-100 MHz and the potential to achieve high-quality 5G coverage (a good balance between coverage and capacity) – was only 51% in 2023.

Figure 19. 5G coverage in the EU's rural areas



In addition, some pioneer bands (most notably the 26 GHz band) have not yet been assigned (or are not fully available) in several Member States. The full completion of all spectrum assignment procedures therefore remains an EU priority.

As a matter of fact, the actual quality of the 5G service, which is variable between networks, depends on several factors (e.g., the density of cells, the spectrum bands being used, the backhauling capacity and core network functionalities).

In general, current coverage progress measurements tend to overestimate the actual impact of 5G because consistent deployment reporting methodologies are still under development. Current KPIs mainly address the simple availability of 5G services (e.g., the percentage of households/population covered by at least one 5G service; the percentage of 4G base stations that have been upgraded to 5G; or the percentage of 5G pioneer spectrum that have been assigned). On this basis, many EU Member States have a similar level of 5G deployment as countries in the competing regions (e.g., China and Japan and the US). However, some Member States are clearly lagging behind, especially with regard to the most advanced version of 5G. Moreover, 5G standards are still evolving and we are at an early stage in the deployment curve in the Business-to-Business (B2B) domain. The current indicators are useful, therefore, but do not depict the actual 'Quality of 5G Service'

([188]) Work to refine KPIs in order to better capture the quality of 5G connectivity is ongoing.

(geographical availability, speed, response time, etc.) delivered to end users (consumers and businesses). The Commission has therefore started to cooperate with Member States through the Body of European Regulators of Electronic Communications to define new KPIs that will better represent such quality of service, possibly including later in the decade a geographical mapping of 5G availability.

EU and Member State measures

During the current Commission 2019-2024 mandate, several important hard law and soft law initiatives have been completed, in order to incentivise and enable investment in the roll-out of connectivity networks while also maintaining competitive markets with important benefits for end users.

Funding measures to incentivise and support the roll-out of connectivity networks and services

On 7 July 2021, Regulation (EU) 2021/1153 establishing the **Connecting Europe Facility (CEF) for the period 2021-2027** was adopted with the aim of supporting investment in key projects in the areas of transport, digital and energy infrastructure, and with an overall budget of EUR 33.71 billion. The budget for digital is EUR 2.07 billion and is committed to supporting the deployment of reliable, secure and affordable VHCNs that could serve the EU's industry and modernise sectors like transport, energy, healthcare and public administration.

Most importantly, **CEF 2 Digital** (the digital part of CEF) supports the deployment of new backbone networks or a significant upgrade of existing backbone networks, **including submarine cables,** within and between Member States and between the EU and non-EU countries (see **focus on submarine cables** below); uninterrupted coverage with 5G systems of all major transport paths, including the trans-European transport networks (see **focus on 5G cross-border corridors** below); VHCN, including 5G systems, in areas where socio-economic drivers are located. In the first two calls for proposals, launched in 2022 and 2023, CEF 2 Digital granted over EUR 400 million to support projects from Member States and overseas countries and territories.

At the same time, having benefited from CEF funding at the end of the previous programming period, the **WiFi4EU** programme has supported the deployment of hotspots in the EU's most remote communities, providing free internet access to the public. It has helped some 7 200 local authorities to establish free WiFi services in public spaces. The initiative has connected EU citizens with over 9 000 wireless networks that encompass some 93 300 hotspots.

The EU's **Connecting Europe Broadband Fund (CEBF)** has been investing since 2018 in the deployment, mostly in rural areas, of high-quality FTTH networks across 1 800 000 residential, business and public administration premises.

Furthermore, the Commission has implemented a number of other EU funding instruments and programmes that support private investments in R&I in relation to the communications sector. These include **Horizon Europe**, the **Digital Europe Programme** (DEP) and **Invest EU**.

The **Smart Networks and Services Joint Undertaking** (SNS JU), which is co-led by the Commission and industry and in which Member States are closely involved, was launched

in the end of 2021 and became autonomous in 2023. It is the current EU platform **for R&I funding for 5G advanced and 6G systems** in cooperation between industry and public actors. One of its main objectives is to leverage the EU's strength in network supply to the broader value chain (including cloud and software as well as devices and components). The SNS JU already addresses several industry-led R&I needs (mostly in anticipation of 6G): research into concepts, architectures and core components of 6G systems; large-scale trials and pilots; standardisation; virtualisation of networks; cloud software; and AI-enabled radio access networks and non-terrestrial networks. SNS JU activities also prioritise key societal aspects of future connectivity systems, such as sustainable 6G and 6G for sustainability, security and safety.

The SNS JU also coordinates the 5G corridors multi-country project, in particular as regards the development of project pipelines, common solutions, and best practices. In particular, the SNS JU will in 2024 publish a **5G Strategic Deployment Agenda**, based on contributions from stakeholders, in order to provide guidance on cooperation models and roadmap scenarios for deployment.

Creating enabling conditions for network deployment

To incentivise the deployment of fixed and wireless VHCNs, the EU has adopted a series of measures to make harmonised spectrum available, reduce the cost of deployment and ensure access under conditions that strike a balance between competition and deployment.

The need for an efficient and effective management of radio spectrum – the essential and scarce resources for wireless connectivity (the 'lifeblood' of connectivity) – has led to the adoption and implementation of EU legislation ([189]) and a number of Commission implementing decisions ([190]). This intense legislative activity has enabled the faster

([189]) In particular:

- Article 53 of Directive (EU) 2018/1972 of the European Parliament and the Council of 11 December 2018 establishing the European Electronic Communications Code, OJ L 321, 17.12.2018, p.36; and
- Decision (EU) 2017/899 of the European Parliament and of the Council of 17 May 2017 on the use of the 470-790 MHz frequency band in the Union, OJ L 138 of 25.5.2017, p.131.

([190]) These include:

- Commission Implementing Decision (EU) 2024/340 on harmonised conditions for the use of radio spectrum for mobile communication services on board vessels in the Union, repealing Decision 2010/166/EU;
- Commission Implementing Decision (EU) 2022/2324 amending Decision 2008/294/EC, to include additional access technologies and measures for the operation of mobile communications services on aircraft (MCA services) in the Union;
- Commission Implementing Decision (EU) 2022/179 on the harmonised use of radio spectrum in the 5 GHz frequency band for the implementation of wireless access systems including radio local area networks;
- Commission Implementing Decision (EU) 2022/173 on the harmonisation of the 900 MHz and 1 800 MHz frequency bands for terrestrial systems capable of providing electronic communications services in the Union;
- Commission Implementing Decision (EU) 2021/1067 on the harmonised use of radio spectrum in the 5 945-6 425 MHz frequency band for the implementation of wireless access systems including radio local area networks (WAS/RLANs);
- Commission Implementing Decision (EU) 2020/636 of 8 May 2020 amending Decision 2008/477/EC as regards an update of relevant technical conditions applicable to the 2 500-2 690 MHz frequency band;
- Commission Implementing Decision (EU) 2020/667 of 6 May 2020 amending Decision 2012/688/EU as regards an update of relevant technical conditions applicable to the frequency bands 1 920-1 980 MHz and 2 110-2 170 MHz;
- Commission Implementing Decision (EU) 2020/590 of 24 April 2020 amending Decision (EU) 2019/784 as regards an update of relevant technical conditions applicable to the 24,25-27,5 GHz frequency band;
- Commission Implementing Decision (EU) 2019/235 on amending Decision 2008/411/EC as regards an update of relevant technical conditions applicable to the 3 400-3 800 MHz frequency band;

deployment of wireless networks with better performance (e.g., higher speed and capacity) as well as security, by reference not only to general 5G coverage but also to wireless connectivity for passengers travelling on aircraft and vessels, in road vehicles and for short-range devices (the numerous devices that enable IoT).

For example, a Commission implementing regulation ([191]) has been adopted in line with the Code to facilitate the deployment and operation of small-area wireless access points, which are particularly needed for 5G network densification and performance enhancement, by enacting rules for a permit-free deployment regime.

At the international level, at the 2023 World Radiocommunication Conference that was held under the auspices of the International Telecommunication Union (ITU), the EU acted with a common position on all key spectrum fields (e.g., broadcasting, mobile and satellite communications). This strongly influenced international decisions in those fields and safeguarded the EU's interests.

Finally, a new piece of legislation (the '**Gigabit Infrastructure Act**') updated and reinforced earlier frameworks with the aim of reinforcing/incentivising network investment and roll-out by addressing persistent administrative barriers to network deployment. This included simplifying, digitising and setting deadlines in permit-granting procedures by national/local authorities; accessing information on existing infrastructure and planned civil works; encouraging co-deployment and sharing of infrastructure (e.g., fibre in buildings); and improving overall coordination between all relevant actors. The legislative proposal has been agreed by the co-legislators, was adopted by the European Parliament in April 2024 and is expected to come into force by June 2024.

In February 2024, the Commission adopted its **Gigabit Recommendation** by which it provides an updated set of guidelines to National Regulatory Authorities on how to design fit for purpose access obligations to guarantee fair competition and roll-out of gigabit networks. Moreover, the Gigabit Recommendation provides an EU framework for accelerating the copper networks switch-off and transition to a fibre-dominated connectivity environment.

In December 2020, the Commission adopted the fourth revision of the **Commission Recommendation on Relevant Markets**. This sets out a list of markets, which still warrant *ex ante* regulation at EU level, in order to promote and safeguard competition and maximise consumer benefits. It focuses on ensuring access-based competition in the broadband business and mass markets, but also reduced regulatory pressure in markets that had evolved towards a more competitive model.

- Commission Implementing Decision (EU) 2018/661 amending Implementing Decision (EU) 2015/750 on the harmonisation of the 1 452-1 492 MHz frequency band for terrestrial systems capable of providing electronic communications services in the Union as regards its extension in the harmonised 1 427-1 452 MHz and 1 492-1 517 MHz frequency bands; and
- Commission Implementing Decision (EU) 2018/637 amending Decision 2009/766/EC on the harmonisation of the 900 MHz and 1 800 MHz frequency bands for terrestrial systems capable of providing pan-European electronic communications services in the Community as regards relevant technical conditions for the Internet of Things.

([191]) Commission Implementing Regulation (EU) 2020/1070 of 20 July 2020 on specifying the characteristics of small-area wireless access points pursuant to Article 57 paragraph 2 of Directive (EU) 2018/1972 of the European Parliament and of the Council establishing the European Electronic Communications Code, OJ L 234, 21.7.2020, p. 11.

Continued efforts towards competitive markets and end user benefits

The EU has incentivised the deployment of very high-capacity networks (VHCN) but has also endeavoured to reinforce the integrity of the single market and to protect end users.

In April 2022, the co-legislators adopted the **Recast Roaming Regulation** that improved and prolonged for another 10 years the right of EU and EEA citizens to stay connected without paying additional charges when travelling in the EU and the EEA. Citizens no longer need to worry about high roaming bills and have also had, since 2022, the right to the same quality of mobile internet abroad, as the one at home. In addition, mobile operators are now obliged to protect their customers by providing them with clear information about any services that are not regulated and that can trigger surcharges, such as calls to premium numbers and roaming when on ships and planes. The roaming rules also set lower wholesale charges (the cost to operators for using networks abroad to provide services to their customers when they are abroad), thus ultimately benefiting consumers.

In January 2024, the Commission published a **review on roaming fair use policy** and sustainability derogations, which confirmed that fair use and derogations rules are still fit for purpose.

The impact of the **Roam Like at Home** initiative has also been spreading to non-EU countries, in tandem with the Roaming Regulation and encouraging initiatives to lower roaming charges with non-EU countries. Mobile operators, facilitated by the Commission, have been signing and prolonging voluntary agreements to offer similar beneficial roaming to those of their customers that travel to and from Ukraine (prolongation of the Joint Statement on affordable connectivity for refugees in July 2023), Moldova (EU and Moldovan operators agreement reached in June 2023) and the Western Balkans (agreement on a retail glide path that entered into force in October 2023). In the framework of relevant association agreements, Ukraine and Moldova have started the process of joining the roam-like-at-home area, amending their association agreements in April 2023 and October 2023 respectively. For the Western Balkans, the New Growth Plan Communication ([192]) of November 2023 foresees the exploration of potential solutions in order to secure a long-term roaming arrangement that would bring the Western Balkans into the EU roam-like-at-home area.

([192]) https://neighbourhood-enlargement.ec.europa.eu/2023-communication-new-growth-plan-western-balkans_en.

Focus on the deployment of pan-EU deployment of 5G corridors

In addition to general coverage of populated areas with 5G networks, Member States, industry and the Commission are also cooperating to build a pan-EU network of 5G cross-borders corridors, through which connected and automated mobility (CAM) solutions will be implemented, including for rail and waterways, The goal is to cover 26 000 km along the TEN-T networks ([193]) with CAM-enabling 5G infrastructure by 2030. The corresponding multi-country project (MCP) allows the necessary cooperation between the stakeholders involved in addressing market-failure areas with public investment and stimulating private investment in commercially viable areas. Furthermore, through the take-up of CAM services over this pan-EU network, this project aims to leverage this early deployment towards the upgrade of 5G networks with such quality levels along a wider set of EU transport paths during this and the next decade.

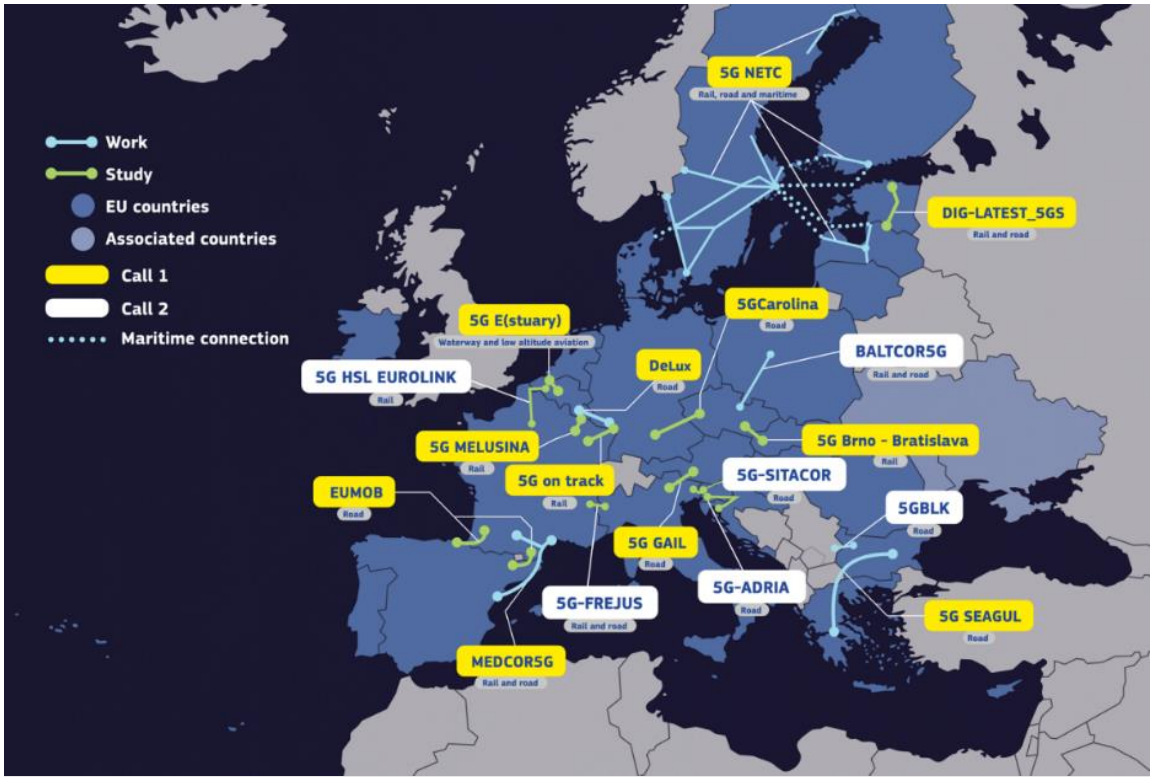
In the first, 2021-2023, phase of the MCP, investment needs are almost exclusively fulfilled by EU funding and private financing. This mix should evolve with the maturity of the deployment of 5G corridors and progressively involve other sources of financing.

Following a pilot phase in 2018-2022 that was partially funded by the former Public Private Partnership on 5G research (Horizon 2020), the first wave of commercial deployment of 5G corridors has now been undertaken by industry with public co-funding.

Further to the two first calls for proposals of the CEF Digital that were launched in 2022 and 2023, a total of 17 projects have been launched to support the deployment of 5G corridors, notably in cross-border corridor sections, to ensure the roll-out of 5G passive network infrastructures, such as 5G radio stations (building, mast, pylons) and proper active solutions for service continuity when crossing borders, thus contributing to connecting different regions. Overall, the total of grants requested under these first two calls amounts to EUR 41.5 million (50% co-funding rate) for a corresponding total cost of EUR 106 million.

([193]) https://transport.ec.europa.eu/transport-themes/infrastructure-and-investment/trans-european-transport-network-ten-t_en.

Figure 20. Map of projects under the CEF Digital Calls 1 and 2



Source: European Commission

6 of these 17 projects started deploying the supporting connectivity infrastructure in 2023. 11 inception studies will pave the way for future large-scale 5G infrastructure deployment projects in view of subsequent CEF Digital Calls. Depending on the nature of the transportation mode and local circumstances, these 17 projects typically gather stakeholders from various industries, telecoms (mobile network operators and tower companies), rail infrastructure managers, road operators, ports and waterways authorities, and OEMs.

A third CEF Call for 5G corridor projects was closed on 20 February 2024 with a budget allocation of EUR 100 million. 8 proposals have been submitted by project consortia (6 for deployment works and 2 for inception studies).

Finally, the Commission will adopt a second CEF Work Programme by the first half of 2024 to address the second implementation phase in 2024-2027. As in the first 2021-2023 implementation period, the project pipeline is expected to be driven by industry with the close involvement of Member States at various levels, not only as potential direct investors but also as strategic stakeholders due to their critical role in the planning and development of transport infrastructures. In particular, complementary funding programmes at national or regional level will become key once funding at EU level reaches a higher scale.

Developing submarine cables

Backbone connectivity including terrestrial, submarine cables and satellite-based connectivity are a prerequisite for high capacity and high performance (in terms of resilience, security, redundancy and latency) of digital connectivity throughout the EU, in particular for the outermost regions, islands and Member States with coastlines, as well as overseas countries and territories. They are also crucial in providing the efficient

international connectivity of strategic importance such as linking the EU with its trading and research partners around the globe.

Submarine cables have been in the spotlight because over 99% of intercontinental data traffic relies on them, and three insular EU Member States (Ireland, Cyprus and Malta) as well as some islands in other Member States and outermost regions depend on them. There have been repeated calls to strengthen the security and resilience of submarine cable infrastructures, including increasing public funding to support private investment in a challenging environment.

CEF Digital is a new programme but has already produced impressive results in its first 2 years of application, including supporting the development of submarine cables. EU direct intervention through CEF Digital aims to focus resources on supporting resilient, high capacity and sovereign connectivity within the EU and internationally, in line with the Nevers Call of 9 March 2022 ([194]). The following are examples of supported projects.

- The **CAM Ring project (Continent-Azores-Madeira**) (EUR 22.3 million grant) this submarine cable is being replaced as an essential priority for the EU because the current cable is becoming obsolescent. The new project will deploy a long-term solution to satisfy the increasing demand for connectivity in the next 30 years. The new CAM Ring will provide greater backbone interconnection in the Atlantic as a possible bridge to the Americas. Its benefits go beyond connectivity because it will be one of the first cables to integrate smart components for detection of seismic and underwater nautical activity, environmental monitoring and data gathering for scientific purposes.
- The **Pisces project** (EUR 29 million grant) addresses the shortfall of digital connectivity between Ireland and the rest of the EU with direct high-capacity open access and scalable dark fibre availability directly to I with provision for future additional subsea branches to Spain and Portugal (approximately 2 100 km). The system will provide a strategic link which will meet the objectives of the EU's Digital Global Gateway Strategy, strengthening connectivity between Ireland and the rest of the EU. The system will also link transatlantic and other international cable systems that land in Ireland and France and will allow capacity interconnection on these systems.
- The **ViaTunisia project** (EUR 9.5 million grant) aims to build a submarine cable between Illes (France) and Bizerte (Tunisia) in full compliance with EU security and data protection requirements. The existing routes between Tunisia and France are either obsolete or are indirect routes via Italy. They therefore do not adequately serve current needs and are certainly not able to cover the estimated exponential traffic increase (+44%/year). ViaTunisia has been designed as a global project of an open access cable that will make it possible, through wholesale offers, to benefit from the latest transmission technologies at competitive prices, thereby enhancing connectivity between the EU and Africa, and contributing to the EU digital sovereignty.
- The **Arctic connectivity projects** (Tussas Connect 1&2, Far North Fiber 1, North Pole Fiber 1 and the Northern Gateways study) (around EUR 37.6 million in grants) where

([194]) Commission Communication on the Fourth Progress Report on the implementation of the EU Security Union Strategy, COM(2022) 252 final: https://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:52022DC0252.

there is a strategic geopolitical interest to create an alternative route to Asia (Japan) through the Arctic. This route is becoming increasingly important due to rising tension in the Middle East and a number of incidents in the Suez Canal / Red Sea passage. At the same time, connectivity in the Arctic is serving Greenland (an EU overseas country and territory) and areas that have remote and isolated populations. The use of 'smart cables' (i.e., cables that have sensors or are used as sensors) would allow cables to serve multiple policy areas of the EU (environmental and climate change, seismic/tsunami detection, submarine fauna monitoring, etc.).

- The **Subsea French Guiana** project (EUR 30 million grant), co-funded by the European Regional Development Fund with EUR 10 million, is building on the existing infrastructure of EllaLink, which links Portugal to Brazil. EllaLink is planning to build a of a 2 145 km long branch in order to connect the city of Cayenne in French Guiana to the main system. French Guiana currently relies on infrastructures going through North America, but this new cable will connect this EU outermost region directly to Europe so that there will be no reliance on any non-EU territory, thus reinforcing the sovereignty of the digital development of the entire Caribbean region. It will also improve the security and resilience of the highly strategical European Spaceport at Kourou in French Guiana.

In the light of various incidents and repeated calls from Member States and stakeholders for immediate action, the Commission adopted the Commission Recommendation to Member States on Secure and Resilient Submarine Cable infrastructures in February 2024 ([195]). The Recommendation contains a set of actions at national and EU level. The aim is to accurately map existing cable infrastructures as the basis for a consolidated EU-wide assessment of risks, vulnerabilities and dependencies (particularly high-risk suppliers) that should be mitigated by a 'Cable Security Toolbox'; a common governance regime for cable technologies and cable-laying services that ensures rapid and secure repair and maintenance of cables; and the identification and funding of critical intra-EU and global cable projects of European interest (CPEIs).

Gigabit and 5G connectivity in national Digital Decade strategic roadmaps ([196])

23 Member States have provided a **trajectory for the gigabit connectivity target**. Most of the national target values assumed for 2030 are in line with the EU target value (i.e., that all end users at a fixed location should be covered by a gigabit network up to the network termination point). 4 Member States assumed a target value below the EU target value. 10 Member States provided a trajectory on the evolution of Fibre-to-the-Premises coverage, which is also monitored separately and taken into consideration when interpreting the data measuring the gigabit connectivity target.

The Member States reported a total of 94 measures that contribute to achieving this target, with a total budget of EUR 81.9 billion. Around 70% of this budget is reported as stemming from private industry investment, around 20% from national sources and around 10% from EU sources. **The roadmaps include several new impulses**: around 20% of the

([195]) Commission Recommendation (EU) 2024/779 of 26 February 2024 on Secure and Resilient Submarine Cable Infrastructures, OJ L, 2024/779, 8.3.2024, http://data.europa.eu/eli/reco/2024/779/oj.

([196]) This analysis only takes account of elements reported by the Member States in their national roadmaps. The measures reported by the Member States were grouped into categories to provide a better overview of the types of measures taken.

measures are reported as new and account for a very considerable budget share of around 80%.

Around 50% of the measures focus on regulatory intervention to facilitate network deployment, including the **regulation of access and the reuse of physical infrastructures.** Around 30% of the measures provide **financial support for commercially non-viable areas** (including rural areas and outermost regions). Around 15% of the measures provide financial support for **backbone and other strategic parts of the network**. The remaining 5% promote **take-up** and other demand-pull initiatives (mainly Belgium, Ireland, Croatia, Cyprus, Poland and Sweden), **spectrum management**, co-deployment and new business models for service deployment and pro-investment regulation (I Denmark, Greece, France and Slovenia).

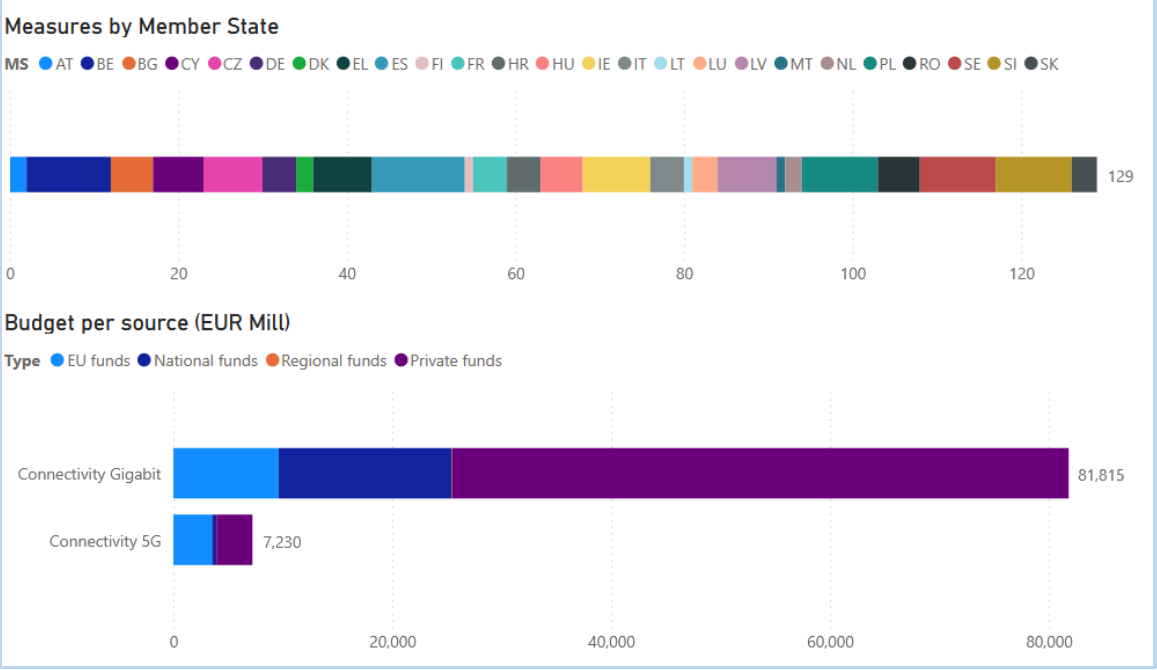
26 Member States provided a trajectory for the **5G coverage target**. Most of the national target values assumed for 2030 are in line with the EU target value, which is that all populated areas should be covered by next-generation wireless high-speed networks with a performance at least equivalent to that of 5G, in accordance with the principle of technological neutrality. 6 Member States assumed a target value below the EU target value.

The Member States reported a total of 35 measures that contribute to this target, with a total budget of EUR 7.2 billion. Around 44% of this budget comes from private industry investments, around 48% from EU sources and the remaining 8% from national sources. The roadmaps include some new impulses: around 25% of the measures are reported as new, with a budget share of around 30%.

Around 30% of the measures focus on spectrum management, including spectrum awards (mainly Belgium, Bulgaria, Austria and Finland). Around 20% of the measures attributed to 5G roll-out focus on regulatory intervention to facilitate network deployment. Other measures include financial support for commercially non-viable, areas (including rural areas and outermost regions), demand stimulation and pro-investment regulation (mainly Czechia, Greece and Luxembourg).

Measures and budget (EUR Mill)

Target category	Measures	Budget
	2	468
1. Regulatory intervention to facilitate of network deployment	46	61,117
2. Spectrum management	15	2,101
3. Co-deployment and new business models for service deployment, pro-investment regulation	9	43
4. Financial support for white/commercially non-viable areas (incl. rural and outermost)	32	15,593
5. Financial support for backbone, other strategic parts of networks	17	9,543
6. Promotion of take up and other demand-pull initiatives	8	180
Total	**129**	**89,045**



Concluding remarks and future challenges

According to a recent study conducted for the Commission, reaching the current Digital Decade targets for gigabit connectivity and 5G may require a total investment of up to EUR 148 billion ([197]). This figure assumes that fixed and mobile networks are deployed independently, and that stand-alone 5G that offers EU citizens and businesses the full capabilities that can be offered by 5G mobile networks is deployed. A further EUR 26 billion to EUR 79 billion of investments may be required under different scenarios to ensure full coverage of transport corridors (including roads, railways and waterways). This would raise the required total investment needs for connectivity alone to over EUR 200 billion.

Improving regulatory conditions could be an important factor in reducing this investment gap. For example, WIK found in the same study that the overall investment level could be reduced by up to EUR 48 billion (i.e., a saving of approximately 20%) if 5G deployment were closely coordinated with fibre deployment, because there are significant synergies that can be harnessed. In particular, the proposed Gigabit Infrastructure Act (GIA) aims at such cost reductions based on synergies.

Moreover, further investments are required for the integration of advanced satellite services that provide complementary solutions for backhaul, for device connectivity in remote areas

([197]) https://digital-strategy.ec.europa.eu/en/library/investment-and-funding-needs-digital-decade-connectivity-targets.

not covered by terrestrial technologies, or to ensure service continuity in the case of crisis or disaster relief.

However, these are not the only investment needs that the sector is confronted with. As the Commission has explained in a recently adopted White Paper ([198]), new applications that make use of data analytics, AI or new forms of content delivery such as high-quality video-streaming require a continuous exponential increase in data processing, storage and transmission. Moreover, remote storage and processing of data in the cloud, between the cloud and the end user through Content Delivery Networks (CDNs), and close to the end user (edge computing) has led to the virtualisation of electronic communications networks functions in software and a shifting of these functions to the cloud or the edge. This new model of network and service provision relies on a complex ecosystem that includes cloud, edge, content, software and component suppliers. These, together with traditional electronic communications network providers, form part of what can be described as a computing continuum: from chips and other components for high-speed processors embedded in devices, to edge computing working cohesively with centralised cloud services and AI-powered applications managing the network.

This transformation raises several challenges. The increasing softwarisation and cloudification of electronic communications networks require an additional EUR 80 billion of investment until 2027 [199]. Increasingly complex network operations are pushing companies in different segments of the value chain to work together at the infrastructure layer. Competition at the service layer is becoming more complex, with the participation of actors from sectors outside the traditional telecom sector and the bundling of electronic communications services with cloud and edge computing. Main trends include network sharing, the separation of infrastructure and service layer and the creation of service platforms based on concepts like Network as a Service (NaaS) and IoT. However, the opening of the traditionally 'closed' electronic communications network in a NaaS approach exposes network capabilities to third parties and entails the risk of large non-EU providers becoming leading players in such ecosystems.

The capacity of the EU's electronic communications sector to carry out the investment needed to succeed puts this transformation at risk, due to high investment needs. As indicated in the White Paper, while European consumers benefit of comparatively better networks and lower prices, EU operators are lagging behind other advanced economies in terms of ARPU or ROCE. In addition, the EU market is highly fragmented, with around 50 mobile network operators and more than 100 fixed operators and with only a handful being present in several national markets. Even the mobile operators that are part of corporate groups with a large footprint across the EU, operate within national markets and do not seem to harmonise their offerings and operational systems at EU level, due to the inherently different market and regulatory landscapes, beyond the need to ensure affordability in Member States with lower purchasing power.

Against this backdrop of fragmentation in the EU and low profitability levels, the White Paper identified as a key question whether industrial policy measures that further facilitate

([198]) European Commission, White Paper - How to master Europe's digital infrastructure needs?, February 2024, https://digital-strategy.ec.europa.eu/en/library/white-paper-how-master-europes-digital-infrastructure-needs.

([199])European Alliance for Industrial Data, Edge and Cloud: 'European industrial technology roadmap for the next generation cloud-edge', extrapolating until 2030 the investment gap identified in the Commission Staff Working Document (27.5.2020): Identifying Europe's recovery needs, SWD(2020) 98 final/2, Brussels, pp. 17-18.

the cross-border provision of electronic communications networks or different forms of cooperation upstream could allow operators to acquire sufficient scale without compromising downstream competition.

3.2.2. Semiconductors

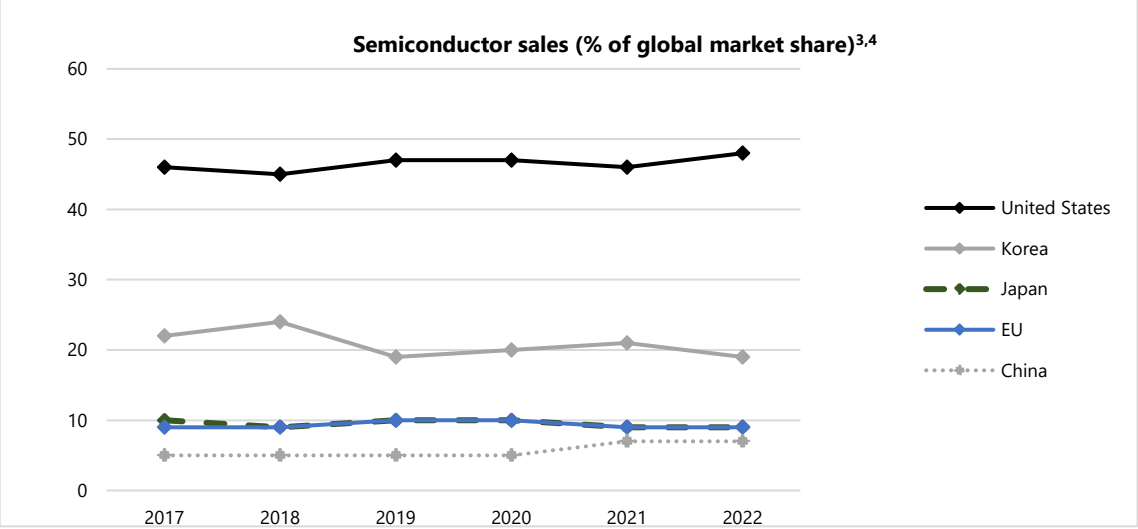
Semiconductors are at the centre of strong geostrategic interests and a global technology race because they are the technology underpinning a secure and sustainable digital transition. A number of factors (emerging data processing capabilities, new applications for AI, the shift towards edge computing and the growing need for cloud and infrastructure to support a distributed workforce) require the computational power, reduced energy consumption and added security offered by cutting-edge semiconductor technologies. The market for AI chips is expected to be a major driver of growth for the whole industry during the Digital Decade.

The pivotal role of advanced chips in the EU

The rapid advancement of AI services relies heavily on the integration of specialised chips optimised for machine learning algorithms, such as GPU. These chips allow the efficient processing of vast amounts of data, powering AI applications across various sectors (e.g., healthcare, finance and autonomous vehicles). Similarly, High Performance Computing (HPC) systems (exemplified by projects like JUPITER) depend heavily on cutting-edge semiconductor technologies to achieve unprecedented computational capabilities. Nvidia's GPUs play a pivotal role in accelerating complex simulations and data analysis tasks. JUPITER will be the first EuroHPC exascale supercomputer, located at the Forschungszentrum Jülich campus in Germany and operated by the Jülich Supercomputing Centre. It will be based on Eviden's BullSequana XH3000 direct liquid cooled architecture, integrating NVIDIA technology into its cutting-edge semiconductor chips. This integration underscores the pivotal role of advanced chips in powering groundbreaking simulations and AI applications, and is a significant milestone in the EU's pursuit of technological leadership in HPC and AI.

In 2021, the EU had a smaller total manufacturing capacity than other regions in the semiconductor value chain because of decreasing levels of investment. The EU is also weak in design and packaging and assembly because few semiconductor companies located in the EU can design chips on the lower node size, and the EU has traditionally relied on outsourcing packaging to East Asia. This creates dependencies in EU industries (e.g., automotive, industrial automation and communications) on non-EU chip designers and manufacturers, and packaging facilities. This can result in supply shortages that can disrupt entire industrial sectors.

Figure 21. Semiconductor sales as a percentage of global market share – international comparison



Source: International benchmarking of the digital transformation, Visionary Analytics, March 2024

To reverse this declining trend, 22 Member States agreed in a joint declaration in December 2020 to reinforce the processor and semiconductor ecosystem and to expand industrial presence across the supply chain, in order to address key technological, security and societal challenges. In addition, the EU has set the ambitious political goal of reaching at least 20% of the world's production in value for cutting-edge and sustainable semiconductors, including processors, by 2030.

Finally, on 21 September 2023, the European Chips Act, a crucial step to enact the EU's policy on semiconductors that was announced by President Ursula von der Leyen in her 2021 State of the Union speech, entered into force. It put in place a comprehensive set of measures to ensure the EU's security of supply, resilience and technological leadership in semiconductor technologies and applications. Concretely, the European Chips Act aims to strengthen manufacturing activities in the EU, stimulate the EU's design ecosystem, and support scale-up and innovation throughout the whole value chain.

State of play and progress towards the Digital Decade target

The aim of the Digital Decade policy programme is for the production, in accordance with EU law on environmental sustainability, of cutting-edge semiconductors in the EU to be at least 20% of world production in value.

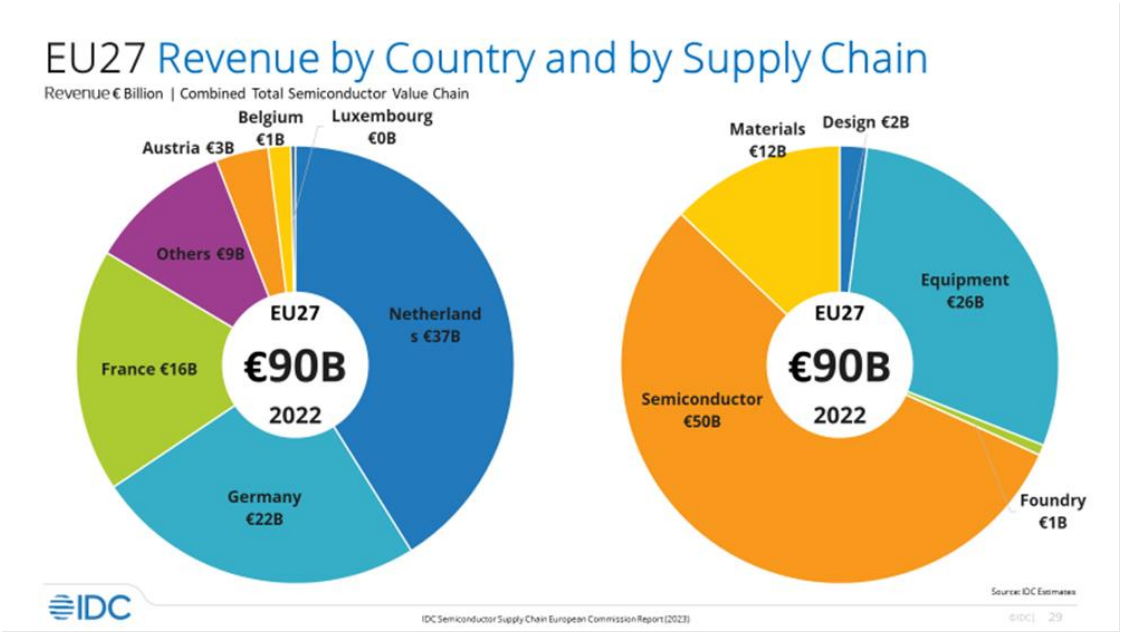
The current low starting point means that this is a very ambitious target. Semiconductor manufacturing in the EU has fallen over time as more semiconductor products based on standard fabrication process were outsourced to foundries outside the EU and was affected by the 2020-2021 shortage.

The combined EU-27 semiconductor value chain market share in 2022 was EUR 90 billion or 9.8% of global value chain revenues. Revenues were up substantially from the 2019 levels of EUR 57 billion, but market share fell slightly from 9.9% in 2019.

In terms of revenues across the semiconductor value chain, the US is currently the market leader, followed by South Korea, Taiwan, Japan and the EU. The EU's revenues are approximately 10% of the global market by value according to current estimates.

By country headquarters, EU-27 total combined value chain revenues are concentrated in the Netherlands, Germany, France, Austria, Belgium, and Luxembourg. Semiconductor manufacturing contributes 56% of total value chain revenues with equipment at 29%.

Figure 22. EU-27 revenue by country and supply chain



Source: IDC Semiconductor Supply Chain, European Commission Report, 2023

Four companies represent 70% of the EU-27's combined value chain revenues: ASML 24% (Netherlands), STMicroelectronics 17% (France/Italy), Infineon 16% (Germany) and NXP 14% (Netherlands).

EU and Member State measures

Projects under the first **Important Projects of Common European Interest (IPCEIs) on microelectronics**, which were approved in December 2018, have been already concluded by all companies in the participating Member States, but Italy's project with STMicroelectronics is still ongoing. These projects have already played a key role in stimulating private investment in innovation and manufacturing in the EU, in the automotive and IoT markets. Manufacturers of chips at leading-edge nodes (TSMC, Samsung and Intel) rely for their technology development on specific EUV photolithography machines that are produced by a single global supplier, ASML (Netherlands), which is part of the EU's electronic ecosystem.

Moreover, **the ECSEL Joint Undertaking** (JU), which was set up in 2014 and which has supported over 90 research projects, has been instrumental in advancing EUV technology towards 2nm. As a follow-up to ECSEL JU, it has been proposed to develop the Key Digital Technologies Joint Undertaking (KDT JU), with public support of up to EUR 3.6 billion provided equally by the EU and the participating national authorities. In November 2023, the Chips JU was launched, as required by the European Chips Act as a follow-up of the KDT-JU. It has already published the calls for the first pilot lines that will support EU companies (particularly SMEs) in bridging their products' gap between design and industrial development to the market. The Chips JU will make EUR 1.67 billion in EU funding available.

In addition to the above-mentioned pilot lines, the **European Chips Act** has also created the framework for further investments. Important players have already announced their commitment to invest in the EU to support the resilience and development of important segments of the semiconductor value chain, in line with the principles outlined in the Chips Act Communication.

The Commission also launched the **Alliance on Processors and Semiconductor Technologies** in July 2021. The Alliance will bring together key actors to design and produce microelectronics chips and will identify current gaps in the production of microchips and necessary technology developments. The Alliance will also act as a sounding board to create synergies between related R&D and deployment initiatives.

As already mentioned, **22 Member States signed a declaration in December 2020**, expressing their interest to work together to bolster the EU's electronics and embedded systems value chain, with a strong focus on processors and semiconductor chips. The declaration called, inter alia, for the mobilisation of industrial stakeholders through the industrial alliance. Moreover, it called for the design of a multi-country and inclusive EU flagship project through the development of an Important Project of Common European Interest (IPCEI).

The Commission approved this **second IPCEI on Microelectronics and Communication Technologies** (IPCEI ME/CT) on 8 June 2023. It involves 14 Member States that will provide up to EUR 8.1 billion in public funding, unlocking an additional EUR 13.7 billion in private investment. 5 more Member States are involved in this IPCEI with indirect participants. As part of this IPCEI, 56 companies, including SMEs and start-ups, will undertake 68 projects to stimulating the design, testing at industrial scale, and manufacturing capacities of EU semiconductor companies. This will support efforts to develop digital logic chips (e.g., low-power processors), which inter alia address the large market sectors (e.g., computing and communications) where the EU currently has only a limited presence, and will further reinforce the EU's position in market segments (e.g., automotive and industrial manufacturing) where it needs to maintain current strengths.

Support for semiconductors in national Digital Decade strategic roadmaps ([200])

Poland has provided a **trajectory** for the EU semiconductor target of increasing the production, in accordance with EU law on environmental sustainability, of cutting-edge semiconductors in the EU to at least 20% of world production in value. Slovenia has provided a trajectory for the number of semiconductor R&D and the number of semiconductor manufacturing enterprises.

Member States reported a total of **47 measures to contribute to this target, with a total budget of EUR 48.6 billion** (the third highest budget reported for a target). Around 30% of this funding will come from EU sources, around 55% from national sources and the remaining 15% from private industry investment. A very small amount of the regional

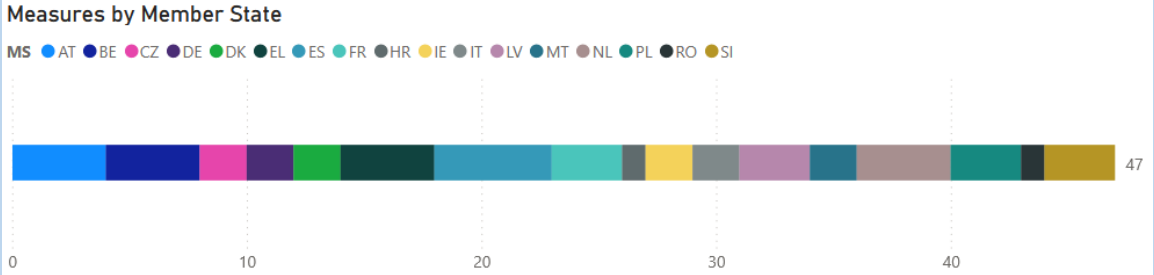
([200]) This analysis only takes account of elements reported by the Member States in their national roadmaps. The measures reported by the Member States were grouped into categories to provide a better overview of the types of measures taken.

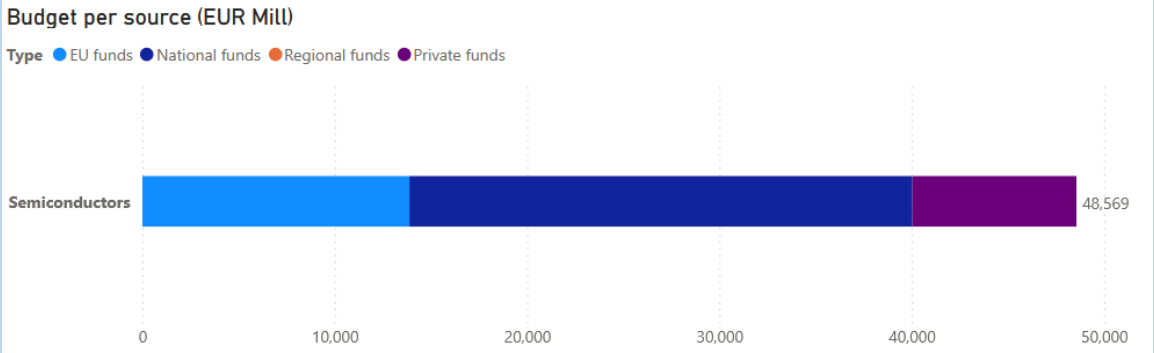
budget was reported for this target. The roadmaps include **several new impulses**: around half of the measures are reported as new – with a budget share of around 50%.

Around 40% of the measures focus **on support for research and development for semiconductors**, including via **multi-country initiatives and projects** (as for example the IPCEI on microelectronics and communication technologies). Around 30% of the measures focus on **support for the production capacity and industrial deployment of semiconductors**, including incentives to attract domestic and international investors for developing and expanding manufacturing facilities. The remaining 30% of the measures focus on bringing semiconductors '**from lab to market'** (i.e., supporting partnerships and knowledge and technology transfer as well competence centres that facilitate collaboration and resource sharing) and **horizontal actions** (including research and development strategies).

Measures and budget (EUR Mill)

Target category	Measures	Budget
1. Support research and development for semiconductors	18	5,922
2. From Lab to market	7	1,323
3. Support production capacity and industrial deployment of semiconductors	13	39,617
4. Horizontal actions	9	1,708
Total	**47**	**48,569**





<u>Concluding remarks and future challenges</u>

- As technologies such as AI, 5G communication, autonomous vehicles and the Internet of Things (IoT) become increasingly pervasive, there is a growing demand for cutting-edge semiconductor solutions. Furthermore, semiconductors are crucial for national security, defence systems and the functioning of critical infrastructures. The economic impact of the semiconductor sector is therefore substantial, making it a strategic area for countries to invest in and compete. All regions around the world are therefore investing in supporting and developing the sector, whose market is expected to double in value between 2021 and 2030 to more than USD 1 trillion by 2030. The EU's

revenues in semiconductors should therefore quadruple by 2030 to match the 20% Digital Decade target, which will therefore be particularly challenging. In this regard, the EU would have to invest over and above the European Chips Act in supporting domestic strengths (e.g., semiconductor equipment, power semiconductors, analogue semiconductors and sensors) and emerging markets (e.g., edge computing and AI).

- Current EU actions are going precisely in this direction and are properly bolstering the entire value chain. Examples include the new four pilot-line preparations for the implementation of the Chips for Europe Initiative, which is envisaged by the European Chips Act. Similarly, the cloud-based virtual environment of the design platform, which is also envisaged by the European Chips Act, integrates a wide range of design facilities, from IP libraries to Electronic Design Automation (EDA) tools, as well as support services. In the same vein, the IPCEI ME/CT combines a wide range of R&D projects covering microelectronics and communication technologies throughout the whole value chain from materials and tools to chip designs and manufacturing processes. All these initiatives will affect the sector in the coming years and support the development of the EU's semiconductor ecosystem. The challenge is nevertheless enormous.

3.2.3. Edge nodes

Edge computing is a distributed computing technology which places data processing units and infrastructures (edge nodes) at the edge of the network and close to the sources of generation of data to supply decentralised data processing services. Edge computing enhances the overall performance of cloud computing environments by providing low-latency data processing in privacy-preserving settings that prevent unnecessary data transmissions.

The Digital Decade Policy's edge nodes target emphasises the strategic importance that edge computing technology plays as part of the European Data Strategy ([201]). The strategy highlights the role of edge computing as the infrastructure required to meet the demand for highly distributed and decentralised data processing in order to optimally handle and extract value from the constantly increasing data deluge that is generated by the widespread deployment of connected objects and their growing requirements for intelligent behaviours.

The strategy also details how edge computing provides an important opportunity for EU edge services and technology providers to overcome existing dependencies on non-EU Cloud providers – unveiling emerging options for technical leadership, while also unlocking economic and sustainability benefits and allowing data producers to have stronger control over their data.

Edge computing is similarly regarded as one of the key AI technologies for processing large amounts of data. The others are high performance computing, cloud computing, and AI (software). All these technologies facilitate the making of decisions and predictions

([201]) https://commission.europa.eu/strategy-and-policy/priorities-2019-2024/europe-fit-digital-age/european-data-strategy_en.

based on data-driven analysis, and are the subject of further risk assessment by Member States as technology areas that are critical for the EU's economic security ([202]).

Edge computing's strategic value should be underlined because it is an indispensable component of the digital network infrastructures and services of tomorrow ([203]). Edge and cloud computing and virtualisation are altering the design of today's connectivity infrastructures, which are increasingly becoming integrated connectivity and computing infrastructures. The need for timely edge nodes deployment as part of the European Telco Edge Cloud capacities is becoming more prominent.

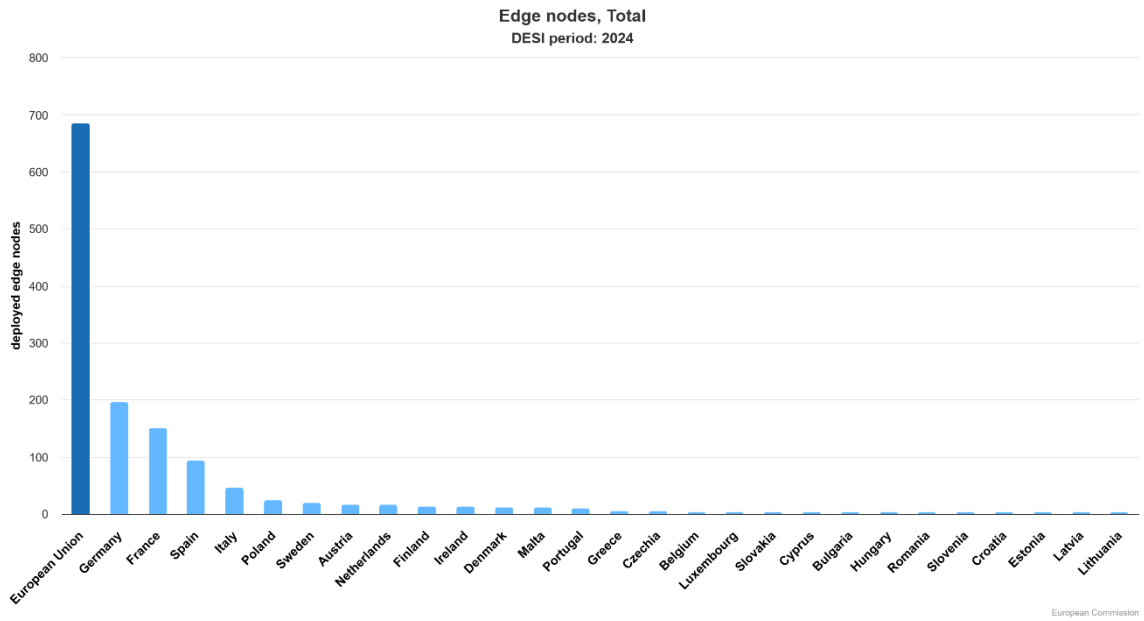
State of play and progress towards the Digital Decade target

The Digital Decade policy programme includes the aim that at least 10 000 climate-neutral highly secure edge nodes should be deployed in the EU and should be distributed in a way that guarantees access to data services with low latency (i.e., a few milliseconds) wherever businesses are located.

According to the Edge Observatory's September 2023 Edge Deployment Data Report ([204]), the estimated total deployment of edge nodes in the EU **grew significantly** from 499 units in 2022 to **1186 units in 2023**. This growth is important but represents only limited progress towards the achievement of the total target, with current figures for the assessed edge deployment base in 2023 accounting for 12% of the edge nodes target for 2030.

It is also relevant to note that these figures apply to edge node deployment in general and do not take into consideration the nodes' climate neutrality and high degree of security, which are set as part of the edge nodes Digital Decade target.

Figure 23. Estimation of distribution of edge nodes



Source: Edge Observatory for the Digital Decade, 2023

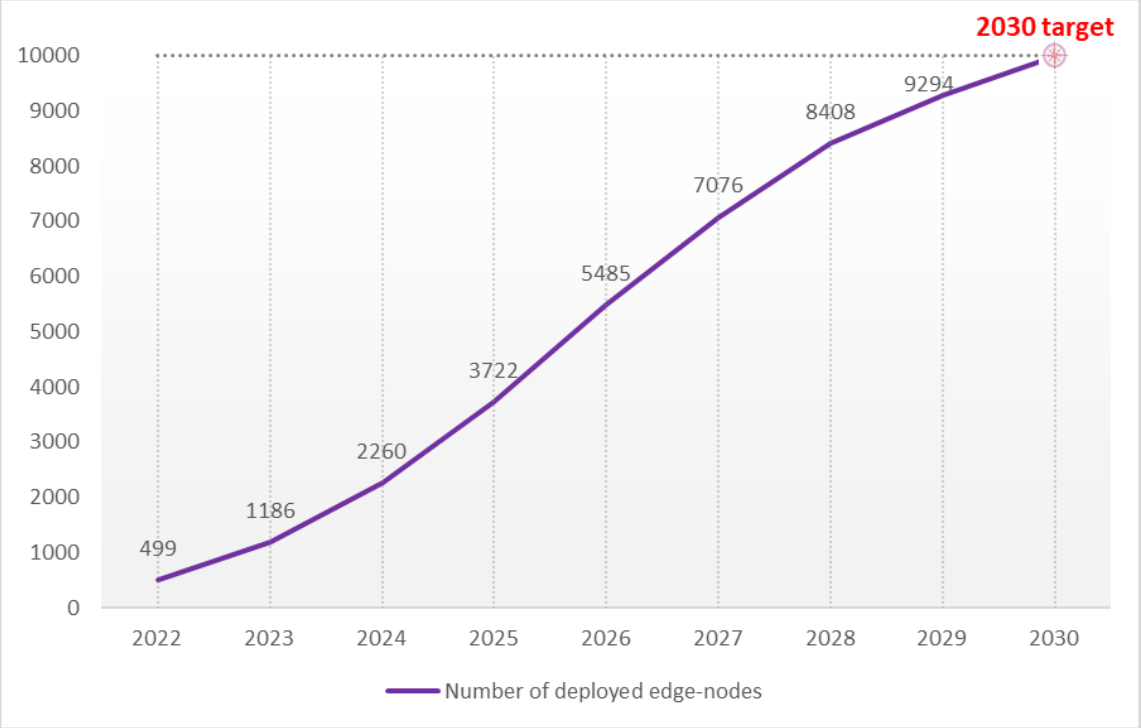
([202]) Commission Recommendation of 3 October 2023 on critical technology areas for the EU's economic security for further risk assessment with Member States.

([203]) Commission press release of 21 February 2024, Commission presents new initiatives for digital infrastructures of tomorrow: https://ec.europa.eu/commission/presscorner/detail/en/IP_24_941.

([204]) Technopolis Group for the Edge Observatory, Edge Deployment Data Report, September 2023: https://ec.europa.eu/commission/presscorner/detail/en/IP_24_941.

The Edge Deployment Data Report ([205]) has further refined the trajectory to the Digital Decade target and the distribution of edge nodes by Member State, taking into account the Member States' surface areas and factoring in several direct and indirect parameters in order to generate a projected estimation of edge nodes deployment until 2030.

Figure 24. Edge nodes deployment (EU projection to 2030)



Source: European Commission

Several factors are influencing the deployment and density of edge nodes in the EU. These include the level of technology maturity, the amount of public support and market uptake of initial edge solutions.

Regarding the deployment status of edge nodes in 2023, the Edge Deployment Data Report ([206]) notes a geographical disparity in the degree of expansion among the EU-27. Member States that are quickly embracing edge computing include Germany, Spain, France and Spain. These Member States can set trends and spread best practices to other Member States. Member States that are adopting edge technology more slowly include Bulgaria, Czechia, Estonia, Greece, Croatia, Cyprus, Latvia, Lithuania, Luxembourg, Hungary, Malta, Portugal, Romania, Slovenia and Slovakia.

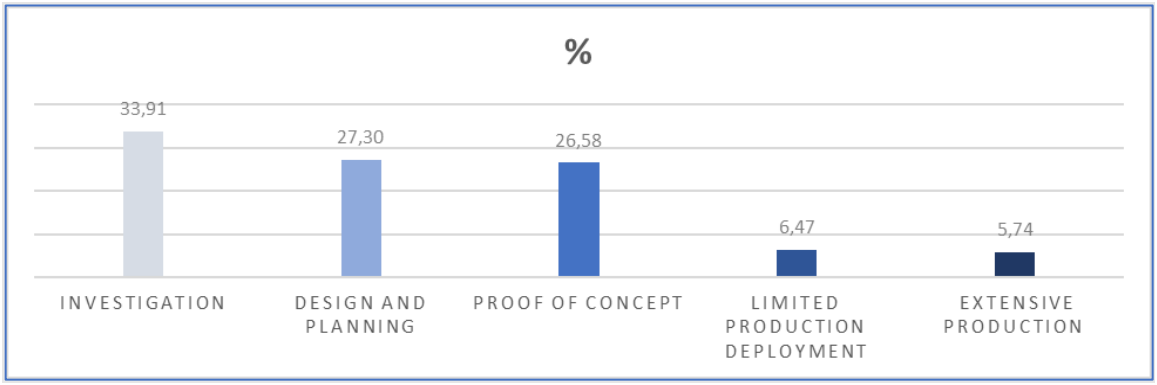
In terms of maturity of deployments, the data gathered by the Edge Observatory, as illustrated in , reveals, in particular, that approximately 88% of the EU organisations deploying edge computing nodes are investigating and testing potential benefits of edge deployment as a means to gain a better understanding of the long-term viability and business prior to deploying edge computing widely. At this stage, it is estimated that only 12% of the existing base of edge deployments in the EU correspond to production environments. Taken together, these figures show that, despite the expansion of the edge deployment base in 2023, the adoption of edge computing technology and the deployment

([205]) Edge Observatory for the Digital Decade, Edge Deployment Data report 1, https://ec.europa.eu/newsroom/dae/redirection/document/100264.

([206]) Report available on europa.eu: https://digital-strategy.ec.europa.eu/en/policies/edge-observatory.

of associated edge nodes remains at an early stage. Particular measures are needed to encourage its uptake.

Figure 25. Proportion of organisations' edge use cases initiatives per stage



Source: Edge Observatory for the Digital Decade, 2023

In terms of international comparison, according to Edge Observatory preliminary findings and IDC figures, the EU's edge computing expenditure in 2023 accounted for 22% of global spending on edge computing (USD 203 billion in 2023). Worldwide enterprise and service provider spending on hardware, software and services for edge solutions is forecast to sustain this pace of growth until 2027 when spending will reach nearly USD 359 billion.

The US is expected to spend most on edge computing, accounting for more than 40% of the worldwide total, followed by the EU and China. However, spending by Latin America and China will grow the fastest over the next 5 years.

North America and China are leading the integration of 5G technology and edge computing as part of future digital networks strategies, particularly in the context of smart city initiatives. In Latin America, edge computing is being leveraged to exploit emerging market opportunities and bridge digital divides. Japan is emphasising precision manufacturing and collaborative robotics to address the challenges posed by an ageing workforce.

EU and Member State measures

Important Project of Common European Interest on Next Generation Cloud Infrastructure and Services (IPCEI-CIS)

In December 2023, the Commission approved, under EU State aid rules, an Important Project of Common European Interest (IPCEI) to support research, development and initial industrial deployment for the advancement of cloud and edge computing technologies in the EU. The project was jointly notified by seven Member States: Germany, Spain, France, Italy, Hungary, the Netherlands and Poland. The Member States will provide up to EUR 1.2 billion in public funding, which is expected to unlock an additional EUR 1.4 billion in private investment. As part of this IPCEI, 19 companies (including SMEs) will undertake 19 highly innovative projects.

The IPCEI-CIS is a key initiative for accelerating the development of edge and cloud technologies in the EU and is a fundamental component in the accomplishment of the European Data Strategy. The IPCEI CIS will provide the technological developments necessary to enable a truly interoperable EU cloud and edge computing market in line with EU rules, for which data privacy, security and sustainability are primary concerns. The

IPCEI-CIS is a unique opportunity to develop EU cloud capacities that will overcome the EU's current strategic dependency on foreign suppliers. In particular, in the area of edge computing, the IPCEI-CIS will play a leading role in supporting EU players to develop.

Simpl, cloud-to-edge federations and data spaces made simple

Simpl is smart middleware that will enable cloud-to-edge federations and support all major data initiatives funded by the Commission (e.g., common EU data spaces). The first contract implementing Simpl has been awarded to a consortium that is led by Eviden Belgium (BE) and includes Aruba (IT), Capgemini Nederland (NL), Engineering International Belgium (BE), IONOS (DE), and COSMOTE Global Solutions (BE), a subsidiary of Deutsche Telekom. The contract provides for 3 years of development for Simpl-Open (the open-source platform), for preparatory studies for its associated testing environment (Simpl-Labs) and for integration into six of the EU data spaces (the Public Procurement Data Space, the European Health Data Space, the Language Data Space, the European Open Science Cloud, Destination Earth, and the Data Space for Smart and Sustainable Cities and Communities) (Simpl-Live).

Digital Europe, EU reference deployments of cloud-to-edge infrastructures and services

This initiative includes a pilot project concerning cloud-to-edge infrastructure that will receive EUR 30 million in grants to enable cross-border Telco Edge deployment and its interoperability with industrial edge, thus demonstrating the benefits obtained in key application areas and sectors. The resulting reference deployments will contribute to the creation of the '3C Network' ecosystem referred to in the recent Commission White Paper on the EU's digital infrastructure needs (see below).

Connecting Europe Facility Digital – 5G for smart communities

The 5G and edge cloud for smart communities' initiative aims at supporting the early deployment of 5G-based solutions that allow use cases for public services of general interest with a funding of EUR 51 million. In addition, when necessary for the implementation of a use case, the action supports the deployment of edge computing hardware and software infrastructure.

Edge Observatory for the Digital Decade

The Edge Observatory for the Digital Decade monitors the evolution of the deployment of climate-neutral and secure edge node landscapes and ecosystems across the EU Member States; investigating the use cases of edge nodes; and assesses the development of the EU edge node market. The Edge Observatory has produced the 'Edge Observatory for the Digital Decade' 2023 data report ([207]), offering an in-depth analysis of the adoption of edge computing and infrastructure deployment in the EU. Future reports will continue to monitor the progression of the edge nodes target in the coming years.

European Alliance for Industrial Data, Edge and Cloud updated cloud-edge strategic industrial roadmap

([207]) Edge Observatory for the Digital Decade, Edge Deployment Data report 1, https://ec.europa.eu/newsroom/dae/redirection/document/100264.

The updated cloud-edge strategic industrial roadmap ([208]) is a collective effort of the main EU cloud and edge industry players which take part in the European Alliance for Industrial Data, Edge and Cloud to identify areas of investment for the joint development and deployment of the next generation of EU cloud and edge technologies. It serves as crucial input for the Commission and Member States when defining the upcoming EU digital investment programmes, and ensuring their alignment with the strategies, needs and goals of EU businesses. All in all, the roadmap strengthens the EU's position in cloud and edge technologies and fosters the emergence of a vibrant and competitive EU cloud and edge industrial ecosystem and market.

White Paper – How to meet the EU's digital infrastructure needs?

The Commission's White Paper ([209]) provides a foundation for a wide-ranging exchange of views with academia, industry, civil society, and Member States in order to gather their perspectives on the challenges that the EU is currently facing in implementing future connectivity networks that will be characterised by the interplay between and integration of computing and connectivity technologies. The White Paper proposes the creation of a 'Connected Collaborative Computing' network (the 3C Network) to accompany this transition. For this purpose, the Commission may propose large-scale pilots that set up end-to-end integrated infrastructures and platforms for telco cloud and edge, bringing together players from different segments of the connectivity value chain and beyond. These pilot infrastructures would be used to test innovative technologies and applications (including demos, proof of concepts and early deployment of technologies).

Support for edge nodes in national Digital Decade strategic roadmaps ([210])

Four Member States (Greece, Italy, Luxembourg and Poland) have provided **a trajectory** for the edge nodes target.

Member States have reported a total of **19 measures to help achieve this target, with a total budget of 2 billion EUR**. Around 45% of this budget will come from EU sources, around 35% from national sources and the remaining 20% from private industry investment. The roadmaps include several **new impulses**: around one third of the measures (with a significant budget share of around 55%) are reported as being new.

Around 50% of the measures focus on support for **deployment of edge nodes**, including via the Important Project of Common European Interest (IPCEI) on Next-Generation Cloud Infrastructure and Services. Around 40% of the measures focus on **support for R&D for edge nodes**. The remaining 10% of the measures support horizontal actions, including the **development of relevant strategies and legislative measures**.

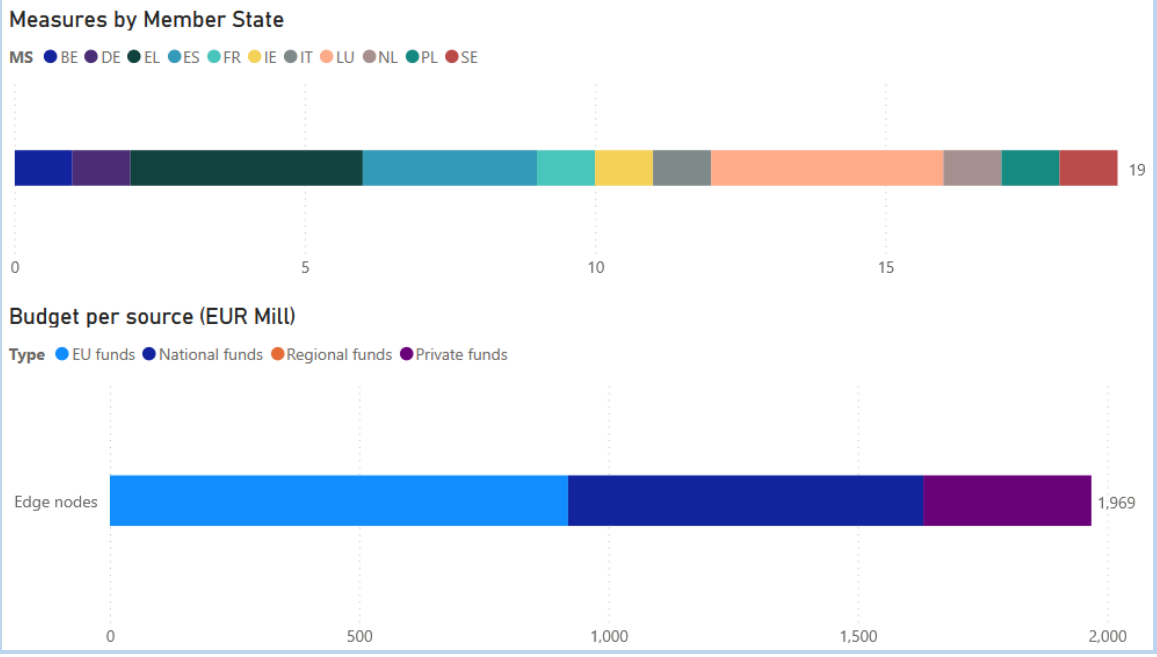
([208]) https://digital-strategy.ec.europa.eu/en/news/european-alliance-industrial-data-edge-and-cloud-presents-its-first-deliverables.

([209]) European Commission, White Paper - How to master Europe's digital infrastructure needs?, February 2024, https://digital-strategy.ec.europa.eu/en/library/white-paper-how-master-europes-digital-infrastructure-needs.

([210]) This analysis only takes account of elements reported by the Member States in their national roadmaps. The measures reported by the Member States were grouped into categories to provide a better overview of the types of measures taken.

Measures and budget (EUR Mill)

Target category	Measures	Budget
1. Support research and development for edge nodes	8	753
3. Support for deployment of edge nodes	9	1,216
4. Horizontal actions	2	0
Total	**19**	**1,969**



Concluding remarks and future challenges

AI is the determinant factor which is driving the proliferation of deployment of nodes at the edge. Edge computing linked with AI enables more immediate processing of the massive data volumes of generated at the edge, and the intelligent interpretation of this data in processing times in orders of magnitude of milliseconds. It also allows a more secure data processing environment and reduces data transmission costs. Most AI training and deployment currently relies on the use of a centralised cloud infrastructure powered with specialised AI chips. The capacity to design and produce these chips is concentrated in a very low number of market actors, but it is equally access by cloud providers to these essential components, resulting in compute capacity bottlenecks and scarcity ([211]). Moreover, the requirement to gather, process and transmit massive amounts of data to the central cloud is often a roadblock for many AI use cases. The deployment of edge nodes could therefore become a critical component of Member States' AI strategies, permitting them to ensure that they have sufficient domestic AI compute infrastructure to accomplish their objectives and secure the anticipated AI benefits that will transform their economies and open up opportunities for productivity, growth, and resilience ([212]).

In addition, edge nodes have an important role to play as an essential component of future digital networks. As digital networks are evolving and becoming reliant on cloud and edge

([211]) Vipra, J, and Myers West, S., *Computational Power and AI*, The AI Now Institute, 27 September 2023, https://ainowinstitute.org/publication/policy/compute-and-ai.

([212]) OECD (2023), 'A blueprint for building national compute capacity for artificial intelligence', *OECD Digital Economy Papers*, No 350, OECD Publishing, Paris, https://doi.org/10.1787/876367e3-en.

computing technologies, European Telco operators and Network equipment providers are becoming increasingly dependent on cloud hyperscaler services in the absence of EU services of comparable breadth and depth. These solutions establish closed ecosystems of products and services, which compromise the freedom of choice and interoperability of the resulting combined compute and communication infrastructures. The Commission is therefore exploring possible measures to support the transition towards interoperable cloud-based networks and the integration of telco-edge infrastructures and services. Such measures might include an infrastructure IPCEI that would depend on the already notified IPCEIs on edge and cloud and microelectronics and connectivity.

In line with these possible measures, and taking into account the initiatives already in place, the deployment of edge nodes is considered to be part of the industrial efforts towards digitalisation. The EU and its Member States have much to gain by rolling out edge nodes.

Without access to state-of-the-art edge computing capacities, EU companies will lag behind their international competitors in unlocking the economic benefits of innovative applications and in capitalising on the economic advantages of improved data collection, storage and processing. An imbalanced deployment of edge nodes across the EU would create new borders within the EU's single market.

Moreover, as the deployment of edge nodes progresses, edge density can be expected to vary between remote locations, heavily populated areas and industrial zones. This might lead to unequal opportunities for users and enterprises outside densely inhabited, commercial and industrial areas, thus increasing the urban-rural digital divide. As with other digital infrastructures, commercial investment is expected to be limited in rural areas, but edge nodes will be distributed more densely in commercial and industrial zones. This would result in an unequal distribution of economic opportunities for companies and limit the cross-border usage of latency-critical applications (e.g., connected autonomous driving) and 5G use cases deployment, AI uptake and IoT development). Both factors would affect the competitiveness of the organisations concerned and would affect citizens' access to first-class infrastructure services.

3.2.4. Quantum computing

Quantum technologies have the potential to transform many sectors: medicine, energy, computing and communications, climate and weather modelling, cybersecurity, space and defence (to name just a few). They will enable huge productivity gains, revitalise industry; and open up new markets, applications and job opportunities. Their economic and strategic value, now and in the future, is clear. They are therefore a high priority for maintaining the EU's sovereignty and have been highlighted in the recently published European Economic Security Strategy ([213]), as well as in the Commission Recommendation of 3 October 2023 on critical technology areas for the EU's economic security ([214]).

The EU has been very active over the last few years in supporting quantum technologies through a variety of funding programmes, multi-country projects, participation in standardisation activities, and other horizontal actions. Member States are also taking a

([213]) Joint Communication from the European Commission and the High Representative of the Union for Foreign Affairs and Security Policy of 20 June 2023 to the European Parliament, the European Council and the Council on 'European economic security strategy', JOIN(2023) 20 final.

([214]) Commission Regulation (EU) 2023/2113 of 3 October 2023 on critical technology areas for the EU's economic security for further risk assessment for further risk assessment with Member States.

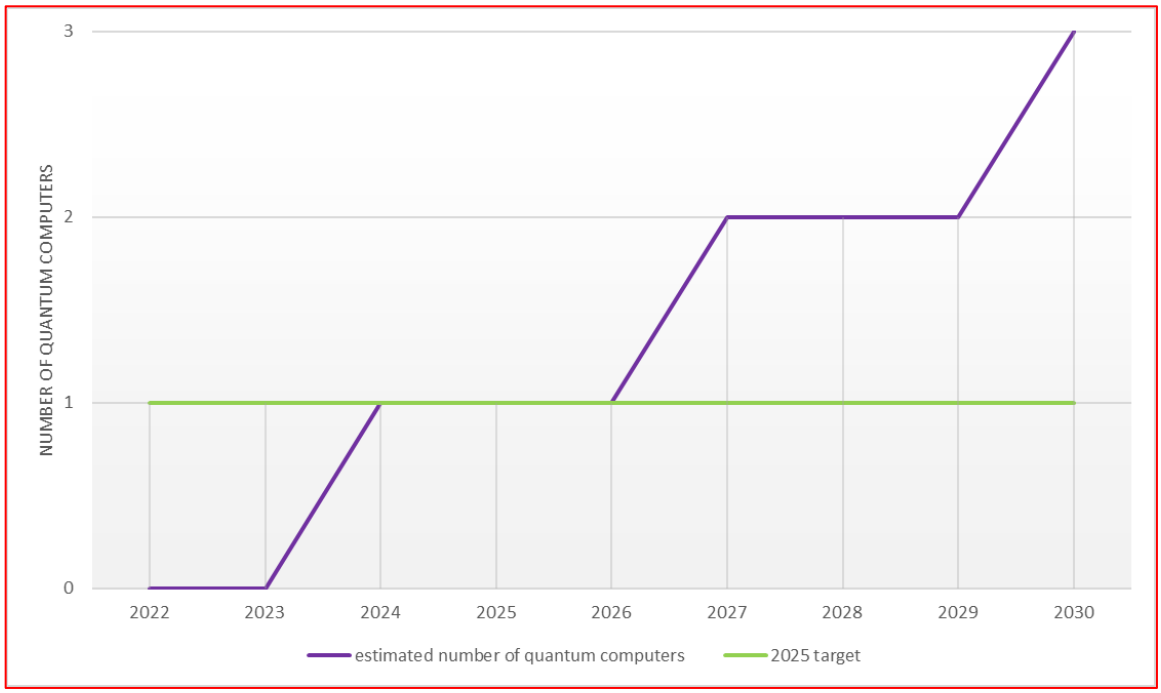
wide range of measures in quantum. Several Member States have established or announced national quantum initiatives (thus demonstrating their aim of leading advances in quantum research and industrial deployment) and have undertaken or are announcing major investment programmes to this end.

The EU and Member States have committed more than EUR 8 billion to quantum technologies since 2018. At EU level, the EUR 1 billion Quantum Technologies Flagship has bolstered the EU's position as a global leader in quantum research and has already resulted in the development of marketable devices and applications. However, the huge potential of quantum to transform many sectors and the fact that other world regions are also investing ambitiously in it together mean that additional coordinated action and investment is needed to ensure that the EU does not fall behind globally.

State of play and progress towards the Digital Decade target

The Digital Decade policy programme contains the aim that the EU will have its first computer with quantum acceleration by 2025, thus paving the way for the EU being at the cutting edge of quantum capabilities by 2030.

Figure 26. Target of quantum computing in the EU



Source: European Commission

The first target of having **a first computer with quantum acceleration by 2025, is expected to be reached this year**. The **HPC-QS project** ([215]) is scheduled to soon deploy two systems manufactured by the French start-up PASQAL, one in France (GENCI) and one in Germany (Jülich).

Further measures (including the continuation of the Quantum Technologies Flagship; the ongoing procurement and deployments of additional quantum computing and simulation systems overseen by the European High Performance Computing Joint Undertaking (EuroHPC); and the development and deployment of the European quantum

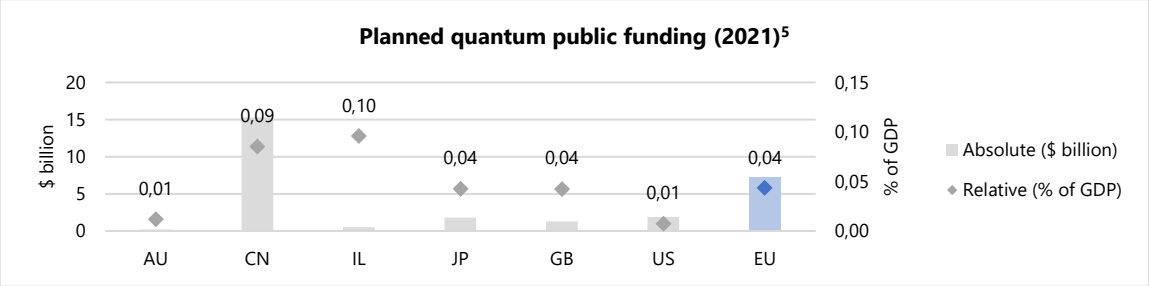
([215]) https://www.hpcqs.eu/.

communication infrastructure (EuroQCI) and of advanced quantum sensing infrastructures) should help to ensure that the EU is **at the cutting edge of quantum capabilities** by 2030.

Moreover, in December 2023 the **Quantum Declaration** was launched by the Spanish Presidency of the Council. It should form a basis for enhanced cooperation between Member States and the Commission, enabling the EU to consolidate its strengths in quantum and to foster the further development of its quantum ecosystem.

From an international comparison perspective, Figure 27 shows that, **in terms of planned quantum public funding, the EU is surpassed only by China.**

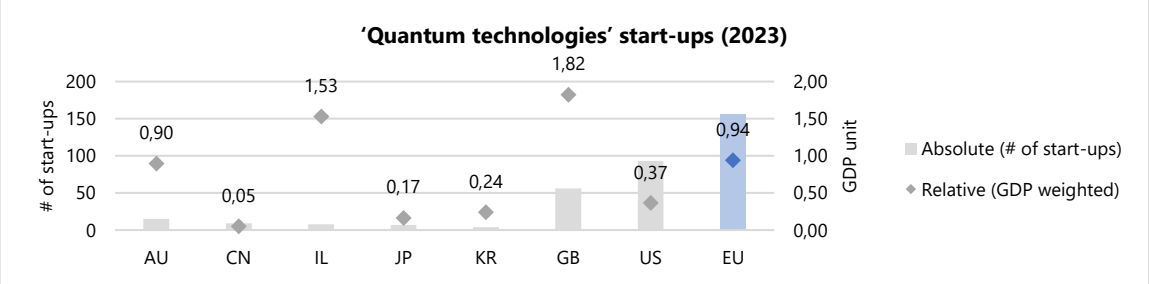
Figure 27. Planned quantum public funding (2021)



Source: International benchmarking of the digital transformation, Visionary Analytics, March 2024

The quantum ecosystem is also relatively strong in the EU, which has the largest number of quantum technologies start-ups in the world (when GDP weighted).

Figure 28. Quantum technologies start-ups



Source: International benchmarking of the digital transformation, Visionary Analytics, March 2024

However, **EU public investment in quantum is promising but has not yet been matched by the private sector**. In 2021, around 25% of the world's quantum industry participants were based in the EU, but the EU has received less than 5% of global funding. EU industry needs to identify and invest in quantum use cases that could transform productivity and lead to concrete improvements in everyday life.

Regarding **critical technologies and dependencies**, the European Quantum Industry Consortium (QuIC) has conducted a joint analysis together with its US counterpart (QED-C). This analysis shows that, while the size of the quantum computing market is currently relatively small, systems under development **rely on a variety of primary components and raw materials,** some of which are primarily mined and/or processed in countries of concern.

The availability of a **skilled labour force** is another important factor determining performance in quantum. The lack of talent concerns both critical component suppliers and manufacturers of high-end critical components.

EU and Member State measures

In 2018, the EU launched the **Quantum Technologies Flagship**, a EUR 1 billion, 10-year initiative with the goal of making the most of the EU's scientific excellence in quantum and bringing research results closer to industrial exploitation and real-life applications. It has already achieved a number of scientific breakthroughs, contributing to the EU's global leading position in a number of key areas of quantum. Following a successful ramp-up phase, its second phase is now well underway. It is a technology supply for downstream activities (e.g., the deployment of quantum computers and simulators by the European High Performance Computing Joint Undertaking, the European quantum communication infrastructure (EuroQCI) initiative), the deployment of pilot lines, and open testing and experimentation facilities.

In June 2023, the **EuroHPC Joint Undertaking** concluded agreements with six sites across the EU to host and operate EuroHPC quantum computers. The aim is to start making available in the EU a wide array of quantum computing platforms and hybrid classical-quantum architectures. This initiative will deploy quantum computers as accelerators within high performance computing environments. It will require significant R&D for a hybrid software stack that can manage both HPC and quantum computing workloads.

Since 2019, the Commission has been working with Member States and with the European Space Agency (ESA) towards the deployment of a **secure quantum communication infrastructure (EuroQCI)**, that spans the entire EU (including its overseas territories). The EuroQCI will consist of a terrestrial component that builds on new and/or existing fibre communication networks that link strategic sites at national and cross-border level, complemented by a space component to cross-link and cover the whole EU. Since 2023, the EuroQCI has been in the process of being integrated into IRIS², the EU's secure connectivity programme.

The European Chips Act, adopted in 2023, will provide EUR 400 million of joint financing from the Commission and Member States for the development of quantum chips and additional supporting facilities (e.g., pilot lines, cleanrooms and foundries for prototyping and producing quantum chips; and facilities for testing and validating advanced quantum chips produced by the pilot lines).

Support for quantum in the national Digital Decade strategic roadmaps ([216])

Six Member States (Czechia, Germany, Croatia, Italy, Poland and Finland) have provided a **trajectory for the quantum target**, which is for the EU to have its first computer with quantum acceleration by 2025, thus paving the way for it to be at the cutting edge of quantum capabilities by 2030.

Member States reported a **total of 56 measures to help achieve this target, with a total budget of EUR 3.7 billion**. Around 80% of this budget will come from national sources,

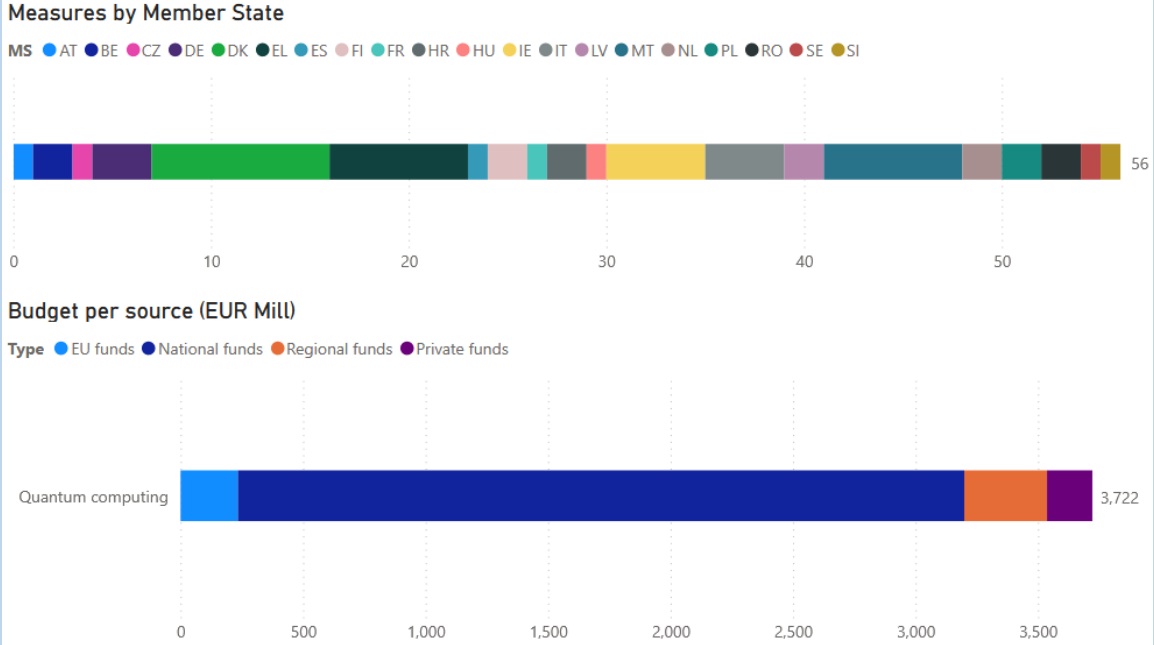
([216]) This analysis only takes account of elements reported by the Member States in their national roadmaps. The measures reported by the Member States were grouped into categories to provide a better overview of the types of measures taken.

around 10% from regional budget and around 5% from EU sources, and the remaining 5% from private industry investment. The roadmaps include several new elements: around one third of the measures (with a budget share of around 10%) are reported as being new.

Around 45% of the measures focus on **support for research and deployment for quantum computing** in companies, including via the European High Performance Joint Undertaking. Around 40% of the measures focus on **support for deployment of quantum technologies**. The remaining 15% of the measures support **horizontal actions**, including collaboration initiatives supporting innovation. Only a very small number of measures (from Croatia and Latvia) focus on activities supporting '**from lab to market**' (i.e., commercialisation of new solutions and services on the market).

Measures and budget (EUR Mill)

Target category	Measures	Budget
1. Support research and development for quantum computing	24	1,972
2. From Lab to market	2	6
3. Support for deployment of quantum technologies	22	1,660
4. Horizontal actions	8	83
Total	**56**	**3,722**



Concluding remarks and future challenges

A wide range of promising initiatives in quantum technologies are ongoing at national and EU level. However, there is a clear need for more coordination and joint action in order to build on EU excellence in quantum; identify and address strengths and weaknesses; and create a globally competitive quantum ecosystem. It is therefore essential to define a coherent approach to collaborating with like-minded non-EU countries while ensuring that EU interests are protected. Another important issue is the relatively low level of the EU's private sector investment in quantum and the need to increase this (correcting this will be crucial for enabling EU quantum start-ups to scale up and compete in global markets). There is also a need to ensure that the EU's workforce is sufficiently skilled in quantum technologies.

3.3. Supporting EU-wide digital ecosystems and scaling up innovative enterprises

DD cardinal points and targets: digitalisation of businesses (cloud/AI/Big Data, digital intensity of SMEs, unicorns/start-ups).

DD objectives: Building interconnected Digital ecosystems (Developing a comprehensive and sustainable ecosystem of interoperable digital infrastructure where high performance, edge, cloud, quantum computing, AI, data management and network connectivity work in convergence; Promote uptake of digital technologies by businesses); **Competitiveness** (Regulatory environment to support the ability of Union undertakings, especially that of SMEs, to compete fairly along global value chains; Fostering the start-up ecosystem; Achieve a high level of digital intensity and innovation in Union enterprises, in particular start-ups and SMEs; Strengthening the synergies between private and public investments and the use of Union and national funds, Developing predictable regulatory and supportive approaches that also involve the regional and local levels; Ensure that policies and programmes to reach targets are coordinated and consistent while avoiding overlaps and minimising administrative burdens); **Resilience** (Reinforcing Member States' collective resilience).

Digital Rights and Principles: A Fair Digital Environment (under Freedom of Choice).

3.3.1. Promoting the digital transformation of EU enterprises

Digitalisation of businesses is a crucial element for the success and growth of the economy. Digitalisation is key to changing the business model of enterprises; achieving greater efficiency in production processes; exploring new opportunities; and generating new products and services and thereby new revenue streams. The take-up of advanced digital technologies such as advanced cloud, AI or data analytics positively affects enterprises' performance. Firms that adopt advanced digital technologies grow faster than non-digitalised firms and are more productive. Digitalisation is particularly important for enterprises that face challenges such as inflation, increasing energy costs, and stagnating or slow growth of the economy. It is therefore also important in improving resilience. Last but not least, studies show that investment in digital innovation and digital transformation is less sensitive to economic cycles: companies have increased their investment in digitalisation since the COVID-19 crisis and that investment trend has continued despite the economic slowdown (Harasztosi et al., 2023).

As highlighted in the EIB investment survey 'Digitalisation in Europe 2022-2023' ([217]), the EU is making slow progress in closing the digitalisation gap with the US. However, the share of digitalised enterprises is higher in the US than in the EU. The EU remains a major global player in R&D and innovation, but the share of EU companies in the top global R&D investors has fallen over time. In particular, EU companies are not well positioned in digital innovation.

To strengthen digitalisation in the EU, the Digital Decade policy programme has set ambitious EU level targets to be achieved by 2030 for business digitalisation (i.e., that 90% of SMEs reach a basic level of digital intensity; a 75% uptake of AI, big data or cloud by

([217]) https://www.eib.org/en/publications/20230112-digitalisation-in-europe-2022-2023.

businesses; and doubling the number of EU unicorns). In 2023, only 54.6% of enterprises in the EU adopted at least one of the technologies (cloud computing services, data analytics or AI), with a higher number of enterprises engaged in the combined these three digital technologies. This will be discussed in the following sections.

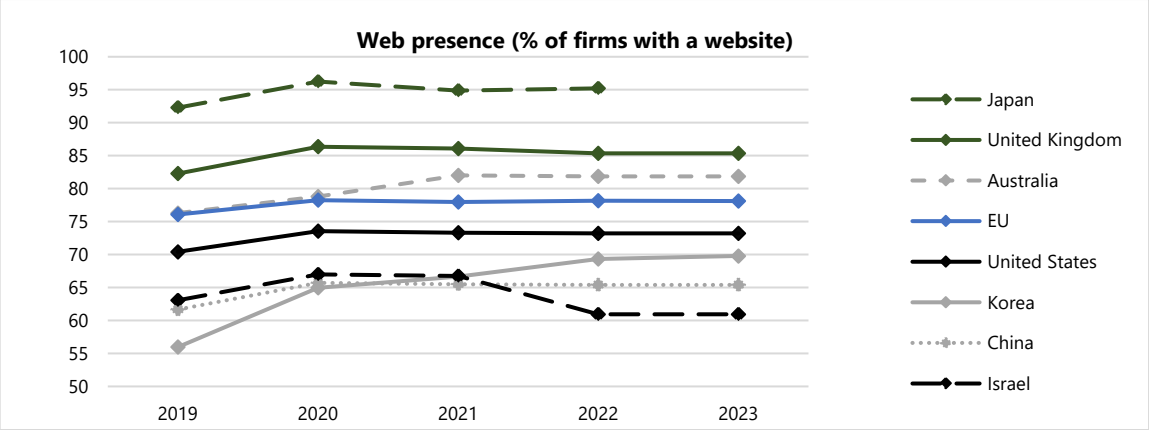
The programme's major objectives include building strong digital ecosystems; supporting the ability of EU undertakings (especially SMEs) to innovate and compete fairly in global value chains; and fostering the start-up ecosystem. The following sections present the progress made in 2023, the Commission's and Member States' efforts towards the achievement of these targets and objectives and the current perspectives towards 2030.

3.3.1.1. Basic digital intensity for all SMEs

One of the Digital Decade's aims is that more than 90% of EU SMEs achieve at least a basic level of digital intensity. However, the EU has been making slow progress towards this. Only 57.7% of EU enterprises had achieved a basic level of digital intensity by 2023.

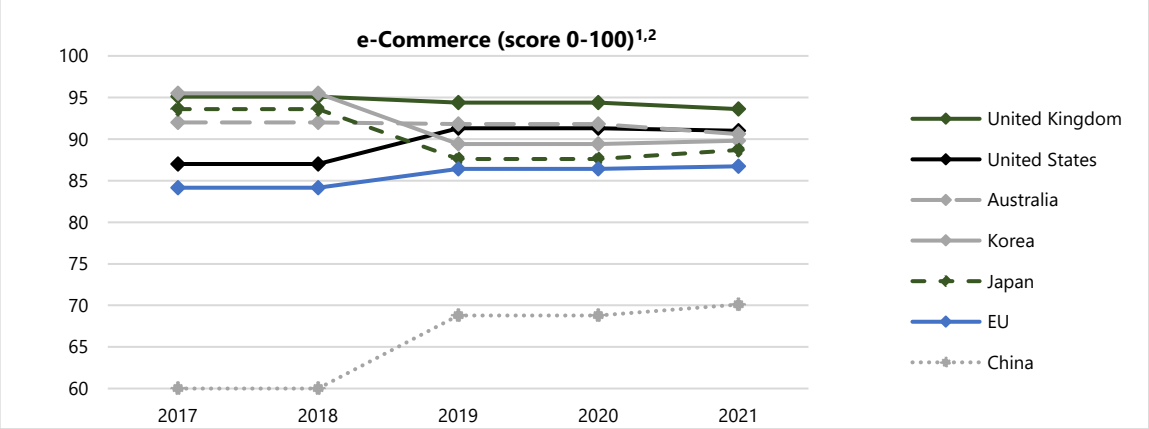
For example, the EU's performance is only average (by worldwide standards) on web presence and close to the low end on e-commerce. These measures indicate the businesses' basic digital intensity.

Figure 29. Web presence as a percentage of businesses around the world with a website



Source: International benchmarking of the digital transformation, Visionary Analytics, March 2024

Figure 30. e-Commerce rates around the world



Source: International benchmarking of the digital transformation, Visionary Analytics, March 2024

This indicates that there is significant untapped potential for productivity, innovation, new business models and competitiveness in different sectors of the economy.

This is also preventing the data economy from flourishing and the EU's advanced digital technologies from developing further, because the potential of advanced digital technologies like AI or IoT and of many digital services can only be harnessed when large numbers of business across all economic sectors are connected and generate data. This is related to the dominance of non-EU players in the data service providers sector and the declining market shares of EU cloud providers.

Central to achieving the Digital Decade objectives is the **European Digital Innovation Hubs (EDIHs) network,** which plays a pivotal role in offering the necessary support and expertise for facilitating digital innovation. Operational since 2023, **EDIHs network emerged** from the **Digital Europe Programme** in order to support SMEs, mid-caps and public sector organisations in their digital transformation. The EDIHs network comprises one-stop shops that offer a variety of services like test-before-invest for new ideas, training sessions to level up skills, funding advice, and opportunities to make new connections. They leverage AI, cybersecurity and IoT expertise, powered by universities, research groups and private companies. By enhancing coordination, the EDIH network ensures that SMEs can quickly and easily find the right digitalisation services, irrespective of the entry point.

The EDIH network comprises over 200 hubs, each acting as a regional multi-partner consortium that brings together public and private entities (including research organisations, universities, industry associations, regional development agencies and private sector companies).

The network operates under a co-funding model, combining grants from the Commission (up to 50%) with national and regional contributions as well as private investment.

The EDIH network's extensive reach is a significant strength. EDIH services are available in all EU Member States and enable any EU SME to obtain support in digitalising.

The EDIH network offers a comprehensive range of services to their clients, categorised into four principal areas:

- **test before invest allows businesses to experiment with technologies before investing;**
- **skills and training provides training programmes to equip employees with digital competencies;**
- **support to find investment assists businesses in finding funding opportunities;**
- **innovation ecosystem and networking facilitates collaboration and networking between businesses, academia, research institutions and public authorities.**

State of play and progress towards the Digital Decade target

Progress towards the **Digital Decade target of more than 90% of SMEs achieving at least a basic level of digital intensity** is measured using the **Digital Intensity Index (DII).** An enterprise's DII score is based on how many of 12 selected technologies are used in an enterprise. The basic digital intensity level requires the use of at least four of these technologies.

Every year, the index covers a broad range of technologies, from basic to more sophisticated ones, and measures the level of digitalisation of SMEs in the EU. The 2023 survey included the following 12 technologies and/or criteria ([218]):

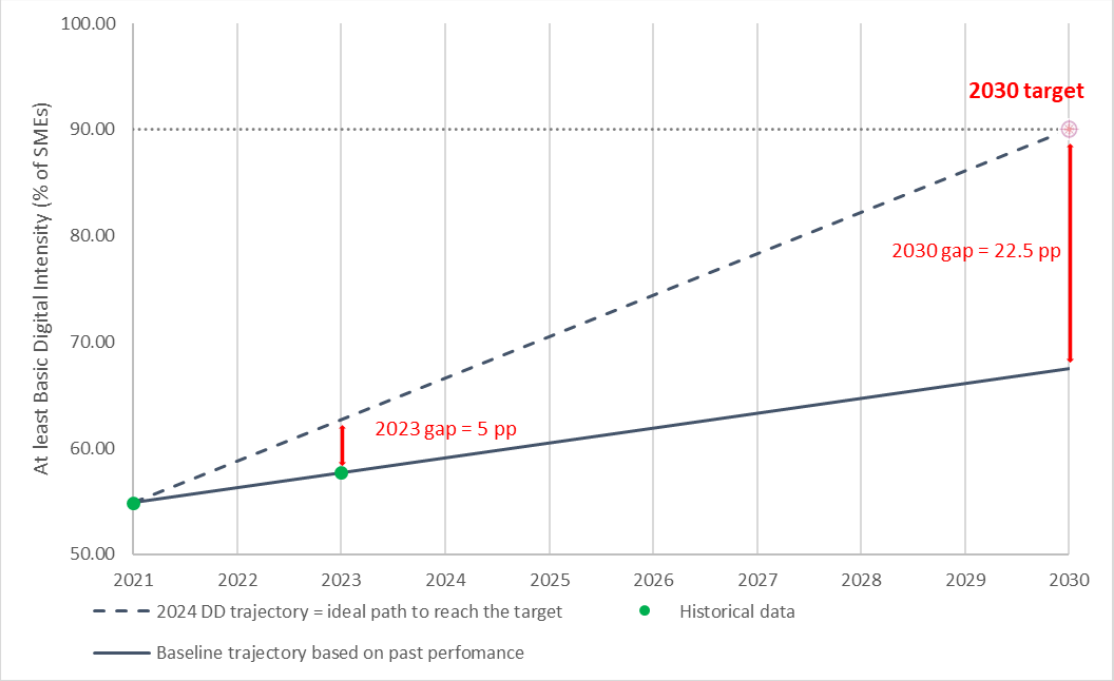
- more than 50% of the persons employed used computers with access to the internet for business purposes;
- have an enterprise resource planning (ERP) software package to share information between different functional areas;
- the maximum contracted download speed of the fastest fixed line internet connection is at least 30 Mb/s;
- web sales were more than 1% of the total turnover and B2C web sales more than 10% of the web sales;
- data analysis is performed by the enterprise's own employees or by an external provider;
- use any social media;
- have customer relationship management (CRM) software;
- buy sophisticated or intermediate cloud computing services;
- use any AI technology;
- buy cloud computing services used over the internet;
- used any computer networks for sales (at least 1%);
- use two or more social media.

The percentage of enterprises with at least basic levels of digital intensity **increased slightly from 54.8% in 2021 to 57.7% in 2023**. This corresponds to a **modest average annual increase of 2.6% that is less than half the annual increase required to reach the 2030 target** (5.65% annually in 2021-2030).

The latest 2030 projected value along the baseline trajectory (i.e., the value that will be reached at the current rate of progress) is 67.5%. **The target will not be met without further effort that leads to an acceleration in the rate of progress.**

([218]) The enterprise survey questions used for the definition of the Digital Intensity Index vary from year to year. However, in 2023 most of the questions were the same as in the 2021 survey. Eurostat provides the list used for each year.

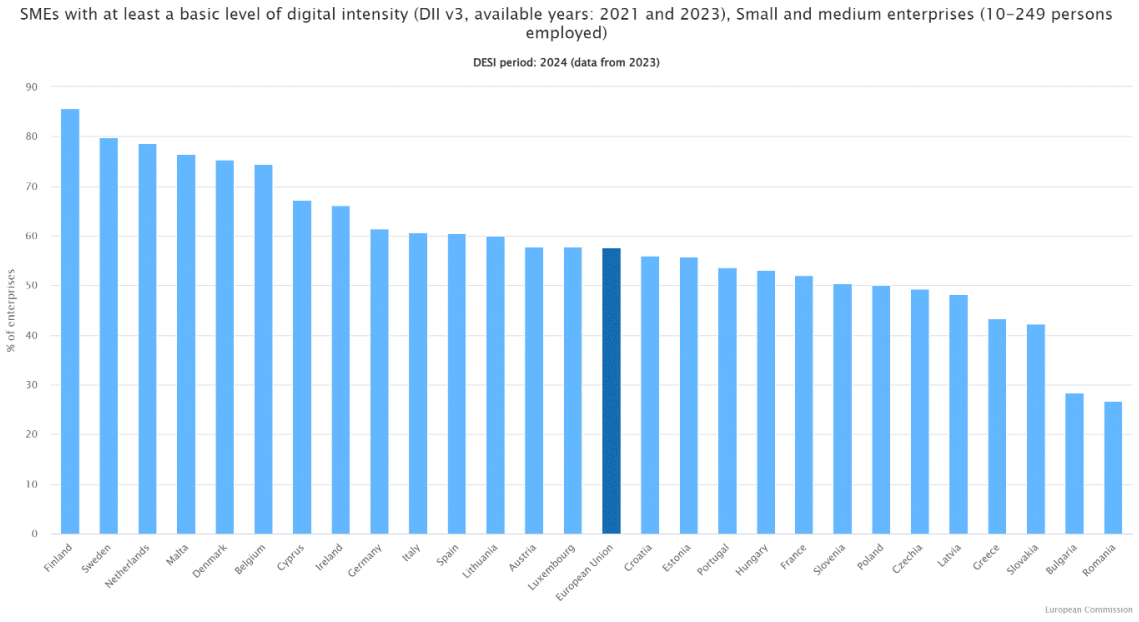
Figure 31. Digital Intensity Index. Historical comparable data and the Digital Decade trajectory towards 2030 (based on DII version III)



Source: European *Commission*

It should nevertheless be noted that this percentage varies greatly between Member States. More than 75% of SMEs have already reached this level in Denmark, Malta, the Netherlands, Finland and Sweden, but less than one third of SMEs have reached it in Bulgaria and Romania.

Figure 32. SMEs with at least a basic level of digital intensity (DII version III)



Source: European Commission

Overall, the level of digitalisation of SMEs remains uneven across Member States and economic sectors. A key barrier is lack of awareness of the potential of digital technologies and employees' lack of skills and technical expertise in integrating basic and advanced digital technologies in business operations.

Support for basic digital intensity of SMEs in national Digital Decade strategic roadmaps ([219])

25 Member States have provided a trajectory for SMEs with at least a basic level of digital intensity target. Most of the national target values for 2030 are in line with the EU target value (i.e., more than 90% of EU SMEs achieving at least basic digital intensity). Six Member States assumed a target value below the EU target value and **four Member States (Denmark, Germany, the Netherlands and Sweden) assumed a target value above the EU target value.**

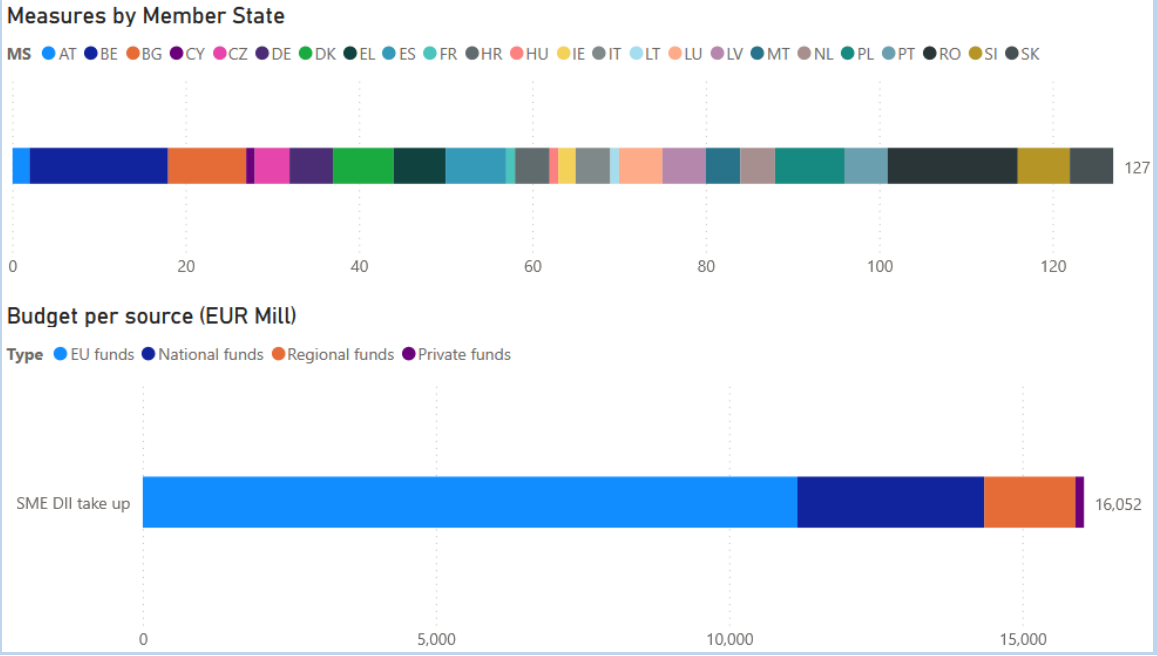
Member States reported a total of **127 measures contributing to this target, with a total budget of EUR 16.1 billion**. Around 70% of this budget will come from EU sources, around 20% from national sources and the remaining 10% from regional sources. Private investment will provide around 1%. The roadmaps include **several new impulses**: around one third of the measures (with a significant budget share of around 70%) are reported as new.

Around 55% of the measures focus on support for uptake and deployment of digital technologies in companies and SMEs in particular. This includes **providing access to training to use digital technologies and financial support** (e.g., via funding programmes). Around 35% of the measures focus on **strengthening the ecosystem, information sharing and exchange of knowledge** on digital technologies, including via European Digital Innovation Hubs. The remaining 10% of the measures support the **development of advanced technologies**. Only a very small number of measures focus on the **commercialisation of new solutions and services** on the market (e.g., in Bulgaria and Portugal).

([219]) Statista, Cloud Computing in Europe – statistics and facts: https://www.statista.com/topics/8472/cloud-computing-in-europe/#topicOverview.

Measures and budget (EUR Mill)

Target category	Measures	Budget
	1	1,222
1. Strengthen the ecosystem, information sharing and knowledge exchange on digital technologies	42	1,921
2. Support for uptake/ deployment	67	12,518
3. Development: Support development of digital technologies	15	240
4. Lab to Market	2	151
Total	**127**	**16,052**



Concluding remarks and future challenges

In terms of policy response, the European Digital Innovation Hubs (EDIH) network has featured significant progress and achievements up to 2024:

- regionally based networks: over 200 hubs (including 151 hubs funded by the Digital Europe Programme), plus over 70 seals of excellence from national/regional funds;
- specifically, according to a 2023 dedicated report by the Joint Research Centre (JRC) (*Characteristics and regional coverage of the European Digital Innovation Hubs network*), EDIH services are available to companies and public sector organisations in 223 regions (almost 90% of EU regions) and companies can reach out to any EDIH, even outside their region;
- over 800 events, 2 400 services and nearly 9 000 companies were served in the first year and the aim is to serve 100 000 by 2027.

In 2023 (the first full year of operations), the EDIHs facilitated over 2 200 digital maturity assessments (DMAs) to evaluate the level of digitalisation of companies and enable tailored support.

Building upon the momentum of 2023, several trends are expected to shape digitalisation efforts in 2024. Firstly, the EDIH network can serve as a coordinating network for the various digital initiatives to support the digitalisation of companies in order to ensure a smooth client journey. Secondly, following the adoption of the AI Act and the GenAI4EU package, the companies will more than ever need support with the implementation of the

regulation and with making the most of AI technology. Over 120 EDIHs focus on AI and are ready to support the companies on the ground. Furthermore, EDIHs can support the companies with other technologies such as cyber, cloud and big data.

More generally, the data and insights derived from the EDIHs will continue to provide valuable guidance for shaping digitalisation strategies across the EU. By reframing the digital maturity assessment tool as a more operational tool that facilitates comprehensive assessment and monitoring of digitalisation efforts, EDIHs network, business and public service entities can gain insights into how to drive sustainable innovation and digital transformation across the EU.

In 2024, leveraging the EDIHs network is strengthening the EU's ability to effectively manage its digital transformation; and promoting sustainable economic growth, resilience and competitiveness in the digital era. Moreover, it is vital to maintain a human-centred approach in this development, focusing on the wellbeing and requirements of people and communities.

3.3.1.2. Take-up of cloud services

The European Strategy for Data recognises cloud computing as the backbone for innovation, growth, competitiveness and sovereignty in the data economy. Cloud computing is also the enabler technology for the development of industrial applications and public services supplied to businesses and citizens.

In 2023, despite the European cloud computing market being expected to be worth EUR 560 billion ([220]), cloud uptake by enterprises in the EU was below 50% and there was a large discrepancy between Member States, company size and cloud service types. This shows that the EU is neither ready to exploit the full potential of its cloud market to bolster its competitiveness nor ready to achieve its Digital Decade's KPI on cloud uptake (i.e., 75% of enterprises using cloud services by 2030).

State of play and progress towards the Digital Decade target

The **take-up of cloud computing** is measured as the percentage of enterprises using at least one of the following cloud computing services: finance or accounting software applications; enterprise resource planning (ERP) software applications; customer relationship management (CRM) software applications; security software applications; hosting the enterprise's database(s); and a computing platform that provides a hosted environment for application development, testing or deployment.

In 2023, just under 39% of enterprises used sophisticated or intermediate cloud computing services. This was an increase of 4.9 percentage points from the last measurement in 2021, when only 34% of enterprises used these services, but represents insufficient progress towards the 2030 target. The current average annual progress of almost 7% remains slightly below the annual progress of over 9% over a decade required to meet the target.

More specifically, the 2023 value shows a gap of 8.4 percentage points with respect to the ideal Digital Decade trajectory. At the current rate of progress, and without further action

([220]) Statista, Cloud Computing in Europe – statistics and facts: https://www.statista.com/topics/8472/cloud-computing-in-europe/#topicOverview.

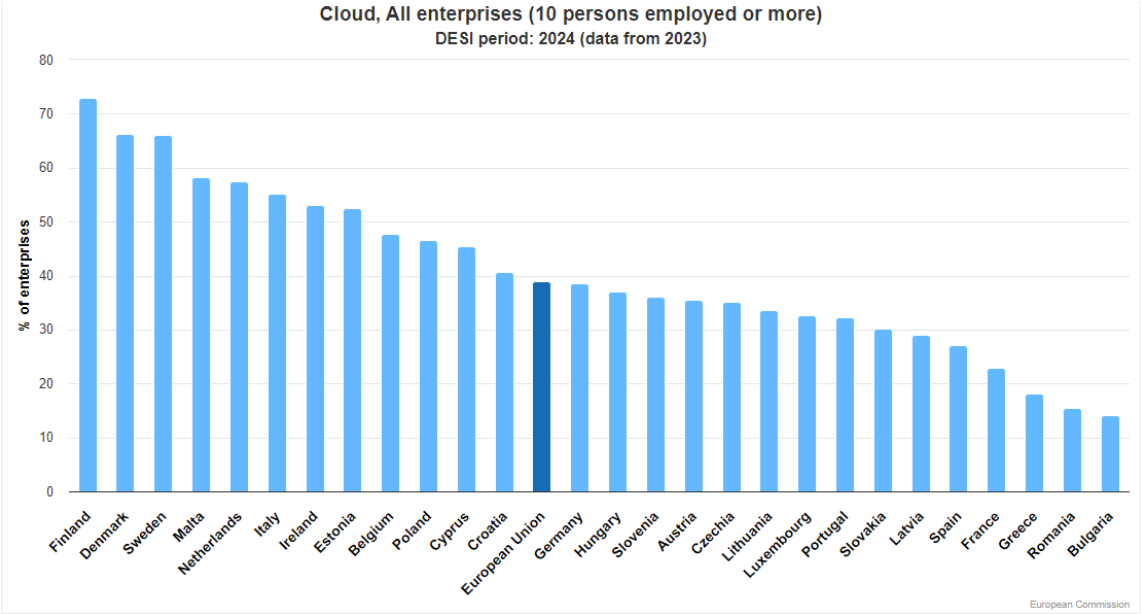
(particularly investment), it is projected that the percentage will increase to 64.4% by 2030, representing a shortfall of more than 10 percentage points below the EU target.

Figure 33. Percentage of enterprises using cloud services in the EU. Historical data, Digital Decade trajectory and revised baseline trajectory towards 2030 ([221])

Source: European Commission

It should be noted, however, that there are important differences between the uptake of cloud services among Member States. Cloud uptake was above 65% in Finland, Denmark and Sweden in 2023, but below 20% in Greece, Romania, and Bulgaria.

Figure 34. Cloud, all enterprises



([221]) Eurostat's indicator 'Enterprises purchasing at least one of the following cloud computing (CC) services: hosting of the enterprise's database, accounting software applications, customer relationship management software, computing power' (code E_CC_GE_ME) is used for the period 2014-2020. A break in the series occurred in 2021, when the indicator 'Enterprises buying sophisticated or intermediate CC Services' was used. This indicator includes different CC services: accounting software (CC_PFACC); ERP software (CC_PERP); CRM software (CC_PCRM); security software (CC_PSEC); database hosting (CC_PDB) and hosting environment for application development (CC_PDEV).

Source: European Commission

Moreover, the significant gaps between cloud uptake by large enterprises compared with SMEs has also been widening in recent years.

In addition, between 2021 and 2023, usage only slightly increased for some cloud service types and has even decreased for others. The increase in use was mainly seen for the most commonly used cloud services (e.g., email and file storage services). There was also some progress for less traditional cloud services (e.g., platforms for application development services for testing or deployment; and security software applications). However, for the first time in years, the business cloud uptake for enterprise database hosting services and client relationship management software services decreased.

EU and Member State measures

At EU level in 2019-2024, there were five main EU initiatives in the field of cloud computing. These initiatives can be clustered around three main axes: regulatory, market oversight and industrial.

The **Data Act** entered into force in January 2024. It will fundamentally reshape the EU's cloud regulatory landscape and enable EU businesses to benefit from a more open and constable cloud market. The Data Act aims to make switching between different providers of data processing services free of charge by gradually withdrawing related fees. It also aims to ensure that switching can happen quickly and does not result in reduced functionalities for the user. By obliging providers across the cloud stack to remove obstacles to switching, the Data Act tackles vendor lock-in practices, which are nowadays a major obstacle to cloud adoption by EU businesses. The possibility of free and fast switching will allow customers of data processing services to benefit from the vast opportunities offered by the EU's cloud market, where providers of all sizes will compete on performance, innovation and price. With its provisions on international data flows, the Data Act will also increase the already existing safeguards for the data of EU businesses in relation to unwarranted non-EU country access.

The **Free Flow of Non-Personal Data Regulation** started to apply in 2019. It led Member States to largely remove data localisation requirements, which have in the past hampered the free flow of data in the EU and impeded the emergence of a true single market for data, to the detriment of EU businesses. Past research suggests that professional users of cloud computing services identified data location requirements as a high-impact barrier limiting their adoption of such services. The results of European Cloud Data Flow Monitoring (see next paragraph) suggest that the total volume of data flows across the EU has increased since the implementation of this regulation and thus brought some significant economic value. However, these flows and their associated economic value are not equally distributed among the Member States, despite the applicability of the principle of free movement of data established by this regulation and the General Data Protection Regulation. Taken together, the Data Act and the Free Flow of Non-Personal Data Regulation set the regulatory framework conditions for an open and fair EU cloud market for EU businesses.

In March 2024, the Commission released the final version of **European Cloud Data Flow Monitoring** ([222]), the first ever monitoring of this kind. This is a worldwide unique economic framework that quantifies and forecasts the volume and economic value of cloud data flows within the EU, the UK and the EFTA countries from 2016 to 2036. It also quantifies the volume and economic value of international cloud data flows between the EU and other non-EU regions (e.g., Africa, America, China and the Middle East). European Cloud Data Flow Monitoring is the concrete deliverable of one of the key actions of the European Strategy for Data: create a framework to measure data flows and estimate their economic value within the EU, as well as between the EU and the rest of the world.

European Cloud Data Flow Monitoring estimated that the volume of cloud data flows across the EU will be 46 000 petabytes (PB) in 2024. This is around 300 times the data storage capacity of the Internet Archive, the world's largest library of internet content, which archives over 860 million webpages. Of the 46 000 PB generated in 2024, 36 600 PB are expected to flow to cloud and edge facilities within the EU, 1 950 to EFTA and the UK, and 7 345 PB to other non-EU regions (Africa, America, Middle East and Asia).

In 2024, the estimated economic value of EU cloud data flows is estimated to be EUR 107 billion, of which EUR 77 billion is in the EU (estimated to increase to EUR 328 billion by 2035), EUR 8 billion in EFTA countries and EUR 22 billion in the UK. To put this into context, the total economic value of cloud data flows in the EU in 2024 is greater than the individual GDPs of Bulgaria, Estonia, Croatia, Latvia and Lithuania.

In December 2023, the European Commission authorized the launch of an ***Important Project of European Common Interest on Next Generation Cloud Infrastructure and Services*** **(IPCEI-CIS).** The IPCEI-CIS directly involves 19 companies from seven Member States: France, Germany, Hungary, Italy, the Netherlands, Poland, and Spain and further aims to create a wider IPCEI CIS ecosystem, involving more than 90 indirect partners, including large, medium and small enterprises, start-ups, and research organisations located in five additional EU Member States (Belgium, Croatia, Latvia, Luxembourg, and Slovenia). It therefore aims to bring together a total of 12 Member States (Belgium, Germany, Spain, France, Croatia, Hungary, Italy, Luxembourg, Latvia, the Netherlands, Poland, Slovenia) and more than a hundred private companies, including SMEs, and research organisations. A total amount of EUR 1.2 billion of public support for the companies directly assessed under the IPCEI Communication is expected to trigger their additional EUR 1.4 billion of private investment France. Germany, Italy, Latvia, Poland, Slovenia and Spain benefitted from the Recovery and Resilience Facility to finance the participation of their respective industries.

This will realise the goal of the **European Strategy for Data** for the setting-up of a **high impact project** enabling the development and deployment of energy-efficient and trustworthy edge and cloud capabilities, hybrid cloud deployment models that allow data processing at the edge with no latency in order to address specific industrial needs in the EU. It will also support the achievement of two of the Digital Decade's targets (for 75% of EU companies to use cloud, AI or big data; and for the deployment of 10 000 climate-neutral highly secure edge nodes across the EU by 2030).

([222]) https://digital-strategy.ec.europa.eu/en/policies/european-data-flow-monitoring.

Since 2021, the **European Alliance for Industrial Data, Edge and Cloud** has been bringing together EU providers of highly innovative and secure edge and cloud technologies to cooperate on an investment roadmap and its deployment. The Alliance also involves Member State experts. By mobilising both industry and Member States, it is helping to overcome fragmentation in the EU cloud market and to forge a common approach to developing and deploying the next generation of cloud and edge capabilities for the benefit of EU businesses.

Support for take-up of cloud in the national Digital Decade strategic roadmaps ([223])

25 Member States have provided a trajectory for the take-up target of cloud computing services, big data or AI. This is a target that at least 75% of EU enterprises have taken up at least one of the following three technologies: cloud computing services, big data or AI. Considering cloud computing services individually**, seven Member States assumed a national target value below 75%, while Denmark and Sweden assumed a national target value above 75%.**

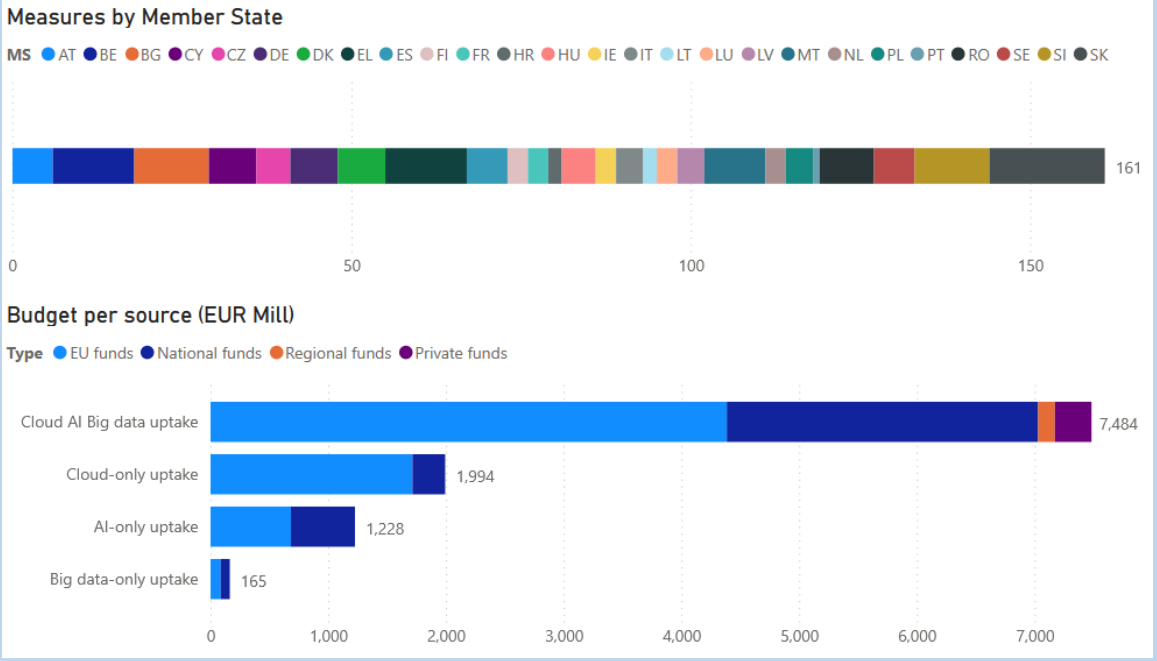
Member States reported a total of **161 measures contributing to the uptake of cloud computing services, big data or AI with a total budget of EUR 10.9 billion**. Around 65% of this budget will come from EU sources, around 30% from national budgets and the remaining 5% from private industry investments and regional budgets. The roadmaps include a **considerable number of new impulses**: around 40% of the reported measures (with a budget share of around 50%) are new.

The measures mainly focus on three areas: (i) **strengthening ecosystems, information sharing and knowledge exchange on cloud/AI/big data uptake**; (ii) enabling **framework conditions for uptake, including access to training and financial support (**e.g., via funding programmes); and (iii) supporting the **development of cloud/AI/big data capabilities, including via R&D for advanced technologies**. The fostering of **the roll-out and establishment of viable industrial** solutions in the market is significantly less present – Belgium, Denmark, Greece, Romania, Slovakia and Sweden have reported relevant measures in their roadmaps.

([223]) This analysis only takes account of elements reported by the Member States in their national roadmaps. The measures reported by the Member States were grouped into categories to provide a better overview of the types of measures taken.

Measures and budget (EUR Mill)

Target category	Measures	Budget
	5	262
1. Strenghen the ecosystems, information sharing and knowledge exchange on cloud/AI/big data uptake	49	2,645
2. Enable framework conditions for uptake	47	1,855
3. Support development of AI/Cloud/Big data capabilities	48	5,028
4. Foster roll-out and establishment of viable industrial solutions in the market (growth stage)	12	1,080
Total	**161**	**10,870**



Concluding remarks and future challenges

In 2023, there was public intervention on the supply side of the EU's cloud market. This intervention was intended to support the diversification of this market by fostering the development and deployment of interoperable and trusted cloud-to-edge business offerings fit for EU users' needs. This intervention was mainly channelled by significant investment (notably via the IPCEI-CIS, Simpl and DIGITAL). It was also prompted by the entry into force of the switching provisions intended to remove vendor lock-in practices present in the EU cloud market under the Data Act.

This public intervention is starting to bring a more diversified EU cloud market, but market issues remain that are hampering a fair, open and contestable market structure. Unfair market practices are still present across the EU's cloud market. These include tying and bundling (e.g., providers tying the use of a software licence to their own cloud infrastructure service); unfair contractual relationships between users and cloud providers that limit customers' contractual negotiation power; and telemetry practices on customers' metadata that give a competitive edge to one provider over the others.

This imperfect market structure has limited cloud uptake among enterprises to less than 50% of EU enterprises used cloud services in 2023. This is lower than is needed in order to stimulate EU businesses' competitiveness; innovativeness, which is rooted in unlocking the full potential of cloud technologies; and effectiveness in daily internal operations, which are often based on cloud-based activities. This is particularly the case when one considers the limited uptake of advanced cloud services among SMEs. SMEs often suffer

the most from unfair contractual relationships because large cloud providers limit their contractual negotiation power when buying cloud services ([224]).

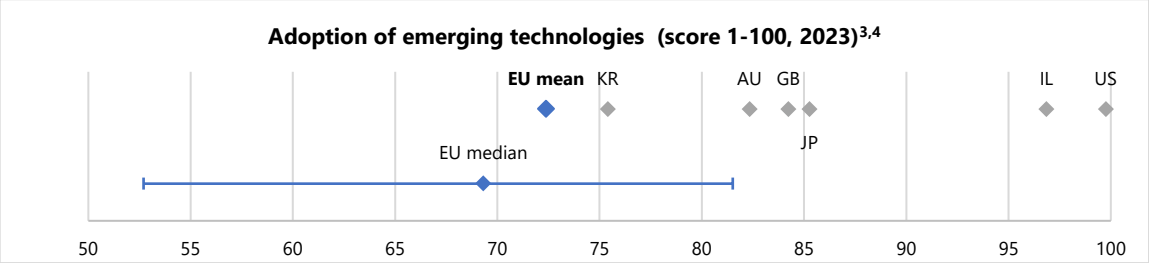
3.3.1.3. Take-up of AI

AI (especially generative AI) drives innovation, enhances productivity and helps business gain a competitive edge. As a transversal technology, it has many potential uses and can, for example, streamline both production processes and revolutionise marketing strategies. It will thus transform all key industrial and public sectors, from healthcare and biotechnologies to mobility, aerospace, security and public administration. Adopting AI enhances the competitiveness of the adopting company. However, not adopting AI endangers competitiveness, no matter how strong it was before. The same applies for the economy at large.

There are some encouraging figures. The EU already has around 100 start-ups working with generative AI and the number is growing. This is encouraging for the market's overall competitiveness ([225]). Recent estimates forecast that EU investment growth in generative AI could outstrip broader AI spending threefold in coming years. The share of generative AI currently stands at less than 9.6% of the total EU AI market in 2023, but it is growing rapidly and is expected to rise to 25% by 2027 ([226]).

However, according to an International Benchmarking study (March 2024), the EU currently lags behind international competitors overall when it comes to the adoption of emerging technologies (including AI).

Figure 35: Adoption rates of emerging technologies across the world (2023)

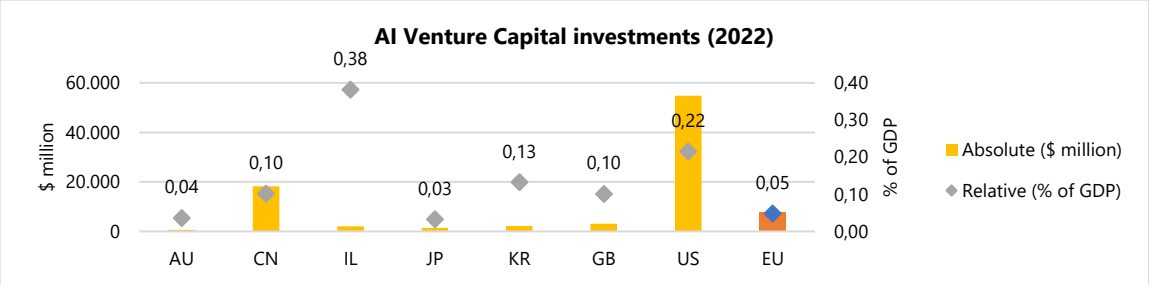


Source: International benchmarking of the digital transformation, Visionary Analytics, March 2024

542 AI companies were funded in the US in 2022, compared with 194 in the EU ([227]). In 2023, the EU invested USD 1.7 billion in gen AI, while US venture capital and private equity invested USD 23 billion. In November 2023, 35 US-based generative AI companies had reached unicorn status, while only 3 EU companies had reached that milestone in the same field ([228]).

([224]) Study on the Economic Detriment to Small and Medium-Sized Enterprises Arising from Unfair and Unbalanced Cloud Computing Contracts: https://commission.europa.eu/publications/study-economic-detriment-small-and-medium-sized-enterprises-arising-unfair-and-unbalanced-cloud_en.
([225]) https://sifted.eu/articles/europe-generative-ai-startups.
([226]) IDC, Worldwide AI and Generative AI Spending Guide, March 2024, https://www.idc.com/getdoc.jsp?containerId=prEUR251966524; https://techmonitor.ai/technology/ai-and-automation/european-genai-spend-could-exceed-30-billion-by-2027
([227]) https://aiindex.stanford.edu/report/; ERT 2024 Competitiveness and Industry Benchmarking Report, March 2024, p.34, https://ert.eu/documents/an-ice-bath-for-eu-leaders-competitiveness-is-crumbling-europes-business-case-needs-a-rebuild/.
([228]) https://www.mckinsey.com/mgi/our-research/accelerating-europe-competitiveness-for-a-new-era.

Figure 36. AI venture capital investments in 2022



Source: International benchmarking of the digital transformation, Visionary Analytics, March 2024

2023 was a disappointing year for the EU's venture capital market, including for AI start-ups ([229]). Venture capital investment in EU start-ups was EUR 51.7 billion in 2023. This was higher than before the pandemic but still a significant drop of 45.6% compared with the previous year, 2022 ([230]). EU enterprises also continue to experience difficulties of scale due to remaining obstacles in the EU's single market. This has implications for the way enterprises (including those supported by venture capital investors) shape AI models and applications. The scarcity of experts in the field makes it more likely that they are employed by larger enterprises, thus driving the concentration of talent away from the EU.

The widespread adoption of AI by enterprises is therefore a key instrument for maintaining the EU's competitiveness. The Digital Decade Policy Programme therefore contains a goal that 75% of EU enterprises should adopt AI technologies.

State of play and progress towards the Digital Decade target

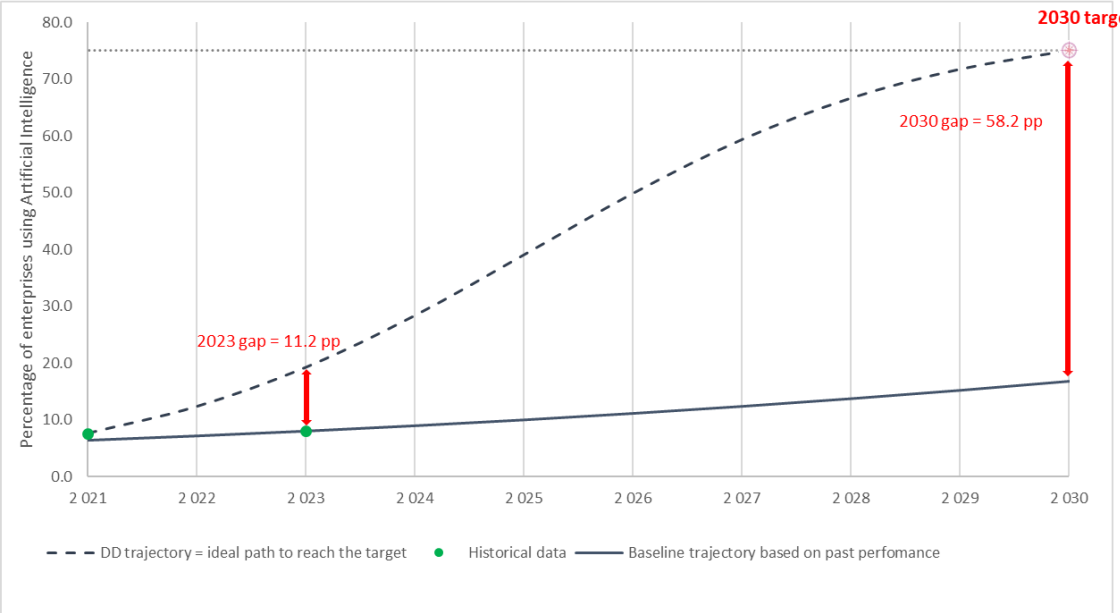
Progress towards the AI adoption target is measured as the percentage of enterprises using at least one AI technology, such as text mining; speech recognition; natural language generation; image recognition and processing; machine learning (e.g., deep learning) for data analysis; AI-based software robotic process automation; or autonomous robots, self-driving vehicles and autonomous drones.

The percentage of enterprises using AI changed little, increasing by a mere 2.6% on average in 2 years from 7.6% in 2021 ([231]) to 8.0% in 2023.

The gap between the observed KPI value and the ideal value that the KPI should have had in 2023 (in order to achieve the target) is above 11 percentage points. Annual progress of nearly 30% is required to reach the 2030 target. It is estimated that this gap will increase to almost 60 points by 2030 in the 'business as usual' scenario. In other words, the updated trajectory shows that under 17% of enterprises are expected to take up AI by 2030 if no further action is taken.

([229]) https://pitchbook.com/news/reports/2023-annual-european-venture-report; World Economic Forum, Global Risks Report 2024, https://www.weforum.org/publications/global-risks-report-2024, p. 50 on AI.
([230]) https://www.orrick.com/en/Insights/2024/03/Deal-Flow-4-5-Things-We-Learned-About-European-Tech-Deal-Terms-in-2023; https://pitchbook.com/news/reports/2023-annual-european-venture-report.
([231]) At the end of 2023, Eurostat published a retrospective revision of the 2021 figures on AI take-up. The EU average was also revised from 7.9% to 7.6%.

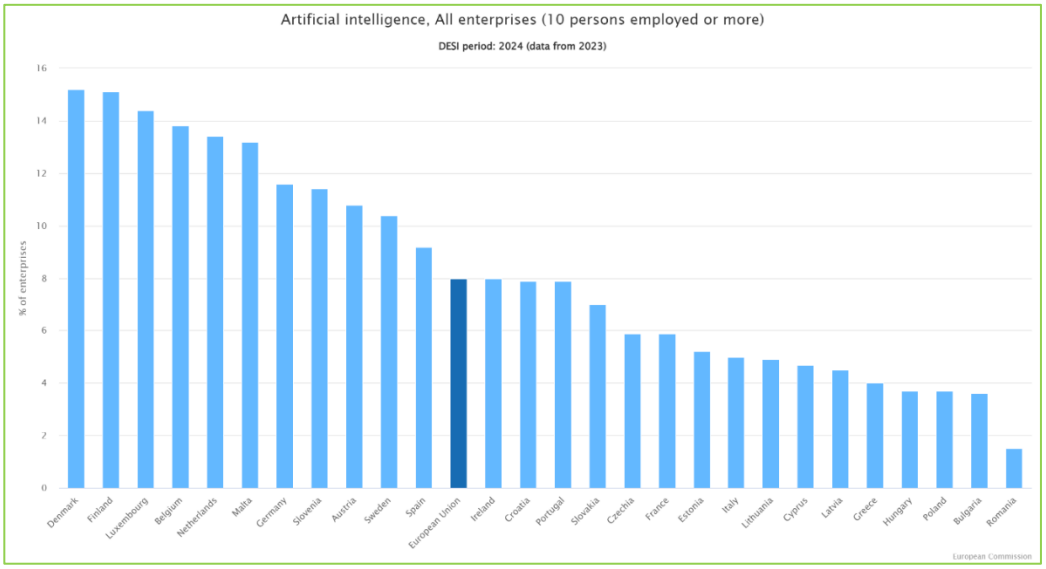
Figure 37. Percentage of enterprises using AI in the EU. Historical data, Digital Decade (DD) trajectory and revised baseline trajectory towards 2030 (same speed of diffusion parameter as in the big data baseline trajectory established in the 2023 Communication on EU-level trajectories)



Source: European Commission

Figure 37 shows the Digital Decade and revised baseline trajectories for the percentage of firms using AI. It shows significant discrepancies between Member States when it comes to the percentage of firms. Figures range from above 15% in Denmark and Finland to 1.5% in Romania.

Figure 38. Percentage of enterprises using AI in the EU. Historical data, Digital Decade (DD) trajectory and revised baseline trajectory towards 2030



Source: European Commission

EU and Member State measures

The development of a **European AI ecosystem of excellence** has been one of the Commission´s main political priorities. Following the coordinated plan on AI, in 2020 the Commission launched a white paper on AI that focused as one key topic on the creation of an AI ecosystem of excellence. The public consultation which following led to the revision

of the coordinated plan on AI in April 2021 which sets out how the EU and Member States could cooperate to promote AI development in the EU.

A further series of EU legal initiatives has followed, with **the Open Data Directive, the Data Act and the Data Governance Act** to a create a true single market for data. This is an essential prerequisite for AI.

In parallel and following the creation of **the EuroHPC Joint Undertaking**, the EU has created a world-class public network of interconnected supercomputers located throughout the EU and is at the forefront of supercomputing globally. Three of these supercomputers are currently among the top ten in the world. Two new exascale supercomputers will be installed respectively in 2024 and 2025. Many of them have or will have **accelerated partitions that are very suitable for running AI training and AI application tasks.**

More recently, the EU launched the **AI innovation package** on 24 January 2024 to enable the creation of **AI factories**. These are open ecosystems formed around EU public supercomputers and bringing together AI-dedicated supercomputers, associated data centres (nearby or connected via high-speed networks) and the corresponding human capital. Moreover, the Large AI Grand Challenge was launched in November 2023 to reward AI start-ups that are developing the best models with financial and computing power support.

The **European Digital Infrastructure Consortia** is another new tool for the successful cooperation of Member States. One of the first applications of this new instrument is the **Alliance for Language Technologies European Digital Infrastructure Consortium (ALT-EDIC)**, which was officially set up in February 2024 and which has attracted great interest from Member States. ALT-EDIC will provide centralised access to language resources for the development of EU generative AI large language models, offering valuable tools (particularly for Member States with limited language data).

To support businesses (SMEs) as well as the public sector, CNECT has made available **AI-based language technology tools** available free of charge through the https://language-tools.ec.europa.eu/ portal. In addition to eTranslation (the Commission's own automated translation tool, which is available in over 30 languages), the package of available tools includes speech-to-text transcription, automated briefing and summarisation tools, named entity recognition, and anonymisation support. In addition, automated website translation plug-ins are available from the Commission's github, with further tools in development.

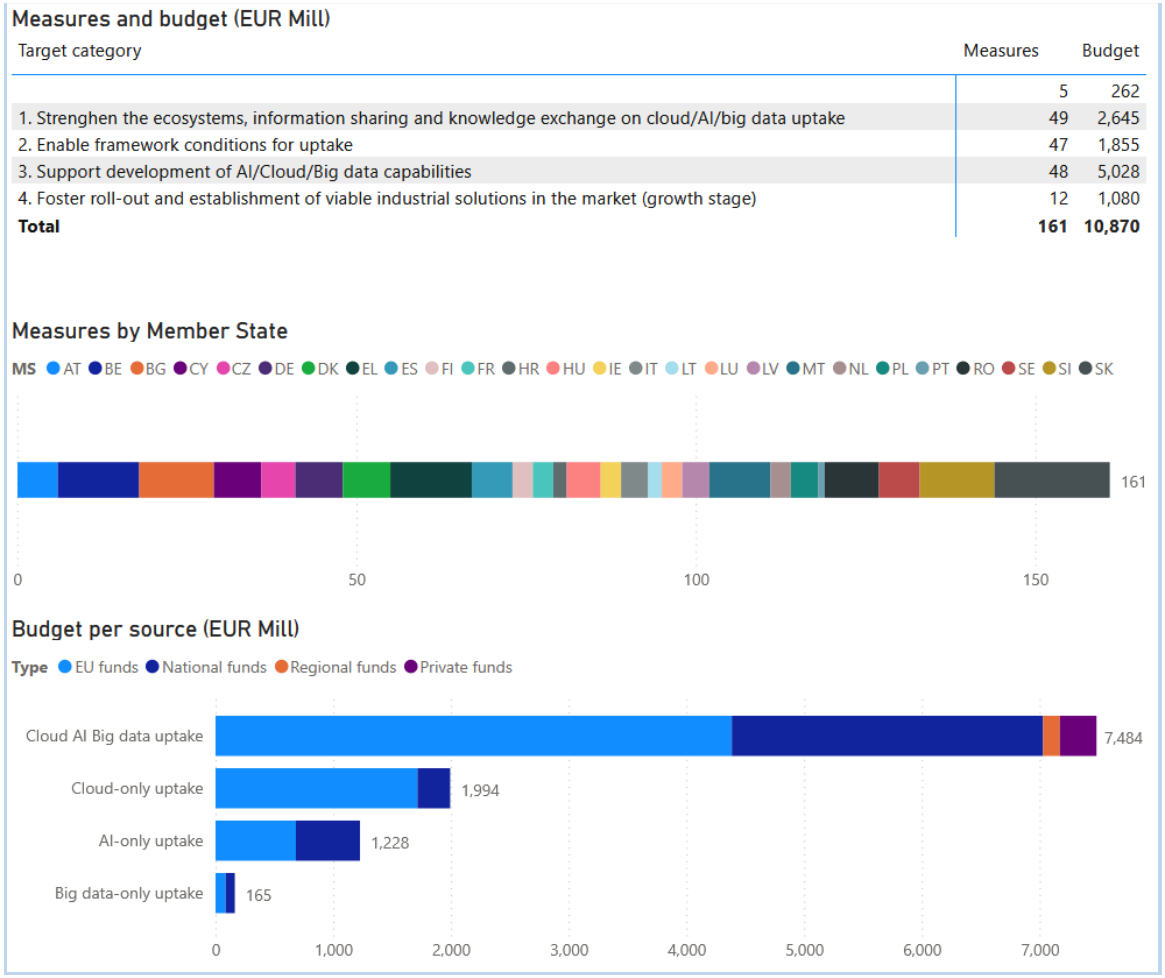
In 2023, eTranslation produced nearly 200 million translated pages for a wide variety of needs, bringing multilingual content and understanding at a scale and speed that only AI solutions can allow.

Support for take-up of AI in the national Digital Decade strategic roadmaps ([232])

25 Member States have provided a trajectory for the take-up of the cloud computing services, big data or AI target, which is that at least 75% of EU enterprises have taken up at least one of the following three technologies: cloud computing services, big data or

([232]) This analysis only takes account of elements reported by the Member States in their national roadmaps. The measures reported by the Member States were grouped into categories to provide a better overview of the types of measures taken.

AI. **Considering AI alone, nine Member States have assumed a national target value below 75%, while Denmark has assumed a national target value above 75%.**



Concluding remarks and future challenges

Following the official adoption of the AI Act, there needs to be a focus on its implementation. The most visible aspect is the expansion of the European AI Office and the adoption of the guidance documents that are foreseen in the AI Act. However, there are also several tasks for Member States, which have to designate the competent authorities and build up the necessary expertise. In parallel, it will be important to follow up on the generative AI package of 24 January 2024, swiftly roll out the AI factories, and make the GenAIForEU concept operational in order to encourage the development and deployment of the latest generation of AI in the EU.

3.3.1.4. Take-up of data analytics

Data are reshaping the way we produce, consume and live. It is the basis for creating many innovative products and services, driving productivity and resource efficiency gains across all sectors of the economy. Above all, data are the fuel for training and improving AI algorithms and is an essential driver for innovation in AI. The benefits of data touch upon every aspect of our lives, ranging from more sustainable energy production and use to healthier lives and better healthcare.

The Commission has therefore put forward a European Strategy for Data in order to create a solid data-driven economy. The strategy sets out a path to the creation of a genuine single

market for data in which both personal and non-personal data (including sensitive business data) will be able to flow across borders and sectors – seamlessly, safely, securely and in line with EU rules and values – for the benefit of EU businesses (particularly AI innovators) and citizens. This will enable the EU to become a leading role model for a society empowered by data to make better decisions in business and the public sector.

The Digital Decade policy programmes contains an aim that 75% of EU enterprises will have adopted big data by 2030.

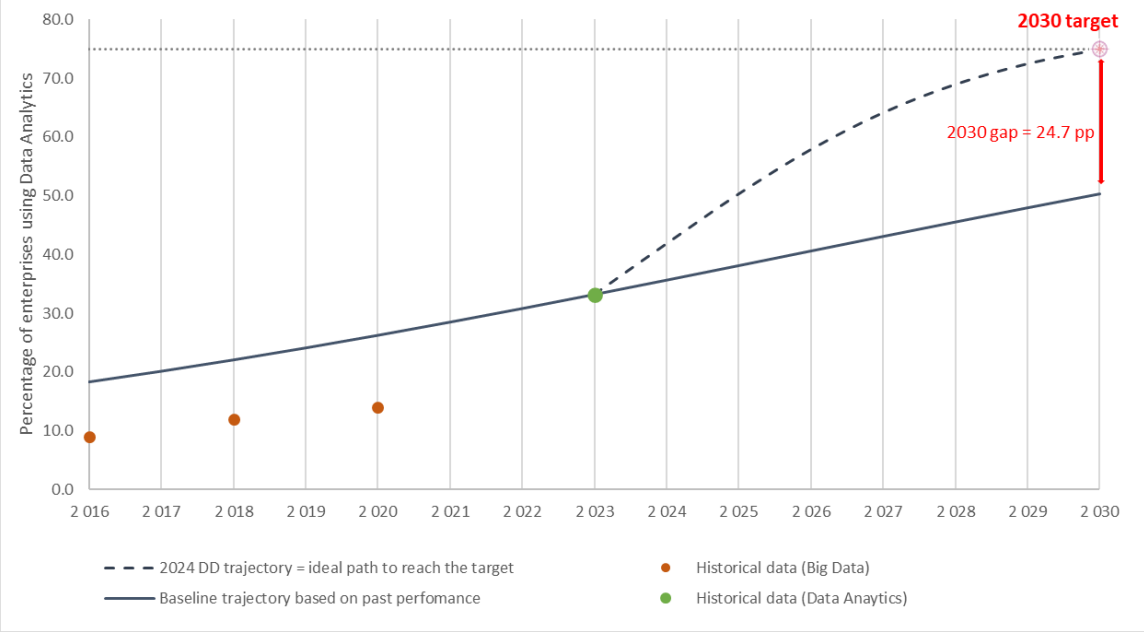
State of play and progress towards the Digital Decade target

Progress towards the Digital Decade target for the adoption of big data is by the percentage of enterprises analysing big data from any data source (internal or external). More precisely, it relates to the use of technologies, techniques or software tools for analysing data to extract patterns, trends and insights in order to draw conclusions, and make predictions and better decisions with the aim of improving performance (e.g., increasing production and reducing costs). Data may be extracted from an enterprise's internal data source or from external sources (e.g., suppliers, customers and the public administration).

33.2% of enterprises were using data analytics in 2023. This indicator only started to be used in 2023, so a new Digital Decade trajectory was established for data analytics with the 2023 value of 33.2% as the baseline.

The estimated 2030 value in the 'business as usual' scenario the 2030 forecast projected along the baseline trajectory is 50.3%, 25 points below the 2030 target. The implication is that efforts will have to be intensified and the rate of progress accelerated if the target is to be met.

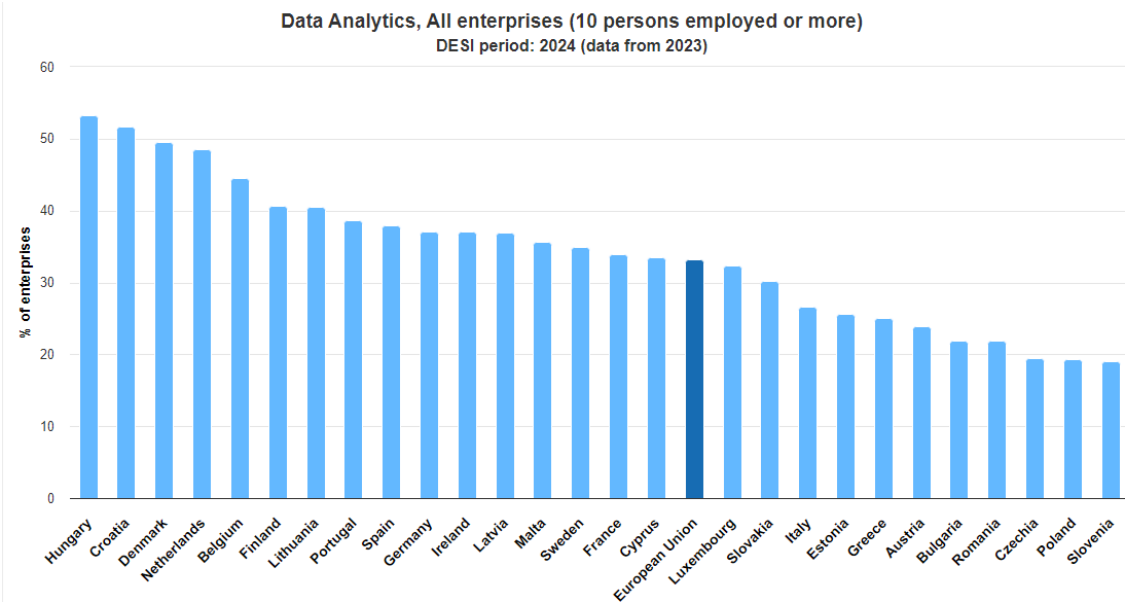
Figure 39. Share of enterprises using data analytics in the EU. Historical data, Digital Decade (DD) trajectory and baseline trajectory towards 2030



Source: European Commission

However, the current (2023) adoption rate varies greatly across the EU. More than 50% of the enterprises in Hungary and Croatia use data analytics, but less than 20% in Czechia, Poland and Slovenia.

Figure 40. Data analytics



Source: European Commission

More broadly, the latest figures ([233]) indicate that the **value of the EU data economy increased from EUR 497.8 billion in 2022 to EUR 544.1 billion in 2023 (4.2% of EU GDP)**. In a baseline scenario, the value of the EU-27's data economy will increase to **EUR 851.5 billion by 2030** (5.8% of the overall EU GDP).

The EU-27's data economy employed around **7.66 million data professionals in 2023** (4.3% of total employment). **By 2030**, it is estimated under the same baseline scenario that the number of data professionals will **increase to 9.9 million**, with a compound average growth rate (CAGR) of 3.5% in 2025-2030.

In 2022, there were 218 340 data companies in the EU-27. This rose to **238 325 data companies in 2023** due to a year-on-year growth rate of 9.2%. Data companies are expected to grow at a CAGR of 3.4% in 2025-2030, increasing to a total of **316 889 in 2030.**

The 2023 Open Data Maturity Report ([234]) found that the EU-27 improved their **average open data maturity** score by 4pp, increasing from 79% in 2022 to **83% in 2023**.

EU and Member State measures

The **European Data Strategy** of February 2020 set out a vision of an EU single market for data in which data can flow freely across borders and sectors while fully complying with the relevant EU rules and values.

In order to realise this vision, the strategy laid the foundations of common **European data spaces** in strategic economic sectors and domains of public interest for the EU as a whole. These concern agriculture, cultural heritage, energy, finance, the Green Deal, health, languages, manufacturing, media, mobility, public administration, research & innovation – EOSC, skills and tourism.

([233]) European Data Market Study (Update October 2023).
([234]) data.europa.eu.

The strategy also announced two new legal acts to complete the horizontal legislative framework and facilitate data-sharing for the benefit of society and economy, with a special focus on businesses across the EU. The first is the **Data Governance Act** ([235]), which has applied since 24 September 2023. It increases trust in voluntary data-sharing and strengthens mechanisms to increase data availability and overcome technical obstacles to the reuse of data. The second is the **Data Act,** which entered into force on 11 January 2024 and will apply from 12 September 2025. It complements the Data Governance Act by clarifying rights to access and use data with the objective of ensuring fairness in the data economy.

National actors play a key role in making the EU-level regulatory toolbox work in practice and benefit the widest possible range and number of beneficiaries in the Member States. They are also instrumental in making the common EU data spaces work in each Member State, so that the EU single market for data foreseen in the Data Strategy can become a reality in the medium term.

The policy actions are underpinned by a number of measures, including **investment in data infrastructures and data research and innovation, via the Digital Europe and Horizon Europe Programmes**. Overall, some EUR 350 million has already been invested in EU funding and another EUR 300 million in additional investment is planned.

Within the Digital Europe Programme, the focus is on the common EU data spaces and the successful exploitation of high-value datasets, the fostering of data-sharing and the development of an EU data infrastructure. Highlights are the various coordination and support measures that are laying the basis for sector-specific or domain-specific data spaces, and the establishment of the Data Spaces Support Centre. The Centre has an essential coordination role, managing the network of stakeholders, ensuring alignment of and interoperability across all data spaces and maximising their industrial and societal impact. With the finalisation of these preparatory actions, the focus is now (and will remain in the coming years) on supporting concrete deployment measures of the sector-or domain-specific data spaces.

Data spaces for manufacturing as an example of a digital driver for industry

- The manufacturing domain has already experimented with the value that data-driven and AI-enhanced manufacturing can leverage in terms of improved engineering, planning, production and maintenance performance, with predictive maintenance as a low-lying fruit. 40% of all data on the internet will soon be machine data and (generative) AI will strongly depend on this type of sensitive data. 55% of industry complains of the high cost of licensing reliable data sets from third parties. 49% of the industry finds data-contracting requirements for licensing data from third parties very challenging and too diverse. 54% of industry cannot get timely and reliable industrial data sets. 50% has difficulty in finding the right data products and blending them with internal deep data. However, data centralisation is not working either. Gartner reveals that data lake implementations for 80% of the industry are nothing more than a data swap.

([235]) Regulation (EU) 2022/868 of the European Parliament and of the Council of 30 May 2022 on European data governance and amending Regulation (EU) 2018/1724 (Data Governance Act), OJ L 152, 3.6.2022, p. 1.

- Data spaces build a unique instrument to harmonise and uplift the value of industrial data. The recent deployment of data spaces for manufacturing provides a natural data infrastructure for data exchange and establishes the necessary trust between manufacturing and industrial-service companies, with controlled and limited data access.
- Two projects were launched on industrial-asset management and predictive maintenance at the end of 2023, and a call is open for supply chains. Data spaces will enable greater traceability on data usage and provide the capacity needed to develop (Generative) AI algorithms more responsibly. Several EU Member States have also recently launched such initiatives (focusing more on industrial data), and several have understood the need to work with industry. It is clearly becoming a priority to join up national initiatives at EU level and to target more use cases involving EU supply chains, setting a rapid expansion of the user base.
- Data spaces for manufacturing therefore play a key role in the digitalisation of businesses and involve an increased use of data and AI (and indirectly the cloud) by industry.

Through Horizon Europe, the Commission has established a partnership with the AI, Data and Robotics Association (ADRA), raising EUR 2.6 billion of public and private investment for technological development. ADRA brings together major industrial stakeholders in the field of AI, data and robotics. Within the programme, funded projects focus on data mining, analytics, secure and privacy-compliant data management, and technologies that supporting the data spaces and data economy (e.g., models for data marketplaces and data monetisation). Other projects address topics as diverse as networks of excellence in Safe AI, AI for the Green Deal and tackling biases in AI.

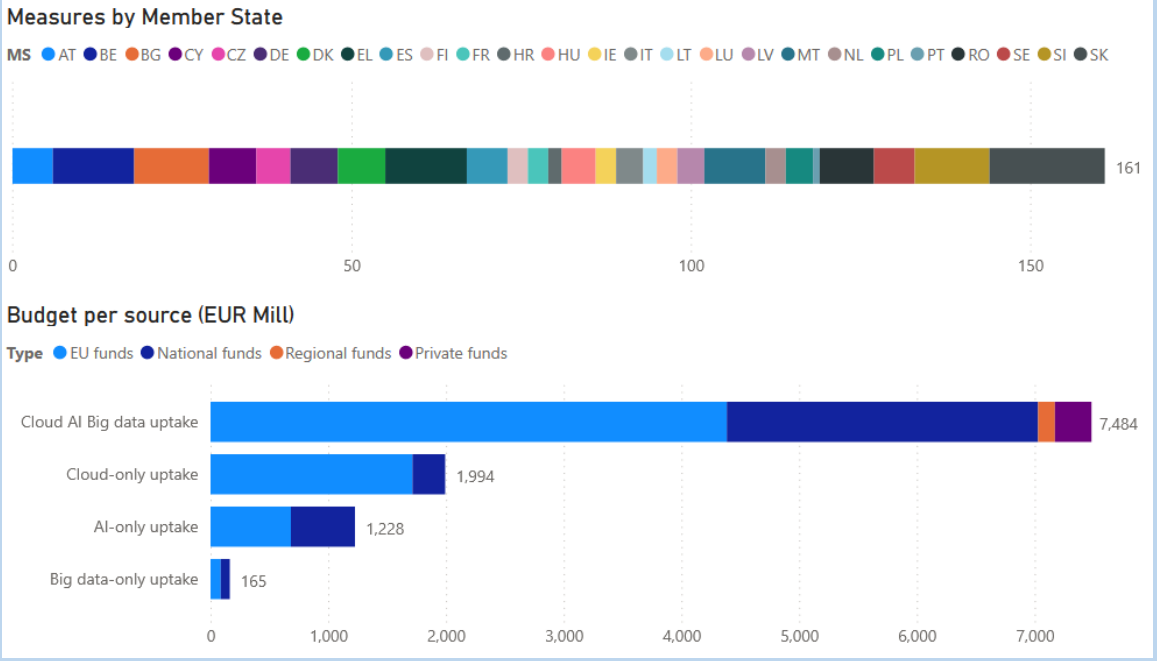
Support for the take-up of big data in the national Digital Decade strategic roadmaps ([236])

25 Member States provided a trajectory for the take-up of the cloud computing services, big data or AI target, which is that at least 75% of EU enterprises will have taken up at least one of the following three technologies: cloud computing services, big data or AI. Considering **big data separately, 10 Member States assumed a target value below 75%.**

([236]) This analysis only takes account of elements reported by the Member States in their national roadmaps. The measures reported by the Member States were grouped into categories to provide a better overview of the types of measures taken.

Measures and budget (EUR Mill)

Target category	Measures	Budget
	5	262
1. Strenghen the ecosystems, information sharing and knowledge exchange on cloud/AI/big data uptake	49	2,645
2. Enable framework conditions for uptake	47	1,855
3. Support development of AI/Cloud/Big data capabilities	48	5,028
4. Foster roll-out and establishment of viable industrial solutions in the market (growth stage)	12	1,080
Total	**161**	**10,870**



Concluding remarks and future challenges

The challenge in the years to come will be to swiftly implement the European Data Strategy in all its components. This means that Member States and stakeholders will need to fully apply the provisions of the Data Governance Act and Data Act, to create legal certainty and ensure a secure and fair legal framework for the data economy. Furthermore, stakeholders will need to focus on the concrete deployment and interconnection of the common EU data spaces, which will lead to an internal data market with more data availability and, ultimately, more data-driven innovation and policies.

3.3.2. Scaling up innovative enterprises

Scale is clearly an essential enabler in today's digital economy. The ability to deliver the framework conditions that allow companies to scale up – and scale up fast – is vital to the EU's strategic interest. As explained at the start of this chapter, the EU is under-performing several other key global regions when it comes to scaling up cutting-edge tech and digital companies. A well-established indicator of an economy's ability to support and nurture companies that can scale up is the number of unicorns (companies that have scaled to market value of over USD 1 billion) that emerge.

In this context, one of the targets of the Digital Decade policy programme is for the EU to facilitate the growth of its innovative scale-ups and improve their access to finance, so that the number of unicorns at least doubles. Recent years have seen the rapid growth of EU companies (e.g., Bolt, Northvolt, MistralAI, Aleph Alpha and Doctolib). The recent rise of

these unicorns has demonstrated that the Silicon Valley model is not the only viable growth model.

However, the EU is currently home to only approximately 13% of the world's unicorns ([237]). At the start of 2023 there were 249 unicorns headquartered in the EU countries, compared with 1 440 in the US and 330 in China ([238]). EU companies are too often bought by larger companies – many headquartered outside the EU – before they reach unicorn status. EU businesses continue to experience difficulties in scaling up due, for example, to challenges in raising growth capital, especially 'big ticket' funding rounds (notably Series C and later). This situation did not improve in 2023, which saw a cooling in private capital markets not just in the EU but around the world. In addition, some obstacles to the EU's single market still remain.

The EU has nevertheless seen a growing 'response' to the US market's 'Magnificent Seven'. Goldman Sachs has coined the term 'granolas' to refer to a select group of European heavyweights that includes GSK, Roche, ASML, Nestlé, Novartis, Novo Nordisk, L'Oréal, LVMH, AstraZeneca, SAP and Sanofi. Their combined market capitalisation exceeds EUR 2.6 trillion and reflects the prowess of Europe's finest on the global markets ([239]). However, of the 50 largest ICT companies in the world by market capitalisation, only three – ASML, SAP and Schneider – are EU-based ([240]). About 25% of global growth in innovation spending is coming from just 10 companies, of which 7 are technology firms based in the US ([241]).

The EU's single market is comparable with the size of the US and Chinese economies (about USD 21 trillion compared with USD 25 trillion and USD 18 trillion respectively in 2022). However, when comparing companies with more than USD 1 billion in revenue, US firms spent 80% more on R&D. China spends 2% to 5% of GDP on industrial policy, compared with the EU's 1%. In December 2023, the EU approved up to EUR 1.2 billion of aid over 8 years for cloud computing-related R&D ([242]), but this is only 4% of what Amazon's cloud division invests every year ([243]).

In 2022, EU companies accounted for less than 4% of the market capitalisation of the world's 70 largest platforms. The US's share was 73% ([244]).

State of play and progress towards the Digital Decade target

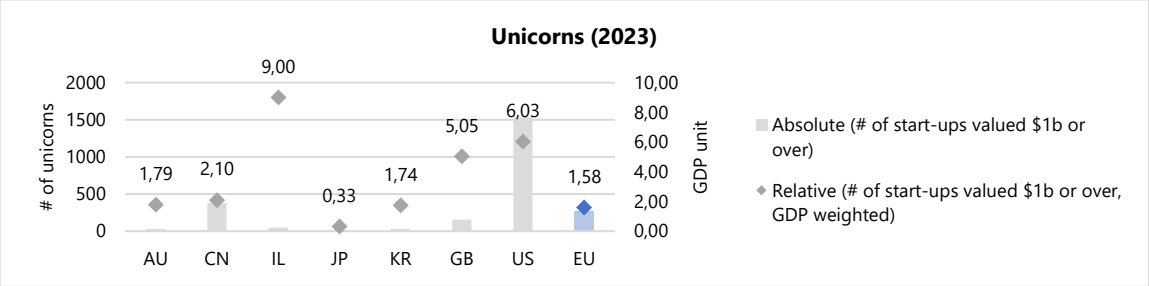
At the end of 2023, there were 263 unicorns in the EU. This was a 5.2% increase on 2022 (there were 249 unicorns at the end of 2022). In percentage and absolute terms, this was significantly less than the annual growth in the number of EU unicorns recorded in 2020 (~30% increase) and 2021 (~62%). Fewer unicorns were created in the EU in 2023 than in

([237]) https://www.economist.com/business/2022/07/04/how-sturdy-are-europes-tech-unicorns – data from PitchBook.
([238]) https://ec.europa.eu/commission/presscorner/detail/fr/ip_23_4619.
([239]) https://www.euronews.com/business/2024/02/13/who-are-the-granolas-a-look-at-europes-magnificent-eleven-stocks.
([240]) https://companiesmarketcap.com/tech/largest-tech-companies-by-market-cap/.
([241]) European Commission, 2023 Industrial Research and Development Scoreboard: https://publications.jrc.ec.europa.eu/repository/handle/JRC135576.
([242]) https://digital-strategy.ec.europa.eu/en/news/commission-approves-eu12-billion-state-aid-seven-member-states-important-project-common-european.
([243]) https://www.mckinsey.com/mgi/our-research/accelerating-europe-competitiveness-for-a-new-era.
([244]) https://www.economist.com/business/2020/02/20/the-EU-wants-to-set-the-rules-for-the-world-of-technology.

any year since 2017 because valuations contracted for start-ups. The valuation boom that characterised the 'COVID-19 times' of 2020, 2021 and 2022 has come to a halt.

This slowdown is aligned with the global squeeze in private capital markets experienced throughout 2023. The EU's performance in percentage terms for annual growth at the end of 2023 was similar to – but slightly lagging behind – that seen in the USA in 2023 (6.6% growth). It is notable that both the USA and the EU were lagging behind China (2023 saw the number of Chinese unicorns grow by 17%).

Figure 41. Unicorns in 2023

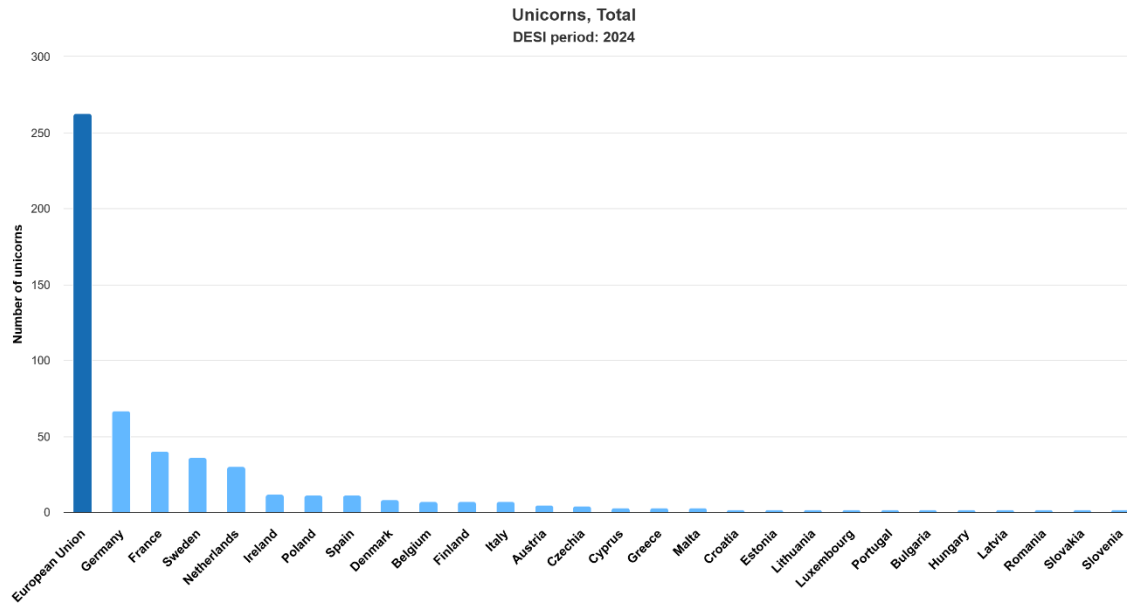


Source: European Commission

The difference in absolute numbers of EU headquartered unicorns compared with other key countries remains stark at the end of 2023: 263 in the EU, 387 in China and 1 539 in the USA. This underlines the need for focused action at both EU and national levels, if the 2030 Digital Decade target of 500 unicorns in the EU is to be met and to ensure sustained growth beyond 2030.

Figure 42 shows the number of unicorns per Member States and highlights great discrepancies.

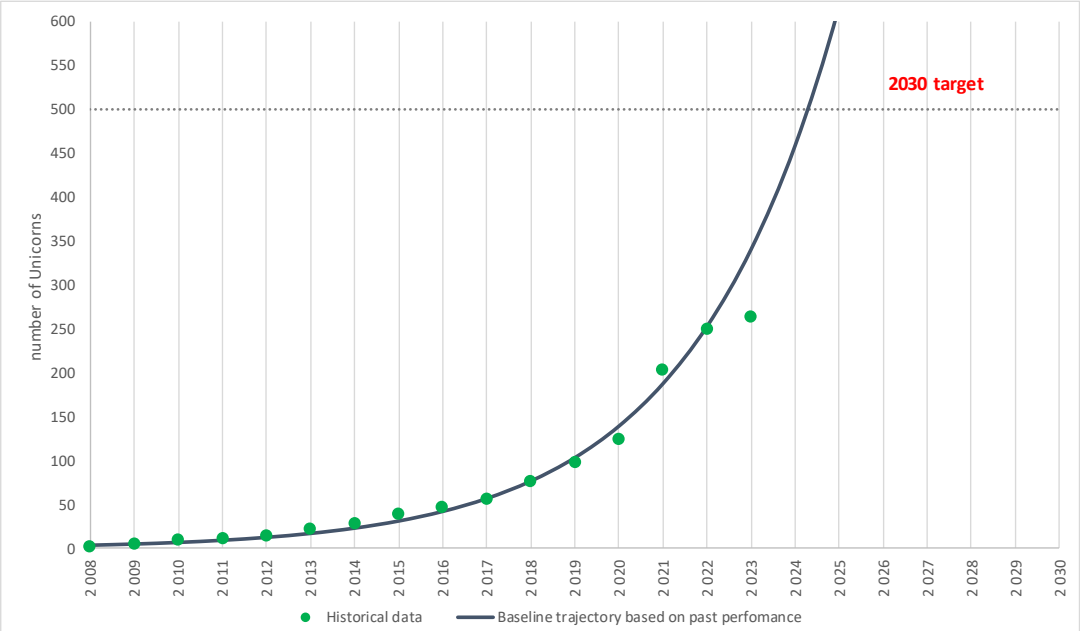
Figure 42. Number of unicorns per EU Member State, 2024



Source: European Commission

It should nevertheless be noted that, despite the clear slowdown in 2023, the exponential trend is still the most appropriate way to capture the historical trend; and that the level of 500 unicorns is expected to be reached by the end of 2025, so well before 2030.

Figure 43. Annual growth in the number of unicorns



Source: European Commission

EU and Member State measures

The **European Innovation Council (EIC)**, which was launched under the EU's Horizon Europe programme, has a budget of EUR 10.1 billion for 2021-2027 to support game-changing innovations. It is particularly focused on financing start-ups and SMEs, and using its public funding to crowd in investments from private investors.

The **European Tech Champions Initiative (ETCI)** was launched in February 2023 by five Member States (Belgium, Germany, Spain, France and Italy) and the EIB Group. ETCI is a new fund of funds that aims to plug financing gaps and thus reinforce the EU's strategic autonomy and competitiveness. By the time of its launch, it had secured initial commitments of EUR 3.75 billion from its launch countries and the EIB Group. It is open to adhesion by other EU Member States.

In March 2021, the Commission launched the **EU Startup Nations Standard**, which outlined best policy practices across eight areas. These practices are hallmarks of a growth-friendly environment for startups. Ministers in 26 EU Member States have endorsed this initiative and the best practices it advocates. The **Europe Startup Nations Alliance (ESNA**) was established at the end of 2021 as the implementation body of the EU Startup Nations Standard. In 2023 the number of Member States that were formal members of ESNA doubled from 9 to 18. This increase reflects the growing commitment of Member States to implement, under national competencies, best policy practices for start-ups and scale-ups.

In 2023, considerable progress was made in the EU in establishing **a robust regulatory environment for the digital sector**. Several flagship acts of regulatory legislation that give legal clarity to start-ups while also aiming to level the playing field, were either finalised (the AI Act) or started to be applicable (e.g., the DMA and the DSA).

Support for unicorns and innovative scale-ups in the national Digital Decade strategic roadmaps ([245])

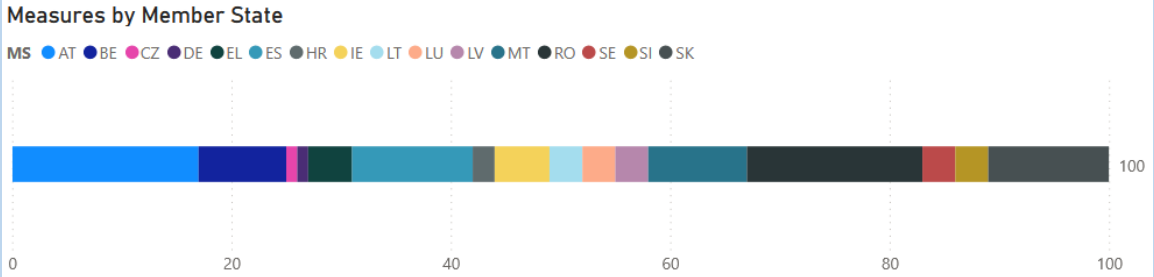
15 Member States have provided a trajectory for the unicorns and innovative scale-ups target, which is to facilitate the growth of innovative scale-ups and improve their access to finance, leading to at least a doubling in the number of unicorns.

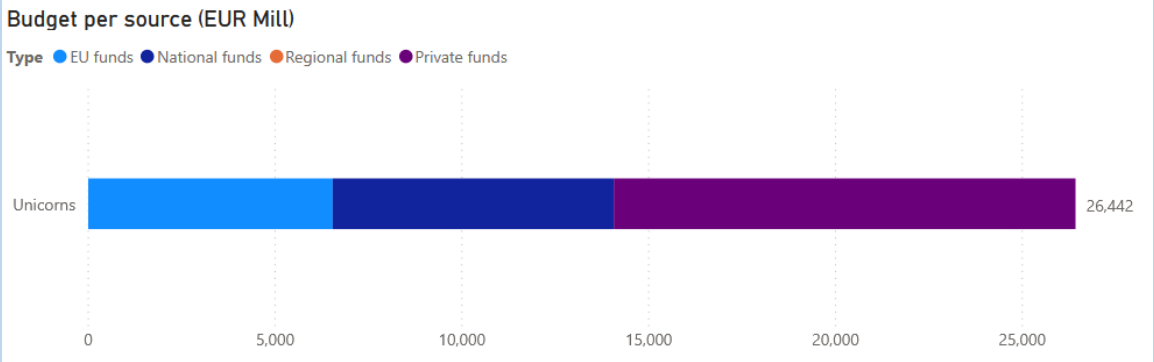
The Member States have reported a total of **100 measures (with a total budget of EUR 26.4 billion) to help achieve the unicorns and innovative scale-ups target**. Around 25% of this budget comes from EU sources, around 28% from national budget and 47% come from private industry. The roadmaps include a considerable number of new impulses: **around 20% of the reported measures are new – with a very considerable budget share of around 75%.**

The largest share of the measures (around 40%) focuses on access to finance, including new funding opportunities adapted to the different unicorns/scale-up life cycles. Around 30% of the measures foster technology transfer, incubation, spin-offs, spin-outs and start-up ecosystems. Another 30% of the measures support framework conditions and regulation for start-ups, including relevant strategies and creating a framework for the promotion of innovation activities.

Measures and budget (EUR Mill)

Target category	Measures	Budget
1. Access to finance	40	24,780
2. Framework conditions- regulation for start ups	29	260
3. Foster technology transfer, incubation, spin offs, spin outs, start-ups ecosystems and Digital Innovation Hubs	31	1,402
Total	**100**	**26,442**





([245]) This analysis only takes account of elements reported by the Member States in their national roadmaps. The measures reported by the Member States were grouped into categories to provide a better overview of the types of measures taken.

Concluding remarks and future challenges

Lack of private capital for EU start-ups that are scaling up from EU-based investors. This forces many EU-27 start-ups to seek growth capital from non-EU (especially US) venture capital investors. Many of those securing growth capital from outside the EU also end up moving their corporate HQ out of the EU.

Established best policy practices that are hallmarks of a growth-friendly environment for start-ups (e.g., in areas such as talent, access to finance and fiscal treatment of stock options) have not been uniformly implemented across EU Member States.

Suboptimal linkages of outputs of the EU's research and innovation programmes with national programmes. National and regional programmes can be key to providing timely and targeted funding and support for a country's leading innovators who have, with EU-funding, developed breakthroughs that demonstrate market potential.

There are opportunities to enrich the pipeline of potential future unicorns by focusing on policies and actions that support and stimulate the generation of spin-offs from EU universities. There is great variation between the Member States in their focus on supporting research centres and universities in the accelerating the number of spin-offs created.

3.4. Strengthening cybersecurity

Cybersecurity is integral to all types of digitisation, especially when it comes to economic and data security.

Today's cybersecurity landscape is characterised by increasing complexity due to unprecedented technological advancements such as generative AI. The current security environment in Europe, (including Russia's military aggression against Ukraine) and the current electoral year in Europe, have brought cybersecurity concerns to a higher level.

In this cybersecurity context, it is imperative to increase efforts to deliver an effective cybersecurity policy to boost the resilience of the EU's critical infrastructure (the NIS2 Directive and the 5G Toolbox); reinforce the security of products and supply chains (the Cyber Resilience Act and certification provisions set out in the Cybersecurity Act); strengthen cooperation at EU level; enhance capabilities to better detect, prepare for and respond to cybersecurity threats and incidents (Cyber Solidarity Act); take decisive steps to close the gap on cybersecurity skills in the EU (Cybersecurity Skills Academy); and increase cooperation across the EU and with like-minded non-EU countries.

To ensure the resilience of the EU and minding the shortage of cybersecurity skilled professionals, it is important to have close cooperation among stakeholders, including in the public sector, the private sector and academia.

State of play

An EU report on the cybersecurity and resilience of the EU's communications infrastructure and networks identified a number of threats to communication networks and infrastructure, including ransomware, supply chain and physical attacks, and sabotage of

digital infrastructure ([246]). According to ENISA's annual Threat Landscape, cyberattacks and extorsion operations were on the rise in 2023. Ransomware groups are not only targeting corporations but also government agencies and critical infrastructures for geopolitical reasons. ENISA recorded more than 2 500 cyber incidents from July 2022 to June 2023. 220 of these specifically targeted two or more EU countries ([247]). Public administrations and health were the top targets at 19% and 8%, while 6% of all hacks targeted the manufacturing, transport and financial sectors.

Hacktivism (mostly through denial distribution of service attacks) and ransomware are the most important of the main threats faced by EU entities. Ransomware attacks involve locking access to files from the targeted entities. Cyber espionage operations continue to target the EU, particularly government, military, critical infrastructure and foreign affairs entities.

2023 saw the entry into force of the ambitious **NIS2 Directive**, which has revised the previous framework that had been in place since 2016. The NIS2 Directive aims to boost cyber reliance across a vast number of sectors and to introduce clearer rules for both national authorities and entities. Among other measures, the NIS2 Directive strengthens and streamlines security and reporting requirements for companies by requiring use of a risk management approach that provides a minimum list of basic security elements that must be applied. The Directive introduces more precise provisions on the process for incident reporting, content of incident reports and timelines. It makes the entities' top management accountable for non-compliance with cybersecurity risk management measures and places particular importance on supply chain security. It requires entities to address cybersecurity risks in their supply chains and supplier relationships. At EU level, the Directive strengthens supply chain cybersecurity for key information and communication technologies. Member States may, in cooperation with the Commission and ENISA, carry out EU-level coordinated security risk assessments of critical supply chains. The NIS2 Directive has to be transposed by the Member States into national law by 17 October 2024.

At the beginning of 2024, the Commission adopted the **first-ever EU cybersecurity certification scheme**, in line with the EU Cybersecurity Act **and the Union Rolling Work Programme**. The scheme offers an EU-wide set of rules and procedures on how to certify ICT products in their life cycle and thus make them more trustworthy for users. The voluntary scheme complements the Cyber Resilience Act that introduces binding cybersecurity requirements for all hardware and software products in the EU. This major step promotes the EU's global digital leadership. The scheme will also boost the implementation of the NIS2 Directive. ENISA is working with industry and other stakeholders on the next candidate schemes (including cloud).

The Commission has also proposed the **Cyber Solidarity Act**, which aims to strengthen solidarity at the EU level in order to better detect, prepare and respond to cybersecurity threats and incidents. The network of national and cross-border hubs would increase detection of cybersecurity threats and incidents by leveraging state-of-the-art technology for advanced data collection and providing real-time situational awareness. The

([246]) https://digital-strategy.ec.europa.eu/en/library/report-cybersecurity-and-resiliency-eu-communications-infrastructures-and-networks.
([247]) ENISA, ENISA Threat Landscape 2023, https://www.enisa.europa.eu/publications/enisa-threat-landscape-2023.

Cybersecurity Emergency Mechanism will enhance preparedness by setting up coordinated preparedness testing and other preparedness actions for important and essential entities to monitor and anticipate risks that would affect the resilience of the digital ecosystem. The Mechanism will also include an EU Cybersecurity Reserve consisting of services from a selected pool of trusted private companies that provide managed security services, such as incident analysis or incident response coordination.

One of the main challenges in achieving the EU's cyber resilience goals is the cybersecurity workforce gap. In 2022, **the shortage of cybersecurity professionals in the EU ranged between 260 000 and 500 000, and was a key problem for the industry**. This shortage puts organisations at moderate to extreme risk of experiencing a cybersecurity attack. In order to boost numbers and have more and better cybersecurity professionals in the EU, the Communication on a **Cybersecurity Skills Academy** was published in April 2023. The Academy provides a single point of entry for cybersecurity training offers as well as funding opportunities and close coordination with key stakeholders (including from the private sector). The Academy is organised under four specific pillars or areas of activity: promoting knowledge generation through education and training; working with stakeholders; building synergies to maximise the impact of spending for developing cybersecurity skills; and developing methods to monitor progress.

EU and Member State measures

The Commission has worked with Member States and ENISA to ensure that **5G networks** deployed throughout the EU are secure and resilient so that all citizens and companies can benefit from them. Starting from a risk assessment on 5G networks to ensure that we have a common understanding of the threats and risks affecting this critical infrastructure, the Commission, Member States and ENISA developed and communicated a set of measures (the EU 5G Cybersecurity Toolbox) to mitigate the identified risks in 2020. 4 years on, the EU Toolbox has had a concrete impact on the ground, but some Member States still need to do more work to effectively mitigate the risks, particularly those related to high-risk suppliers. The Commission has also underlined its strong concerns about the risks to EU security posed by certain 5G suppliers and is working to ensure that its own corporate communications and EU funding activities will not rely on these suppliers.

To complement this work, the Commission and Member States, together with ENISA, have also identified risks in the **Open RAN** architecture, which will in the coming years provide an alternative way of deploying the radio access part of 5G networks based on open interfaces. They have recommended a set of actions to help mitigate these risks and a cautious approach to deploying this new architecture.

More recently and as explained above, a **risk assessment** on the telecommunications sector at large has identified a number of key threats that could pose significant risks for the security and resilience of the connectivity infrastructure. To mitigate these risks, several strategic and technical recommendations for Member States, the Commission and ENISA have been put forward.

In recent years, the EU has faced a rise in **supply chain attacks**. As one action to tackle this problem, the NIS Cooperation Group, in cooperation with the Commission and ENISA, has started developing a toolbox as a common framework to carry out coordinated security risk assessments of critical ICT services, systems and products supply chains. This

work will be completed during 2024 and allow risk assessment of specific critical ICT supply chains.

Building on this, the Commission and the NIS Cooperation Group are, with support from ENISA and the EEAS, **conducting risk assessments and creating a standard cyber risk assessment methodology at EU level** in response to the Council Conclusions on the EU's Cyber Posture of May 2022, with an initial focus on the telecommunications and electricity sectors. Special attention is given to spill-over effects between sectors, which will be taken forward as different sectors will be assessed in the future.

Work is also being carried out on **enhancing preparedness and capabilities in the area managing incidents and crises**.

The **NIS2 Directive** has updated the EU cyber incident response framework and introduced EU-CyCLONe, a network of Member States and the Commission that will ensure the management of large-scale cybersecurity incidents at operational level. The framework strengthens the EU's resilience to cyber threats and ensures a more coordinated and effective response to cyber crises. The Commission is actively involved in organising and participating in various **cyber exercises** to improve cyber incident response. These exercises simulate real-life cyber threats and provide an invaluable opportunity for participants to test and enhance coordination at technical and operational level. The Commission has started the process of developing a cyber situational awareness and analysis centre as part of DG CNECT. This centre will enhance situational awareness and strengthen the collective cyber resilience of EU institutions, bodies and agencies.

Cybersecurity in national Digital Decade strategic roadmaps

Some Member States do include cybersecurity specific measures in their roadmaps. Such measures include cybersecurity-related strategies and action plans, awareness-raising, cybersecurity skills training and protecting critical infrastructures.

Concluding remarks and future challenges

Not all Member States have yet placed **restrictions on high-risk suppliers of 5G networks**, and some Member States are heavily dependent on them. We cannot maintain such a critical dependency in our 5G networks, which will underpin many essential services and is key to our green and digital transitions. The Commission therefore urges those Member States that have not yet implemented the Toolbox to urgently adopt relevant measures recommended in the EU Toolbox in order to quickly and effectively these risks.

On 30 November 2023, the co-legislators reached a political agreement on the forthcoming **EU Cyber Resilience Act (CRA)**, which has been adopted by the European Parliament on 12 March 2024 and will enter into force in the course of 2024. The CRA sets as condition for the placing of hardware and software products on the EU market that they comply with cybersecurity requirements. The CRA is the first regulation of its kind not only in the EU but also internationally. The CRA's provisions include security-by-design obligations for manufacturers of hardware and software products. It acknowledges that manufacturers along the entire supply chain are responsible for security outcomes; and covers not only final consumer or business products (e.g., laptops and operating systems) but also hardware and software components.

Manufacturers will have to comply with the essential requirements of the CRA after a transition period of 3 years from its entry into force. During that transition period, the EU standardisation organisations will be tasked with developing standards to make it easier for manufacturers to comply. The Commission will also adopt delegated and implementing acts as well as guidance to ensure that manufacturers can easily comply with the CRA.

4. PROTECTING AND EMPOWERING EU PEOPLE AND SOCIETY

Digital transformation has become intertwined with nearly every aspect of our life. With the emergence of 'hybrid lives', it is becoming imperative to empower everyone to harness the benefits of digital technologies; protecting people and society; and ensure that digital technologies reinforce rather than undermine fundamental elements of our societies such as the respect of fundamental rights and democracy. In the European Declaration on Digital Rights and Principles for the Digital Decade ([248]), the EU has set out its vision as well as concrete commitments to apply the rights and freedoms enshrined in the EU's legal framework and the EU's values in a digitally transformed world.

This endeavour means **accompanying people in the digital transformation, equipping them with the skills and tools** they need to fully benefit from the digital transformation. This is also a necessary in order to address the **digital divides** that persist due to various factors and reflect (if not exacerbate) existing social inequalities. A number of groups in our society are often faced with low access to digital communications. They include people with low incomes; people with low digital literacy; marginalised communities or minorities such as Roma living in segregated settlements; older people; and persons with disabilities. These groups often lack affordable and accessible devices and internet access; encounter barriers in navigating user interfaces; have no access to secure information; and/or lack locally relevant services in local languages ([249]).

Societal reluctance to adopt new technologies can also be caused by **trust issues** that are driven by safety and security concerns, and fears over the rapid advances of technologies in general. Such concerns cannot be downplayed.

In parallel, **digital technologies, online platforms and their business models** are posing **new challenges**. Both adults and children are exposed to negative experiences such as age-inappropriate content, illegal content, hate speech and disinformation. Specific efforts are also needed to ensure protection from the misuse of personal data or manipulative practices (e.g., dark patterns); ensure effective consumer protection online; and strengthen the transparency of online services (including better information on terms and conditions; and transparency regarding both the systems used for content moderation and the algorithms used for recommending content or products to users).

Online disinformation and misinformation can have significant impacts on our democracies, hindering the ability of citizens to take informed decisions, contributing to polarisation in our societies and challenging democratic processes.

The Digital Decade policy programme clearly calls for the bridging of digital divides and promotes 'human-centred, fundamental-rights based, inclusive, transparent and open digital environments'. This is also an ambition at the core of the European Declaration on Digital Rights and Principles, which complements the Digital Decade Policy Programme

([248]) https://digital-strategy.ec.europa.eu/en/library/european-declaration-digital-rights-and-principles.

([249]) Report on access to essential services in the EU, Commission staff working document, 2023.For example, Roma communities are among the groups flagged in this report. The Staff Working Document accompanying the Roma strategic framework for equality, inclusion and participation for 2020 – 2030 (SWD(2020) 530) also notes that 'remote learning through digital education is most often not accessible and/or affordable for marginalised Roma children, lacking adequate or any IT equipment, and/or internet connection or sometimes, even electricity.' The SWD(2020)530 is available at: https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52020SC0530.

and promotes a digital transformation that puts people at the centre, empowers them and contributes to a fair and inclusive society and economy in the EU ([250]).

This is the background to the Commission's considerable ongoing efforts to accompany and support people in the digital transformation; to build safe digital environments where fundamental rights are protected, and people are placed at the centre; and to protect foundational values of the EU like democracy and freedom of expression.

4.1. Empower people and bring the digital transformation closer to their needs

DD cardinal points and targets: digital skills; digitalisation of public services (key digital public services and eID).

DD objectives: Empowering people (Promoting continuous opportunities for all individuals; Developing digital skills and competences and fostering the development of high-performing digital capacities within horizontal education and training systems); **Bridging divides** (Digital technologies and services accessible to all, everywhere in the EU; Promoting the deployment and the use of digital capabilities with a view to reducing the geographical digital divide); **Public services** (Public services, health and care services are accessible in a trusted and secure online environment for everyone; Offering inclusive, efficient, interoperable and personalised services and tools).

Digital Rights and Principles: Putting people at the centre of the digital transformation; Solidarity and Inclusion (especially digital education, training and skills; connectivity; digital public services online; fair and just working conditions).

This chapter addresses the need to empower people by promoting continuous opportunities for individuals; developing digital skills and competences; and enhancing digital capacities within education and training systems. It also looks at bridging the digital divides, ensuring that digital technologies and services are accessible to all across the EU, emphasising the importance of making public services (including health services) accessible in a trusted and secure online environment for everyone, and of offering inclusive, efficient, interoperable and personalised services and tools.

These objectives are strictly interlinked with the key elements of the European Declaration on Digital Rights and Principles for the Digital Decade. These elements include putting people at the centre of the digital transformation; and promoting solidarity and inclusion (particularly in areas like digital education; public services; and the European Pillar of Social Rights and its Principle 20 on universal access to essential services, including digital communications and Principle 1 on education, training and lifelong learning).

([250]) In particular, the Declaration's Chapter I (Putting people at the centre of the digital transformation) states that 'Technology should serve and benefit all people living in the EU and empower them to pursue their aspirations, in full security and respect for their fundamental rights.' Chapter II (Solidarity and inclusion) equally categorically states that 'Technology should be used to unite, and not divide, people. The digital transformation should contribute to a fair and inclusive society and economy in the EU.'
The Declaration also highlights, inter alia, the need to protect privacy and individual control over data (Chapter V: Safety and security and empowerment); the need to preserve freedom of choice, including in the context of interactions with algorithms and AI systems (Chapter III: freedom of choice); and that 'Access to diverse content contributes to a pluralistic public debate and effective participation in democracy in a non-discriminatory manner.' (Chapter IV: participation in the digital public space).

4.1.1. Equip people with digital skills

4.1.1.1. A digitally skilled population: at least basic and above basic digital skills

The EU is currently grappling with a **significant gap in digital skills**. A considerable portion of the population lacks fundamental skills needed for navigating online platforms and using digital devices. This not only reduces their confidence and ability to fully engage with digital technologies, but also exacerbates the digital divide and prevents digital inclusion. This deficiency **is not exclusive to older demographic groups**. Evidence suggests that a significant portion (30%) of those aged 16-24 years also lack at least basic digital skills (see Figure 47 below), although with notable variances between Member States. In addition, the results of the latest International Computer and Information Literacy Study (ICILS) in 2018 revealed that around one third of eighth graders (i.e., pupils around the age of 13) fell below the basic proficiency level in computer and information literacy ([251]). Gaps in digital skills also exist in terms of formal education level and location as more people in cities tend to have at least basic digital skills (see Figure 46 below).

Moreover, the **evolving job landscape** increasingly requires digital skills ([252]). The COVID-19 pandemic expedited the integration of digital technologies into workplaces following a 'digitalisation push' by companies. Nearly half of adult workers are encountering new digital tools ([253]).

Ensuring equitable access and training of digital skills is therefore crucial in order to **prevent anyone from being left behind in the digital revolution**. This imperative aligns with **Principle 20 of the European Pillar of Social Rights** ([254]), which emphasises universal access to essential services, including digital communications and advocates for support measures for those in need. It also resonates with **Principle 1**, which affirms that everyone has the right to high-quality and inclusive education, training and lifelong learning in order to acquire and maintain skills that enable them to participate fully in society and successfully manage changes in the labour market ([255]). The need to address the digital gap is underscored in the **European Declaration on Digital Rights and Principles for the Digital Decade**, which emphasises everyone's entitlement to education, training, and lifelong learning, as provided for by Article 14 of the Charter of Fundamental Rights of the European Union ([256]).

([251]) ICILS measures the share of students in their 8th year of schooling who perform below the level 2 threshold on the ICILS computer and information literacy achievement scale. More precisely, low achievement in digital skills means that students are unable to use computers to complete basic and explicit information-gathering and management tasks. It is also important to note that this number cannot be considered a meaningful EU-27 average because it refers to the average share of low achievers in the six EU Member States (Denmark, Germany. France, Italy, Luxembourg and Finland) that participated in ICILS 2018. For further information, see Fraillon J., Ainley J., Schulz W., Friedman T. and Duckworth D., *Preparing for Life in a Digital World: International Computer and Information Literacy Study 2018 International Report*, IEA, Amsterdam, 2019.

([252]) According to Cedefop's second European Skills and Job Survey, 87% of adult workers use computing devices at work. For further information, see Cedefop, *Setting Europe on course for a human digital transition: new evidence from Cedefop's second European skills and jobs survey*, Cedefop reference series No 123, Luxembourg, 2022, available at http://data.europa.eu/doi/10.2801/253954.

([253]) Cedefop, *Setting Europe on course for a human digital transition: new evidence from Cedefop's second European skills and jobs survey*, Cedefop reference series No 123, Luxembourg, 2022, available at http://data.europa.eu/doi/10.2801/253954.

([254]) https://ec.europa.eu/social/main.jsp?catId=1606&langId=en.

([255]) Moreover, the Report on access to essential services in the EU, Commission staff working document, 2023, which is one of the deliverables of the European Pillar of Social Rights Action Plan, identifies lack of digital skills as of the main barriers preventing vulnerable groups to access digital communications.

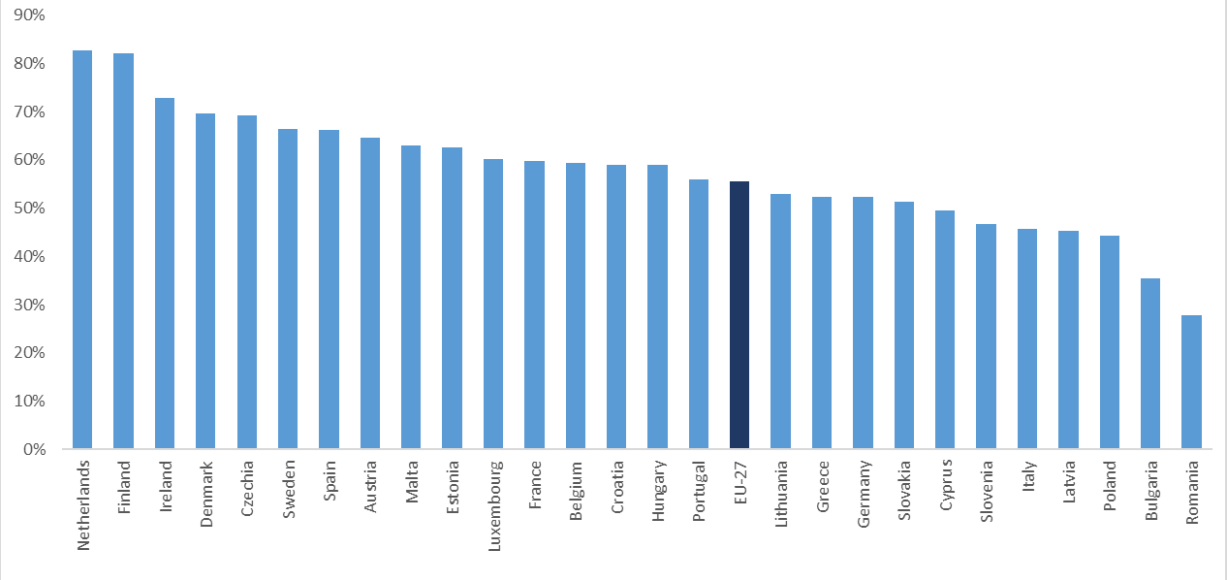
([256]) https://www.europarl.europa.eu/charter/pdf/text_en.pdf.

State of play and progress towards the Digital Decade target

The EU's ambitious **Digital Decade targets**, which are outlined in the Path to the Digital Decade Policy Programme (DDPP) require focused and coordinated action ([257]). One key target in the area of digital skills is to ensure that at least **80% of individuals aged 16-74 possess at least basic digital skills by 2030**. This target is included in the **European Pillar of Social Right Action Plan** ([258]) as a precondition for inclusion and participation in the labour market and society in a digitally transformed EU. This target focusing on individuals aged 16-74 is complemented by a target set within the European Education Area of reducing the proportion of eighth graders who underachieve in computer and information literacy to less than 15% by 2030 ([259]).

In 2023, it was reported that slightly more than 55.6% of EU citizens aged 16-74 possessed at least basic digital skills ([260]). Possessing at least basic digital skills means knowing how to do at least one activity related to each of the following five areas: information and data literacy skills; communication and collaboration skills; digital content creation skills; safety skills; and problem-solving skills. There is a **large variation between the Member States**. The Netherlands and Finland have already reached and surpassed the Digital Decade 2030 target of 80%, some Member States (e.g., Romania) are lagging considerably behind, with about 28% of the target population reporting at least basic digital skills.

Figure 44. Percentage of all individuals with at least basic digital skills



Source: Eurostat, isoc_sk_dskl_i21, reference year 2023

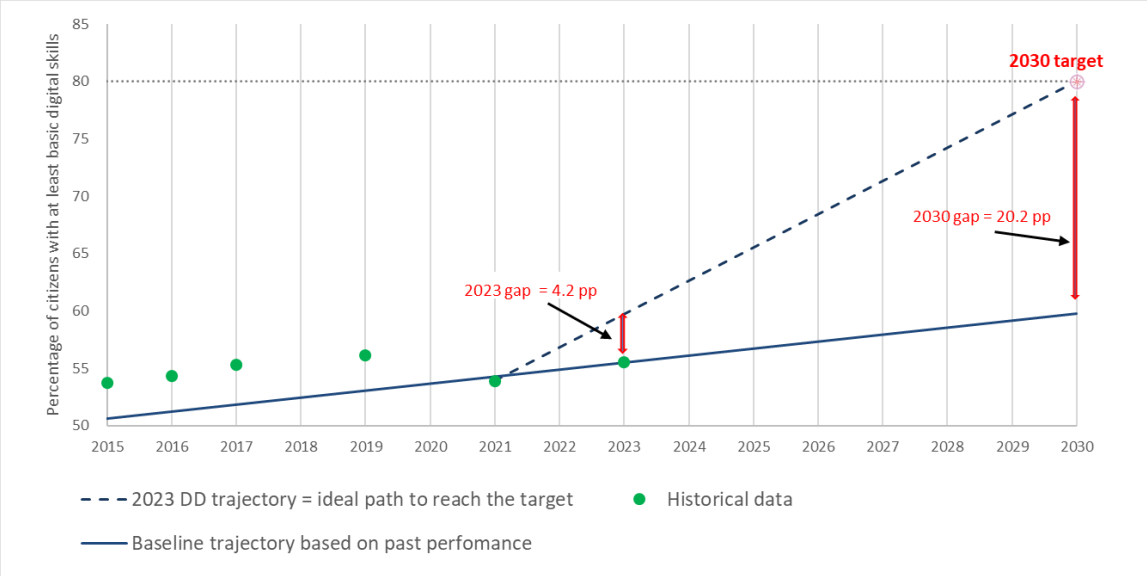
The EU average level of at least basic digital skills increased by only 1.7 percentage points between 2021 and 2023, so it made only limited progress and remained far below

([257]) https://commission.europa.eu/strategy-and-policy/priorities-2019-2024/europe-fit-digital-age/europes-digital-decade-digital-targets-2030_en#the-path-to-the-digital-decade.
([258]) https://op.europa.eu/webpub/empl/european-pillar-of-social-rights/en.
([259]) Council Resolution on a strategic framework for European cooperation in education and training towards the European Education Area and beyond (2021-2030), OJ C 66, 26.2.2021, p.1.
([260]) ESS (ICT survey). The dataset on individuals' level of digital skills (from 2021 onwards) is available at: https://ec.europa.eu/eurostat/web/products-datasets/-/isoc_sk_dskl_i21.

the trajectory needed to reach the 2030 target (i.e., 80% of individuals aged 16-74 will have at least basic digital skills by 2030).

In other words, the **rate of progress to reach the 2030 target remains insufficient**. Compared to the trajectory, **the EU was in 2023 4.2 percentage points below the value that would be needed to be on track to achieve the 2030 target**. According to the baseline trajectory, **only 59.8% of the population would have at least basic digital skills in 2030 if no further action is taken** – 20.2 percentage points below the 2030 target of 80%.

Figure 45. At least basic digital skills in the EU. Historical data, Digital Decade (DD) trajectory and baseline trajectory towards 2030 ([261])



On the positive side, **gender** differences in basic digital skills continue to narrow. The percentage of men reporting that they possess at least basic digital skills has remained fairly stable in recent years, but the percentage of women reporting that they possess at least basic digital skills has increased. In 2023, 2.2 percentage points more men than women reported that they possessed at least basic digital skills.

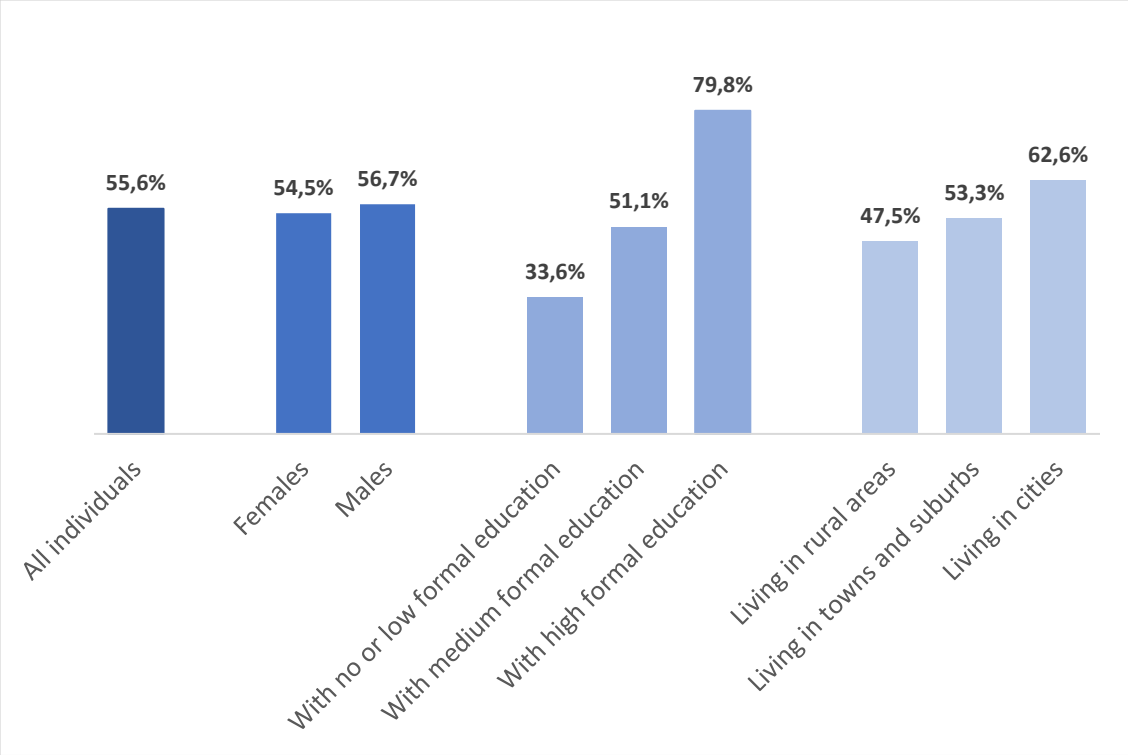
The level of **formal education and training** influences proficiency in digital skills. In the EU, in 2023 there was a considerable difference in at least basic digital skills between individuals with a high level of formal education (79.8%) and those with no or low formal education (33.6%) – a 46.2 percentage point gap. Ireland, Portugal, and Greece, had the widest disparities (73.8, 65.6, and 63.1 percentage points respectively). Conversely, Estonia, Finland, and Lithuania had the smallest disparities (11.6, 13.9 and 22.2 percentage points respectively).

Older people, who were born and grew up in a time when digital technologies were not available or were less widespread, are less likely to possess at least basic digital skills. 70% of those aged 16-24 possess at least basic digital skills, but only 28.2% of those aged 65-

([261]) The baseline trajectory is based on the linear functional form. The assumption is that the indicator will follow a linear trend, with a constant growth rate until 2030. Between 2019 and 2021, a revision of the methodology to measure this indicator caused a break in the series. For this reason, the baseline trajectory is first estimated based on the historical time series until 2019 (included) and then adjusted to correct for the break in series. More information can be found in the 'Communication from the Commission establishing Union-level projected trajectories for the digital targets', C(2023) 7500.

74. There is also a considerable divide in terms of at least basic digital skills between people who live in **cities, towns and suburbs, and rural areas** (62.6%, 53.3% and 47.5% respectively).

Figure 46. Percentage of people aged 16-74 with at least basic digital skills by gender, level of education and type of residential location, EU-27, 2023



Source: Eurostat, isoc_sk_dskl_i21, reference year 2023

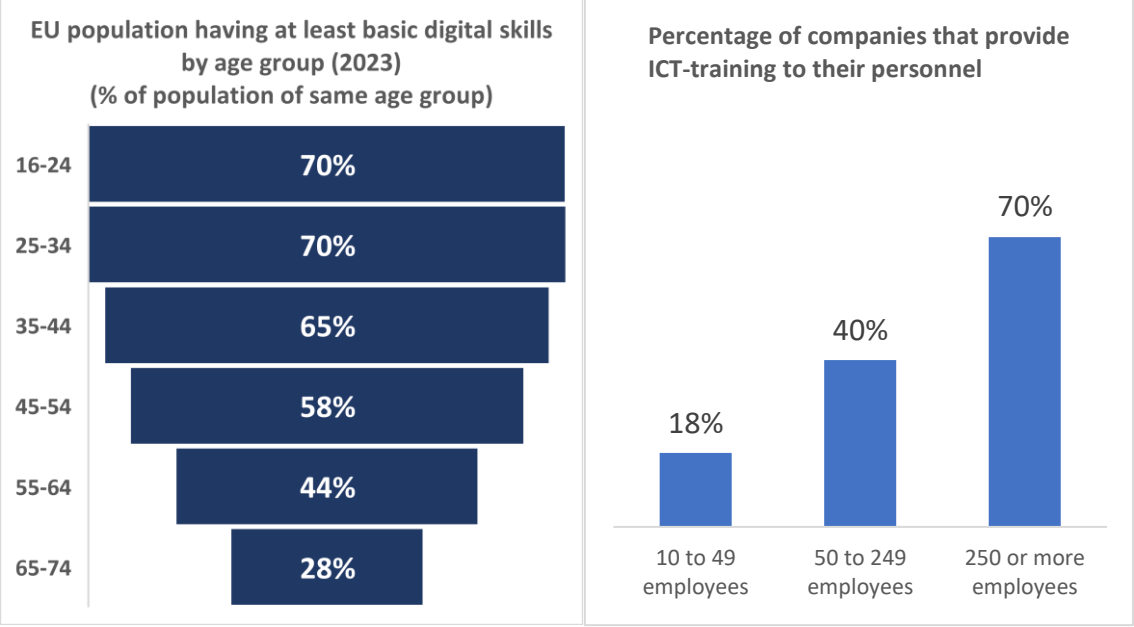
In addition to this, a recently published policy report by the Joint Research Centre on supporting policies addressing the digital skills gap ([262]) put forward a list of **highest priority groups** in the context of employment for policies that aim to increase digital skills and reduce digital skills gaps and mismatches. Nine priority groups were identified through a detailed analysis using different sources of data, including 1) young 16-24 years old, with low-level formal education, and NEETs (aged 16-35 not in employment, education and training), 2) individuals aged 55-64 years old, 3) individuals 25-64 years old with low-level formal education, 4) individuals 25-64 with medium-level formal education, 5) individuals unemployed, 6) individuals inactive, 7) nationals of non-EU countries, 8) individuals living in rural areas and 9) individuals employed in semi-skilled and low-skilled occupations.

Basic digital skills also play an **important role in the workplace**. Following the COVID-19 outbreak, 87% of jobs located in the EU-27 Member States plus Norway and Iceland require at least basic digital skills. In addition, 60-70% of workers in those countries use standard software at work (web browsing, emailing, word processing and spreadsheets) that requires basic or moderate digital skills, and half of those workers use specialised

([262]) Centeno C., Karpinski, Z., Urzi Brancati, C., Supporting policies addressing the digital skills gap – Identifying priority groups in the context of employment, EUR 31045 EN, Publications Office of the European Union, Luxembourg, 2022, ISBN 978-92-76-51319-3, doi:10.2760/07196, JRC128561.

software ([263]). Employers thus play a crucial role in equipping the workforce with digital skills. However, the likelihood of receiving training to develop digital skills still largely depends on the size of the company, with workers employed by large companies being almost twice as likely to receive training as those employed by small and medium sized enterprises. Furthermore, companies' training activities seem to have reached a plateau since 2019, which is surprising considering the impact that the COVID-19 pandemic has had on the digitalisation of businesses ([264]). Evidence from Cedefop's second European skills and jobs survey (ESJS2) shows that, in 2021, around 35% of EU workers experienced some form of technological change in their jobs and 26% of the EU workforce participated in (formal or non-formal) digital skills training. Around 13% of EU workers reported being digitally under-skilled to a great extent, and another 39% to a moderate extent, relative to the skills needs in their current jobs. Digital skills mismatch rates were generally lower among people with an initial vocational education and training (VET) qualification ([265]).

Figure 47. Percentage of people with at least basic digital skills (left) and percentage of companies that provide ICT training to their personnel (right).



Source: Eurostat, isoc_sk_dskl_i21, reference year 2023 and isoc_ske_itts, reference year 2022

The data on the EU's average performance in basic digital skills **relative to other global** economies is currently limited. Data regarding Member States' individual performance in various specific digital activities, relative to other global economies, is currently provided by the United Nations specialised agency for information and communication technologies (ITU) ([266]). Moreover, the Digital Skills Gap Index (DSGI) survey conducted by the education and research organisation Wiley ranks 134 economies based on a host of global

([263]) Cedefop (2022). Challenging digital myths, first findings from Cedefop's second European skills and jobs survey. https://www.cedefop.europa.eu/files/9173_en.pdf.

([264]) https://ec.europa.eu/eurostat/databrowser/view/isoc_ske_itts/default/table?lang=en&category=isoc.isoc_sk.isoc_skt.

([265]) Bertoni, E., Cosgrove, J., Pouliakas, K. and Santangelo, G., What drives workers' participation in digital skills training, European Commission, Seville, 2024, JRC137073. Available at: https://publications.jrc.ec.europa.eu/repository/handle/JRC137073

([266]) https://datahub.itu.int/data/?i=100082&s=16691.

indicators that reflect how advanced and prepared an economy is with digital skills needed for sustained growth, recovery and prosperity ([267]). The results show that Singapore scored highest in terms of the DSGI score, followed by the United Arab Emirates. Among the top 10 performers, there were five EU Member States (Finland, Sweden, Norway, Luxembourg and the Netherlands).

Interesting insights also come from the 2022 OECD PISA assessment. This revealed, for example, that just 13.3% of students in the EU achieved the highest level of proficiency in science, mathematics and reading (compared with 18.1% of students in the US). Further data by the OECD shows that the share of women among all those aged 16-24 who can program was 30.6% in the EU in 2023, while it was 28.7% in Canada and 41.5% in South Korea ([268]). In additional, the proportion of the EU workforce that performs ICT task-intensive occupations was 12% in 2022, so significantly less than the 17.9% in the US in 2020 ([269]).

The EU's population also recognises the importance of digital skills. The recent Digital Decade Eurobarometer 2024 shows that **three out of four Europeans (73%) consider that digital technologies make their lives easier** ([270]). Similarly, three out of four think that by 2030 digital technologies will be important to accessing education and training opportunities (75%), engaging in democratic life (74%), and accessing and making use of transport services (76%). In addition, 72% of respondents consider that more education and training to develop their skills for using digital services would significantly facilitate their daily use of digital technologies, while 74% think the same about receiving human support to help them access and use digital technologies and services.

EU and Member State measures

In recent years, the **Commission** has significantly ramped up its efforts to enhance digital skills through various initiatives. Basic digital skills feature in the **European Pillar of Social Rights Action Plan** ([271]), as a precondition for inclusion and participation in the labour market and society in a digitally transformed EU. The 2020 European Skills Agenda for Sustainable Competitiveness, Social Fairness and Resilience ([272]) also placed significant emphasis on digital skills, by setting targets like ensuring at least 70% of adults have at least basic digital skills by 2025.

Moreover, digital skills development is a strategic priority within the **Digital Education Action Plan 2021-2027** ([273]), which sets out the Commission's overarching vision for digitising education. This plan calls for coordinated EU-level support to bolster education and training systems, with a specific focus on digital skills. One notable initiative of the Digital Education Action Plan was the **Structured Dialogue on digital education and skills** ([274]), which took place between October 2021 and March 2023 with the objective of

([267]) https://dsgi.wiley.com/.
([268]) OECD Going Digital Toolkit, https://goingdigital.oecd.org/theme/4.
([269]) OECD Going Digital Toolkit, https://goingdigital.oecd.org/theme/4.
([270]) Special Eurobarometer 551 'The Digital Decade' 2024: https://digital-strategy.ec.europa.eu/en/news-redirect/833351.
([271]) https://op.europa.eu/webpub/empl/european-pillar-of-social-rights/en.
([272]) https://ec.europa.eu/social/main.jsp?langId=en&catId=89&newsId=9723&furtherNews=yes.
([273]) Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions of 30 September 2020 on the Digital Education Action Plan 2021-2027: Resetting education and training for the digital age, COM(2020) 624 final. Available here: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A52020DC0624.
([274]) https://education.ec.europa.eu/focus-topics/digital-education/action-plan/action-1.

bolstering political attention and commitment to digital education and skills. This dialogue was executed through discussions at the EU level and bilateral meetings between the Commission and representatives from individual EU Member States. These meetings brought together diverse sectors and governmental institutions, in a whole-of-government approach, as well as stakeholders (e.g., social partners, civil society and the private sector).

Recognising the critical need to foster skills (including digital skills across all sectors), the **European Year of Skills** ([275]) underscored the need for individuals to acquire essential skills through education and upskilling in order to obtain high-quality employment, address labour market disparities, help businesses overcome skilled workforce shortages, and attract talent to the EU. It also aimed to consolidate EU-wide efforts to enhance the skill sets (including digital skills) of EU citizens. The European Year of Skills successfully promoted reskilling and upskilling and put skills at the centre stage through 2000 events across Europe and 190 EU-led initiatives that highlighted the importance of skills development for competitiveness, the green and digital transitions, and every economic sector. The Year played a crucial role in advancing the implementation of the European Skills Agenda ([276]). The communication activities reached 90 million video views and 69 million people via social media.

Furthermore, a significant initiative in the area of digital skills was the **adoption of a digital education and skills package** aimed at enhancing digital skills, education and training. This package included two Council recommendations that were adopted by the Council in November 2023: the Council Recommendation on the key enabling factors for successful digital education and training ([277]); and the Council Recommendation on improving the provision of digital skills and competences in education and training ([278]). The aim of the Council Recommendation on key enabling factors is to ensure universal access to digital education by addressing key enablers such as connectivity, equipment and teacher training. The aim of the Council Recommendation on improving the provision of digital skills and competences in education and training is to help the EU's population develop basic, intermediate and advanced digital skills in all sectors of education and training. These recommendations also address vulnerable groups, including persons with disabilities ([279]), e.g., by maintaining and, where necessary, enhancing efforts towards digital inclusion.

The **Council Recommendations on individual learning accounts** ([280]) and **on a European approach to micro-credentials for lifelong learning and employability** ([281])

([275]) The European Year of Skills ran from 9 May 2023 to 8 May 2024. For further information, see: https://year-of-skills.europa.eu/index_en.

([276]) For instance, the Pact for Skills reached 2500 members and 20 large-scale Partnerships in all 14 Industrial Ecosystems and provided training to 3.5 million people. 15 Member States are using EU funding to develop Individual Learning Accounts. The 'European Alliance for Apprenticeships' has reached more than 430 pledges and 40 national commitments and there are now 53 EU-funded Centres of Vocational Excellence.

([277]) Council Recommendation of 23 November 2023 on the key enabling factors for successful digital education and training, OJ C, C/2024/1115, 24.1.2024, ELI: http://data.europa.eu/eli/C/2024/1115/oj.

([278]) Council Recommendation of 23 November 2023 on improving the provision of digital skills and competences in education and training, OJ C, C/2024/1030, 23.1.2024, ELI: http://data.europa.eu/eli/C/2024/1030/oj.

([279]) According to Eurostat estimates, about 101 million people (or one in four people adults in the EU) had some form of disability in 2022, see: https://www.consilium.europa.eu/en/infographics/disability-eu-facts-figures

([280]) Council Recommendation of 31 May 2022 on individual learning accounts, OJ C, 2021/0405, 31.5.2022, ELI: https://data.consilium.europa.eu/doc/document/ST-8944-2022-INIT/en/pdf.

([281]) Council Recommendation of 25 May 2022 on a European approach to micro-credentials for lifelong learning and employability, OJ C, 2021/0402, 25.5.2022, ELI: https://data.consilium.europa.eu/doc/document/ST-9237-2022-INIT/en/pdf.

also have the potential to support the acquisition of both basic and advanced digital skills. For instance, Member States could top up individual learning accounts in strategic sectors, to support the green and digital transitions. Regarding delivering on the potential of micro-credentials, Member States are recommended to integrate micro-credentials into both education and training systems and skills policies by using micro-credentials as a further means to improve basic and advanced digital skills and competences of a wider range of learners, in line with the Digital Education Action Plan and the European Pillar of Social Rights Action Plan.

Another important recent initiative includes the adoption of the **Upskilling Pathways Evaluation Package** ([282]) in July 2023 as part of the European Year of Skills, in which the Commission evaluated the actions taken in response to the Council Recommendation on Upskilling Pathways ([283]). This initiative identifies digital skills as the third basic skill besides literacy and numeracy skills. It aims to provide those with a lower level of skills with opportunities to develop basic skills and/or acquire a wider set of skills that are relevant for active participation in society and the labour market. The evaluation concludes, among other that, the objectives of the Recommendations are still relevant, and that it is necessary to fill the skills gaps on the labour market and drive forward the EU's competitiveness and the green and digital transitions.

In terms of funding, the Commission has been mobilising several **funding programmes** to boost digital skills, notably the Digital Europe Programme, Erasmus+ ([284]), the European Social Fund Plus (ESF+) ([285]) and the Recovery and Resilience Facility (RRF).

Moreover, during 2019-2024, a large number of initiatives took place at the EU level, either directly focusing on digital skills or encompassing digital skills as part of broader efforts to enhance skills development. The following are some of the initiatives related to digital skills.

Selected initiative	Further details
European Digital Skills and Jobs Coalition and its National Coalitions ([286])	This initiative tackles the digital skills gap by bringing together Member States, social partners, companies, non-profit organisations and education providers to raise awareness and encourage organisations to take different actions to support digital skills training, share good practices and close the digital skills gap. National coalitions are currently established in 25 EU Member States.
European Digital Skills and Jobs Platform ([287])	This is the EU's one-stop-shop for digital skills. It brings together initiatives, information and resources on digital skills; good practices; training opportunities; funding opportunities; opinion posts; events; and a self-assessment tool. It is also the home of the European Digital Skills and Jobs Coalition (see point above) and a

([282]) https://ec.europa.eu/social/main.jsp?langId=en&catId=1223&furtherNews=yes&newsId=10637.
([283]) Council Recommendation of 19 December 2016 on Upskilling Pathways: New Opportunities for Adults, OJ C 484, 24.12.2016, p.1. ELI: https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32016H1224(01).
([284]) Erasmus+ is supporting the initiative on Centres of Vocational Excellence with EUR 400 million in 2021-2027. Several of the 25 projects that have so far received support have a strong focus on digital skills.
([285]) So far, around EUR 2 billion has been programmed under the ESF+ exclusively for the support to the development of digital skills in Member States.
([286]) https://digital-skills-jobs.europa.eu/en.
([287]) https://digital-skills-jobs.europa.eu/en/about/digital-skills-and-jobs-coalition.

Selected initiative	Further details
	meeting place for stakeholders looking for partners. Stakeholders can also make pledges, which are commitments made to reduce the digital skills gap.
European Digital Skills Awards ([288])	These aim to give visibility to and reward regional, national and EU projects and initiatives that are helping to bridge the digital skills gap in the EU. On 28 June 2023, six winners were chosen across five categories: empowering youth; digital skills for education; inclusion; women in ICT; and digital upskilling at work. Giving these initiatives – which are supporting digital skills for everyone – the attention they deserve also inspires new initiatives and the upscaling of existing initiatives.
Pact for Skills ([289])	This aims to get public and private organisations together and encourage them to make concrete commitments to upskilling and reskilling adults. There are currently over 2500 organisations under the Pact for Skills. More than 3.5 million workers received training in 2022 and 2023, according to key results of the annual survey on the Pact. The Digital Skills Partnership ([290]), composed of European and national associations, clusters and digital innovation hubs, universities, research centres, companies, and VET providers, aims to help reach the EU Digital Decade targets to equip 80% of people with basic digital skills, achieve gender convergence, and have 20 million ICT specialists employed by 2030. Partners are developing a joint strategy to design and implement an ecosystem-wide upskilling and reskilling framework, which will support Europe's green and digital transitions across all industrial ecosystems. Work of the partnership also focuses on collaboration and synergies with relevant initiatives such as Digital Skills & Jobs Coalition.
Digital competence frameworks for citizens (DigComp) ([291])	This provides a common framework to assist the EU's citizens and workforce by facilitating a common understanding of digital skills. It can also be used for framing policy, curriculum development and skills assessment and certification in either an education or a labour market context. DigComp is used in all 27 Member States, referenced in digital skills policies in 22 Member States, used as a reference for certification of digital skills in 21 Member States, and has inspired more than 20 tools in different EU Member States, across different target groups of society. The framework defines 21 key digital competences across five areas: information and data literacy, communication and collaboration; digital content creation; safety; and problem solving. In March 2022, DigComp was updated (DigComp 2.2) to take account of emerging technologies such as AI and datafication, and phenomena such as teleworking, misinformation and disinformation (and the new skills requirements they bring). Work is being carried out with the Joint Research Centre (JRC) to develop digital learning outcomes based on DigComp.
SELFIE for work-based learning ([292])	This is a free online tool for vocational education and training (VET) institutions and companies. It helps them reflect on how to make the

([288]) https://digital-skills-jobs.europa.eu/en/european-digital-skills-awards-2024-0.
([289]) https://pact-for-skills.ec.europa.eu.
([290]) https://pact-for-skills.ec.europa.eu/about/industrial-ecosystems-and-partnerships/digital_en.
([291]) https://publications.jrc.ec.europa.eu/repository/handle/JRC128415.
([292]) https://education.ec.europa.eu/selfie/selfie-for-work-based-learning.

Selected initiative	Further details
	most of digital technologies for teaching, learning and training. SELFIE WBL helps schools and companies to become fit for the digital age. It is a specific module of the SELFIE tool that has been adapted to match the requirements of work-based learning. It thus supports the digital transition, one of the Commission's key policy priorities. The tool has been used in 16 countries, by 42 725 users and in 195 schools.
European Digital Education Hub ([293])	This is a community of practice for cooperation across all levels and sectors of education and training with the aim of supporting digital education and skills. The Hub works in close cooperation with the new Support, Advanced Learning and Training Opportunities (SALTO) resource centre and other initiatives such as the Digital Education Hackathon.
Data Space for Skills	In line with the European Strategy for Data ([294]), the Commission is investing in a data space for skills. It will facilitate secure data-pooling and data-sharing and will foster an ecosystem in which new products and services can be created that are based on more accessible data. A preparatory action for the data space for skills was completed in October 2023. It has delivered a blueprint ([295]) for implementation that addresses important aspects ranging from business models and governance to technical architecture, user experience, and growth and roll-out strategy. In addition, an interactive inventory ([296]) of skills data initiatives was provided. The call for the deployment action for the data space for skills was published in February 2024.
EU Code Week ([297])	This is a grassroots initiative whose main goals are to encourage children and young people to discover and master the basics of coding and computational thinking; and to make them interested in taking up science, technology, engineering and mathematics (STEM) subjects at school, and eventually study and pursue careers in the digital field. At the heart of EU Code Week are groups of motivated volunteers, including Code Week ambassadors and leading teachers from around the world. Moreover, EU Code Week provides teachers with free resources, ready-made lesson plans, free online introductory courses and other materials to help bring coding and technology into the teaching of all subjects and classrooms. 71 655 events were registered in 2023, reaching over 3 million participants. Italy, Poland and Türkiye organised the most events.

In their **national roadmaps**, Member States placed a specific focus on digital skills. They did so in line with the horizontal recommendation in the 2023 State of the Digital Decade Report that Member States should prioritise investment in digital education and skills. They also took into account the Commission's proposals for a Council recommendation on improving the provision of digital skills and competences in education and training and for a Council Recommendation on the key enabling factors for successful digital education

([293]) https://education.ec.europa.eu/focus-topics/digital-education/action-plan/european-digital-education-hub.
([294]) https://digital-strategy.ec.europa.eu/en/policies/strategy-data.
([295]) https://skillsdataspace-blueprint.eu.
([296]) https://inventory.skillsdataspace.eu.
([297]) https://codeweek.eu.

and training. The box below summarises how the Member States have addressed basic digital skills in their roadmaps. The actions related to ICT specialists and advanced digital skills are presented in the relevant section (Section 4.1.1.2).

At least basic digital skills in Member States' national Digital Decade strategic roadmaps ([298])

26 Member States provided a **trajectory for the at least basic digital skills target**. Most of the national target values assumed for 2030 are in line with the EU target value, which is that at least 80% of those aged 16-74 have at least basic digital skills. 8 Member States assumed a target value below the EU target value and 3 Member States (Spain, Finland and the Netherlands) assumed a target value above the EU target value. Bulgaria is the only Member State that explicitly referred to achieving gender balance for this target.

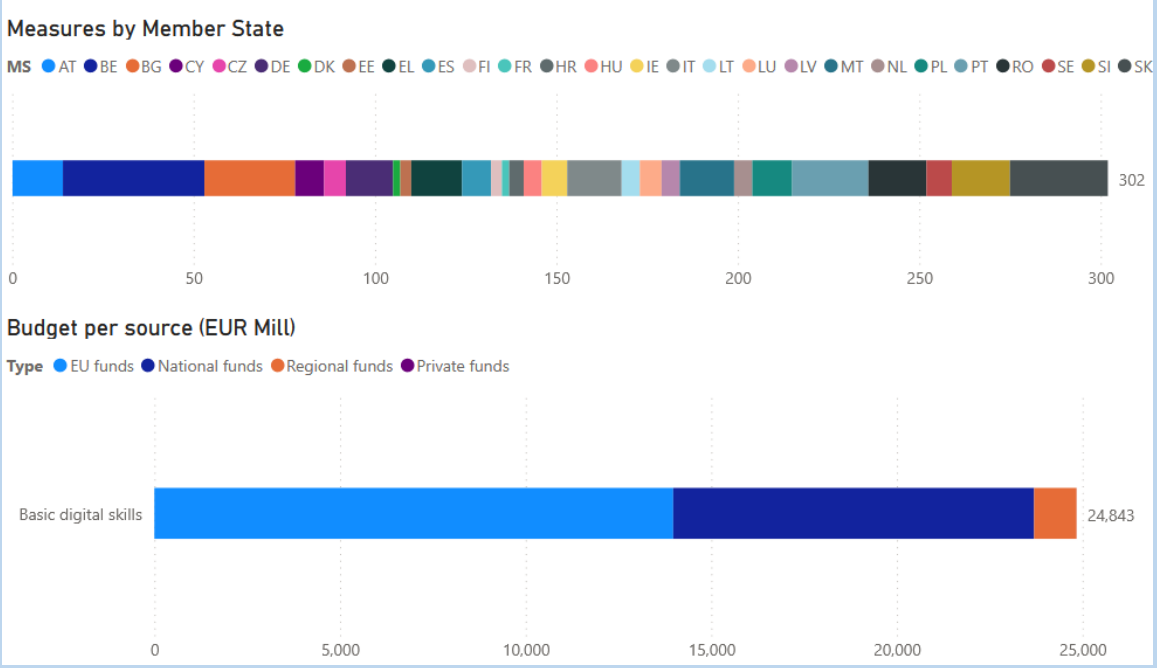
Member States reported a **total of 292 measures contributing to this target**, with a **total budget of EUR 24.8 billion**. Around 55% of this budget will come from EU sources, around 40% from national sources and the remaining 5% from regional sources. The roadmaps include several new impulses: around one third of the measures are reported as new (budget share of around 20%).

Around **one third** of the measures focus on digital skills in **formal education**, including to improve the digital skills of learners and teachers and to provide digital infrastructure/learning resource; and **another third** on **digital inclusion**, including to improve the digital skills of vulnerable groups. The **remaining third** of the measures are equally composed of measures supporting digital skills of **people currently in employment**, including broad upskilling and reskilling programmes as well as (sector)-specific initiatives (e.g., for public servants and SME employees); and **governance and other support initiatives,** including initiatives to support a skills ecosystem and monitoring and evaluation activities related to digital skills. A **very small part** of the measures is explicitly focused on improving the gender balance by increasing the basic and intermediate digital skills of **girls and women** (particularly in Italy, Cyprus, Austria and Portugal).

([298]) This analysis only takes account of elements reported by the Member States in their national roadmaps. The measures reported by the Member States were grouped into categories to provide a better overview of the types of measures taken.

Measures and budget (EUR Mill)

Target category	Measures	Budget
	3	173
1. Basic and intermediate digital skills in formal education	89	17,382
2. Basic and intermediate digital skills of people currently in employment	54	1,955
2. Strengthening of advanced and highly specialised digital skills of people currently in employment	1	20
3. Basic and intermediate digital skills of girls and women	5	1,100
4. Basic and intermediate digital skills for all to achieve digital inclusion	98	3,071
5. Governance and other support initiatives not covered in points 1-4	52	1,143
Total	**302**	**24,843**



Concluding remarks and future challenges

The data described above reveal that the digital skills gap remains significant, especially for older people, those with limited formal education, and residents of rural or remote areas. There are significant variations between and within Member States that pose a risk of further widening **economic inequalities** within the EU. Firms operating in countries where a higher share of the population have above-average digital skills tend to have implemented advanced digital technologies to a greater extent ([299]). Regions with lower digital skills levels may struggle to attract digital investment and businesses, impeding their economic growth by comparison with more digitally advanced regions.

The digital skills gap risks widening **existing inequalities**. As technology advances rapidly, individuals that lack adequate digital skills may find it difficult to obtain employment or may have to accept lower-paying jobs.

People with low levels of digital skills may also risk **marginalisation and exclusion** from important aspects of daily life because our societies increasingly rely on digital technologies for communication, participation in society, shopping and public administration. More precisely, access to **digital communications** is increasingly needed in order to obtain essential services ([300]). It allows the use of applications for **financial services** because online banking and digital payment systems are becoming increasingly

([299]) European Investment Bank, *Digitalisation in Europe 2021-2022: Evidence from the EIB Investment Survey*, 2022, https://www.eib.org/en/publications/digitalisation-in-europe-2021-2022/.
([300]) https://ec.europa.eu/social/main.jsp?catId=1592&langId=en

prevalent. Access to mobile internet is also becoming increasingly important as a way of obtaining information on **transport solutions** and timetables, as well as receiving online tickets. It is also important for accessing **public services** and **health services**, due to the rise of telemedicine and digital health platforms. These trends are making access easier by ensuring the availability of services outside office hours and regardless of location, but people (particularly older people) that lacking digital skills may struggle to learn to use the digital services, and therefore face new or aggravated forms of exclusion.

In business settings, the digital skills gap can reduce **productivity and competitiveness**. Employees that lack proficiency in digital tools may struggle to complete tasks efficiently and use automation technologies effectively. Two out of five employers consider that a lack of adequate AI-related skills (including digital) is a barrier to using AI at work ([301]). In addition, insufficient digital skills also increase **cybersecurity risks**. Individuals that lack proficiency in basic cybersecurity practices may inadvertently expose themselves and their organisations to cyber threats, such as phishing attacks or malware infections.

The pace of technological innovation often exceeds the ability of traditional **educational institutions and training programmes to keep pace**. This results in a growing disparity between both the basic and advanced digital skills demanded by the digital economy and those possessed by schoolchildren and students, who are the future workforce. More precisely, introducing changes to curricula and syllabi of formal education is often a very lengthy process and at odds with the dynamic nature of technology. In addition, by the time new technologies or solutions are fully incorporated into traditional learning and teaching frameworks, they may have already evolved further or been replaced by even more advanced technologies. This gap can have far-reaching implications for individuals, businesses and society as a whole.

4.1.1.2. A highly skilled digital workforce: ICT specialists and advanced digital skills

In the context of the **Digital Decade Policy Programme 2030** (DDPP), the EU has set objectives and targets for 2020 for ICT specialists. More precisely, the EU's ambitious Digital Decade targets in the Path to the Digital Decade Policy Programme ([302]) include a target that at least **20 million ICT experts will be employed in the EU, with more graduates and better gender convergence**. Meeting those targets (including increased female representation, engagement and retention in ICT) is crucial so that the EU's industry can adapt to structural changes and remain competitive.

Innovations and breakthroughs in different areas such as AI, robotics, quantum technology or 6G are triggering a **wave of demand for a new generation of advanced digital skills**, such as skills in machine learning algorithms, the Internet of Things (IoT), big data analytics, cloud computing, cybersecurity, and emerging technologies that will deeply impact the way we work, produce and collaborate (e.g., virtual worlds and Web 4.0) ([303]). Throughout society, there are also widespread initiatives across the EU to digitise public services with the goal of enhancing efficiency and promoting inclusivity. To prepare our

([301]) OECD Employment Outlook 2023: Artificial Intelligence and the Labour Market, available here: https://www.oecd-ilibrary.org/employment/oecd-employment-outlook-2023_08785bba-en.

([302]) https://commission.europa.eu/strategy-and-policy/priorities-2019-2024/europe-fit-digital-age/europes-digital-decade-digital-targets-2030_en#the-path-to-the-digital-decade.

([303]) For emerging technologies in education see JRC report (2023): On the Futures of Technology in Education: Emerging Trends and Policy Implications, doi:10.2760/079734.

society and businesses for the digital future and tackle strategic dependencies, it is essential to build up a sufficient talent pool of highly skilled professionals in those key capacity areas.

However, we are still facing a **substantial advanced digital skills gap in the EU**. Companies are facing increased competition for digitally skilled talent, particularly small and medium sized enterprises. In addition to the significant **shortage of ICT specialists**, the EU is also facing a **significant digital skills gap in more traditional non-ICT professions**. Examples include medical doctors who are increasingly relying on advanced digital technologies to provide more accurate diagnoses; and sector specialists that are needed to unlock the potential of innovative digital solutions in the green transition in order to maintain the EU's competitiveness in the coming carbon-neutral economy.

State of play and progress towards the Digital Decade target

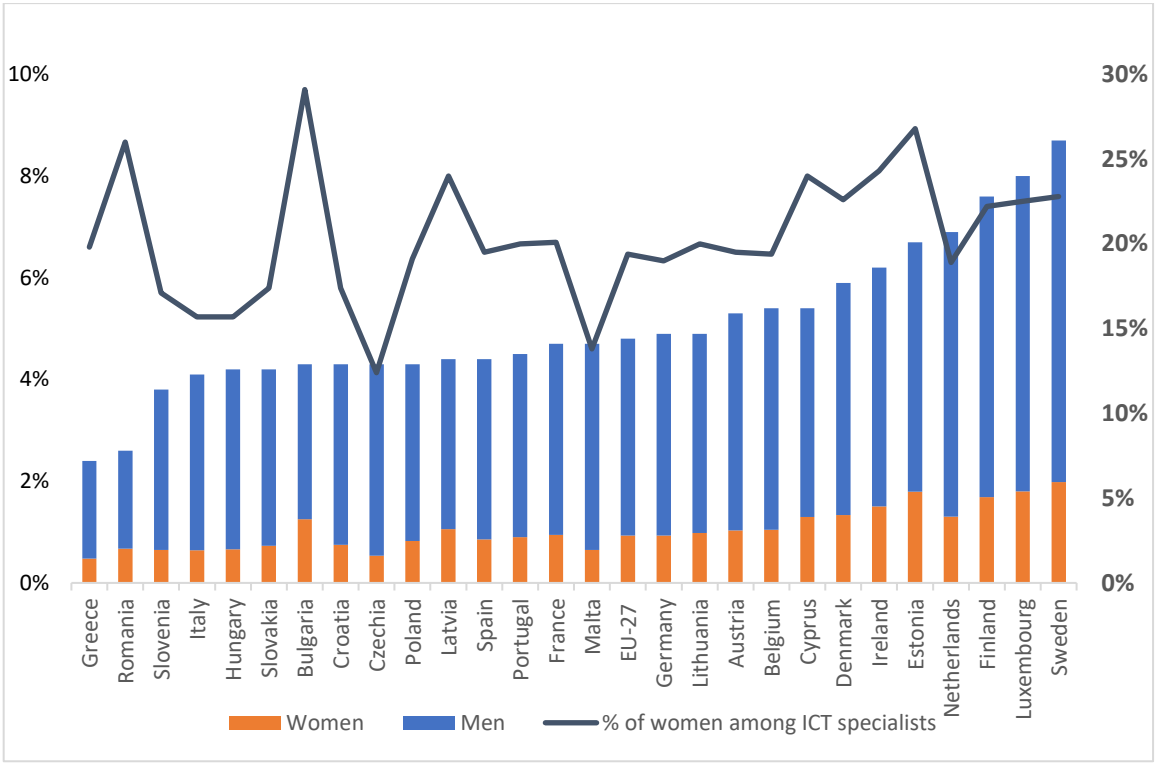
Over the past years, **significant progress** has been made in the **supply of ICT specialists**. The number of ICT specialists employed in the EU has increased between 2014 and 2023 by **almost 55%** ([304]). More precisely, **in 2023, nearly 9.8 million ICT specialists were contributing to the EU's employment** (a 4.1% increase compared to 2022). However, this is still **far below the ambitious Digital Decade target** of 20 million ICT specialists employed in the EU by 2030.

Employing 20 million ICT specialists in the EU by 2030 would mean that **roughly 10% of the EU's total employment would be employed as ICT specialists** ([305]). However, Figure 48 below shows that in 2023, **only around 4.8% of the EU total employment were working as ICT specialists** (0.2 percentage points more than in 2022). In addition, there is substantial variation between Member States, with Sweden being close to achieving the Digital Decade target on ICT specialists, but other Member States clearly lagging behind.

([304]) Eurostat isoc_sks_itspt, https://ec.europa.eu/eurostat/databrowser/view/isoc_sks_itspt/default/table?lang=en&category=isoc.isoc_sk.isoc_sks.isoc_skslf.

([305]) This estimate was calculated on the basis of the number of persons in the EU's workforce in the third quarter of 2023 (195.1 million), see: https://ec.europa.eu/eurostat/statistics-explained/index.php?title=EU_labour_market_-_quarterly_statistics.

Figure 48. ICT specialists as a percentage of total employment (left axis) and the percentage of women among ICT specialists (right axis)

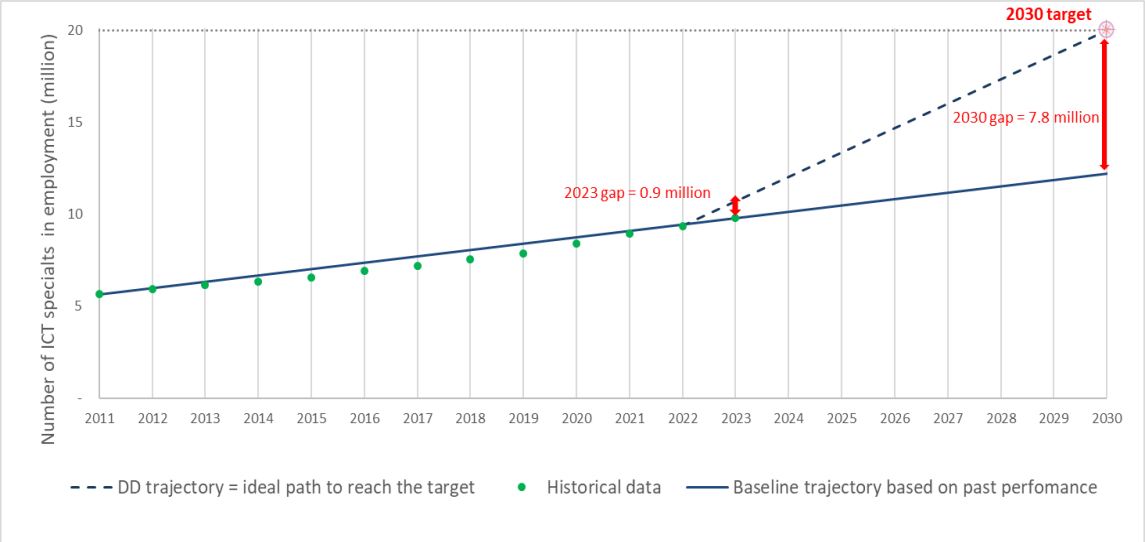


Source: Eurostat, Labour Force Survey, Reference year 2023

Figure 49 below shows the evolution of the number of ICT specialists in the EU, as well as the estimated baseline trajectory for the future based on historical data ([306]). Comparing the two trajectories shows that, in 2023, **the EU was 0.9 million employees below the value that would be needed in order to be on track to meet the 2030 target**. According to the current trend, the number of ICT specialists in the EU will be around 12.2 million in 2030 instead of the target figure of 20 million. The current trend points to a total growth of 24.5% between 2023 and 2030. However, the EU would **need to more than double** the number of ICT specialists (from 9.8 million to 20 million) in order to meet the Digital Decade target.

([306]) The Digital Decade trajectory is assumed to be a straight line connecting the 2022 value (the most recent available data point) with the 2030 target. The baseline trajectory is based on the linear functional form and based on historical data (all available years included). The assumption is that the KPI will follow an increasing trend with a constant rate over the whole period.

Figure 49. ICT specialists in the EU. Historical data, Digital Decade (DD) trajectory and revised baseline trajectory towards 2030



Apart from increasing the total number of ICT specialists in the EU, the Digital Decade targets also focus on reducing the **gender gap in ICT specialists**. The gender gap remains substantial and there has been little **progress** during the past decade. Figure 50 shows that, in 2012, just 17% of ICT specialists employed in the EU were female, a figure that rose only slightly to **19.4% by 2023**. It also shows that significant disparities exist between Member States. In 2023, Bulgaria was leading with the highest proportion of female ICT specialists at 29.1%, whereas Czechia was lagging behind at just 12.4%.

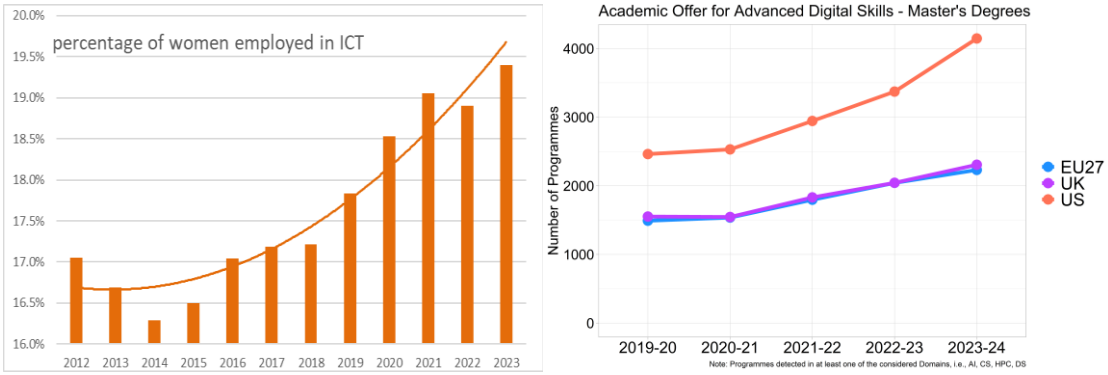
In order to understand why the EU is facing challenges in attracting and keeping skilled women in technology, a recent study by McKinsey Digital (2023) examined the entire journey from early education to professional entry and revealed that there are two major drop-off points for women in EU tech: at the end of secondary education and on entering the workforce ([307]). In addition, retaining women who have already embarked on an ICT career remains challenging: The study also found that over half of women working in tech leave the industry by the midpoint of their career. This is more than double the rate for men and results in many fewer women obtaining leadership positions ([308]). Women's participation in digital entrepreneurship and innovation is also low: fewer than 15% of start-ups are currently founded or co-founded by women and most investment goes to male-only teams ([309]).

([307]) McKinsey Digital, *Women in tech: the best bet to solve Europe's talent shortage*, 2023, https://www.mckinsey.com/capabilities/mckinsey-digital/our-insights/women-in-tech-the-best-bet-to-solve-europes-talent-shortage.

([308]) McKinsey Digital (2023): Women in tech: the best bet to solve Europe's talent shortage, available at: https://www.mckinsey.com/capabilities/mckinsey-digital/our-insights/women-in-tech-the-best-bet-to-solve-europes-talent-shortage.

([309]) https://eic.ec.europa.eu/news/eu-launches-women-techeu-pilot-put-women-forefront-deep-tech-2021-07-13.

Figure 50. Percentage of women among ICT specialists (left) and number of English-taught master's programmes in four digital domains (AI, high performance computing, cybersecurity and data science) (right).



Sources: Eurostatisoc_sks_itsps and the Joint Research Centre.

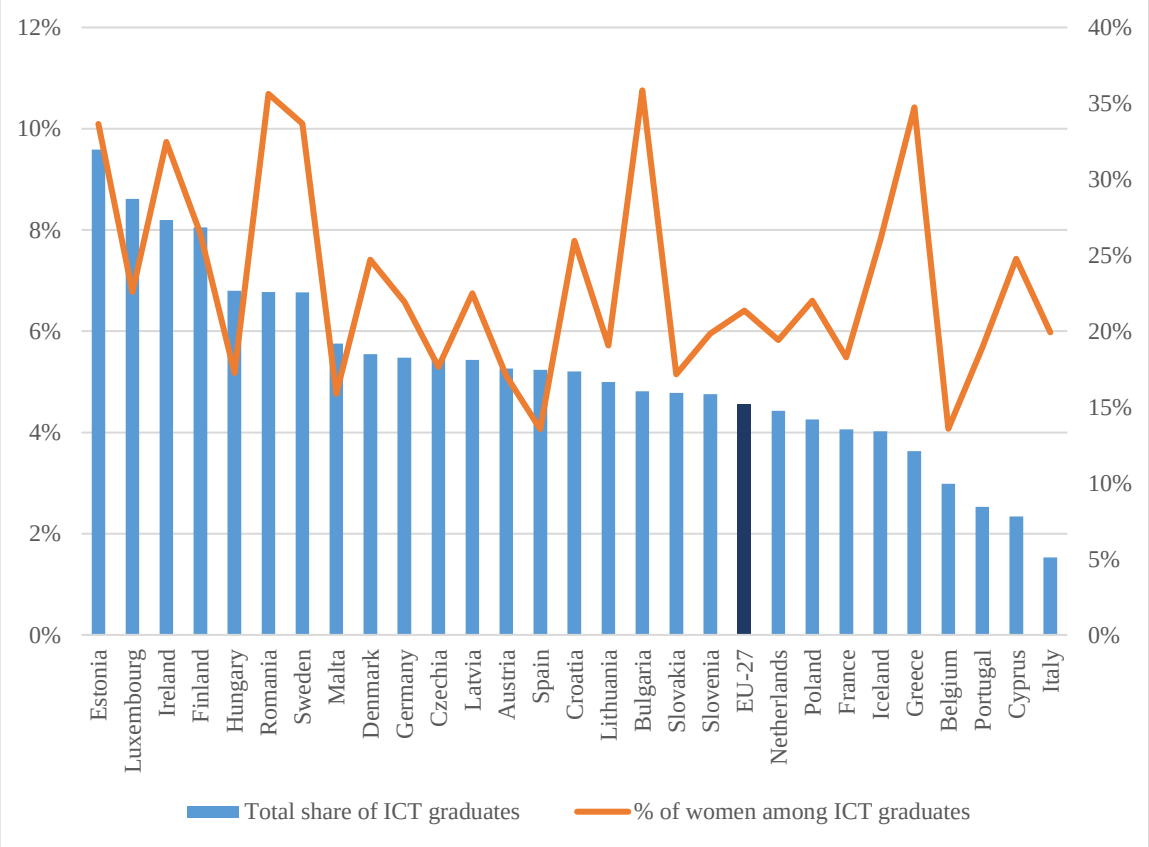
Higher education and vocational education and training (VET) institutions are crucial for increasing the number of ICT specialists in the EU and this is reflected in the progression in educational attainment within the ICT workforce. In 2023, 66.7% of employed ICT specialists had completed academic or advanced vocational/professional education and training (ISCED levels 5-8) ([310]). The **popularity of ICT studies** at the level of tertiary education has consistently increased during the past decade, to a similar degree for men and women. In 2014, only 3% of all graduates from tertiary education in the EU pursued ICT degrees, but this figure rose to 4.5% in 2022.

Figure 51 shows the variance between Member States (Estonia boasted the highest percentage of ICT graduates at over 9.6% and Italy the lowest at 1.5%). Women represented 21% of ICT graduates, and their level of representation also varied significantly between the Member States.

VET institutions can play an important role in developing advanced digital skills. Analysis has shown that VET programmes are particularly relevant in the areas of business intelligence and data science, security technologies, and cloud technologies ([311]). Among upper secondary and post-secondary VET graduates, 4.6% had obtained a degree in the ICT field, a proportion similar to tertiary education ([312]). Figure 52 shows the variance between Member States (Bulgaria and Portugal each having more than 12% ICT graduates in VET, while Croatia and Slovakia do not have any ICT graduates in VET at all).

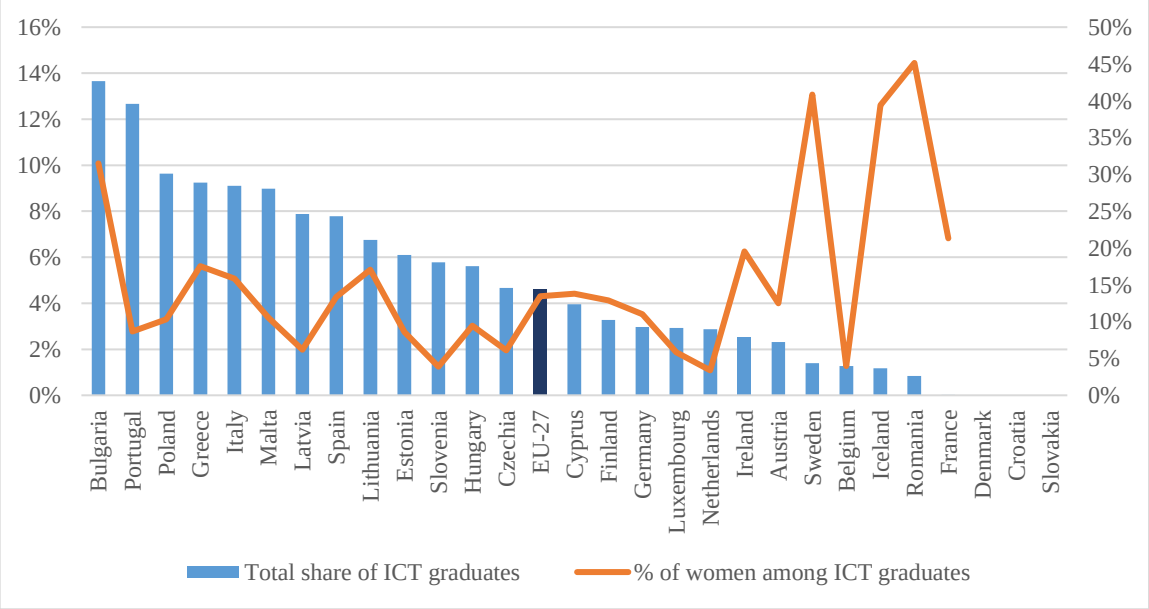
([310]) Eurostat, isoc_sks_itspe, https://ec.europa.eu/eurostat/databrowser/view/isoc_sks_itspe/default/table?lang=en&category=isoc.isoc_sk.isoc_sks.isoc_skslf.
([311]) https://advancedskills.eu/wp-content/uploads/2023/10/D2.2_LEADS_GAP_ANALYSIS_v1.0.pdf.
([312]) Eurostat, educ_uoe_grad02, https://ec.europa.eu/eurostat/databrowser/view/EDUC_UOE_GRAD02__custom_5451972/bookmark/table?lang=en&bookmarkId=2b0446a9-c20a-4e43-a024-8a75c5afa79e.

Figure 51. ICT graduates at tertiary education levels as a percentage of total graduates (left axis), percentage of women among ICT graduates (right axis).



Source: Eurostat, year 2022, tertiary education levels ISCED: 5-8.

Figure 52. ICT graduates at upper secondary and post-secondary non-tertiary vocational education as a percentage of total graduates (left axis), percentage of women among ICT graduates (right axis).



Source: Eurostat, year 2022, upper secondary vocational education and post-secondary non-tertiary vocational education, ISCED levels 3-4 ([313]).

A recent study conducted by the Joint Research Centre sheds light on the **academic landscape of advanced digital skills offers** in the EU, the UK and the US in the 2023-2024 academic year ([314]). Figure 50 above shows that concerning the overall educational provision of master's programmes across four digital domains (AI, high performance computing (HPC), cybersecurity and data science), there has been a substantial increase in offerings in all three regions since 2020-2021, with the US maintaining its lead. The EU is lagging behind the US (EU n=2231 vs. US n=4146), with its English-language master's degree offerings almost the same as those of the UK (n=2306). However, it is crucial to note that the total EU offerings are likely higher, because the JRC study focused only on English-taught programmes and did not cover programmes taught in other languages. When one looks at the data more closely, the study shows a significant increase in AI master's programmes in all three geographical areas (EU n=1316, UK n=1219, US=1787). In addition, the US's offer has also increased remarkably for programmes in cybersecurity, an area in which development has been considerably weaker in the EU and the UK. Moreover, whereas the offer in HPC and data science is still led by the US, the EU has improved. Another noteworthy finding of the study was that, during 2023-2024, 9.41% of all English-taught EU master's programmes across all disciplines (not only ICT) incorporated some AI-related content, a proportion that was significantly higher than the UK's 6.03% and more than double than the US's 4.33%. The study also discovered that ICT is still the main field of education (followed by engineering studies, and business, administration and law studies) in which AI content, HPC and cybersecurity are taught ([315]).

In addition, a recent analysis and mapping on programmes and courses by the LEADS project ([316]) has shown that most of the specialised ICT courses currently available in the EU still do not adequately teach the skills that are most sought after by the industry. They instead tend to focus primarily on the **theoretical learning of concepts**.

Continued training of the active workforce also remains crucial for adapting to the digital age. Companies play a pivotal role in ensuring that their ICT specialists are equipped with the most up-to-date digital competences so that they can stay competitive and drive innovation. However, even though the number of enterprises that provide training to their ICT specialists to either develop or upgrade their ICT skills has slightly increased over the past 10 years, access to such training remains largely **dependent upon the size of the company**. In 2022, 58% of companies with 250 or more employees provided training to their ICT specialists, but only 26% of companies with 50-249 employees and only 7% of companies with 10-49 employees provided such training ([317]).

([313]) Denmark, Croatia and Slovakia each have less than 5 ICT graduates in VET in total. Due to these overall low numbers, the percentage of women among them is not shown in the graph.

([314]) Joint Research Centre (2024): Academic offer of advanced digital skills (academic year 2023-24). Available in the JRC Data catalogue: https://web.jrc.ec.europa.eu/dashboard/ACADEMIC_OFFER/index.html.

([315]) Further detailed analyses for each investigated domain can be found in the recently published dataset in the JRC data catalogue available at: https://data.jrc.ec.europa.eu/dataset/7aed1a89-c904-43ed-af0f-b024fc9cb92a. For other resources, see dedicated webpage (available at https://joint-research-centre.ec.europa.eu/predict/academic-offer-advanced-digital-technologies_en) and dashboard (available at: https://web.jrc.ec.europa.eu/dashboard/ACADEMIC_OFFER/index.html).

([316]) https://advancedskills.eu/, https://advancedskills.eu/wp-content/uploads/2023/10/D2.2_LEADS_GAP_ANALYSIS_v1.0.pdf.

([317]) Eurostat, isoc_ske_itts, https://ec.europa.eu/eurostat/databrowser/view/isoc_ske_itts/default/table?lang=en&category=isoc.isoc_sk.isoc_skt.

Rapid technological advancements, the ongoing digital transformation of organisations as well as evolving societal needs have significantly increased the **demand for ICT specialists** in the EU. In 2022, more than 60% of EU enterprises that recruited or tried to recruit ICT specialists had difficulties in filling ICT vacancies ([318]). Experimental statistics from Eurostat, which are derived from web-scraping of online job adverts, show that, in 2023, 8.5% of job advertisements were aimed at recruiting ICT experts ([319]). Significantly, nearly 60% of these advertisements were for software and application developers and analysts. Similarly, data from an OECD analysis of online job adverts shows that the demand for professionals working in AI development and deployment increased considerably between 2019 and 2022 ([320]). On average, across countries in the sample, the share of online vacancies requiring AI skills increased by 33% over this 3-year period. In addition, a recent supply-and-demand analysis of current and future advanced digital skills ([321]) by the LEADS project showed that, in the coming years, the demand for advanced digital skills will rise most in areas such as **data analysis, AI application development and implementation, cloud solutions and IoT analytics**. To meet industry's future demand for **AI skills** alone, it is estimated that between 0.5 million and 2.8 million EU citizens will need to acquire these skills over the next 5 years, while approximately 1.2 million to 3.7 million individuals will be required to gain proficiency in **cloud computing skills**. Overall, hiring challenges are reported to be most pronounced in fields that require expertise in AI, cybersecurity and quantum technologies, because this specialised expertise is particularly challenging to find.

The EU is relying increasingly on foreign talent to address the shortage of ICT specialists. Figure 53 below illustrates three key metrics: the share of ICT specialists who are EU citizens residing in another EU Member State, the share of ICT specialists working in the EU who are non-EU citizens, and the total number of ICT specialists in the EU. Over the past four years, the share of EU citizens working as ICT specialists in another Member State has remained relatively stable (ranging from 3.2% in 2019 to 3.7% in 2023), with a slight decline in 2020 due to the COVID-19 pandemic. In contrast, the proportion of non-EU citizens employed as ICT specialists in the EU has consistently increased, rising from 7.6% in 2019 to 10.9% in 2023, despite a minor dip in 2020 caused by the pandemic ([322]).

([318]) Eurostat, isoc_ske_itrcrs: https://ec.europa.eu/eurostat/databrowser/view/ISOC_SKE_ITRCRS__custom_10249290/default/table?lang=en. The percentage is lowest for smaller companies with 10-49 employees (59.9%) and highest for companies with 250 or more employees (72.2%).

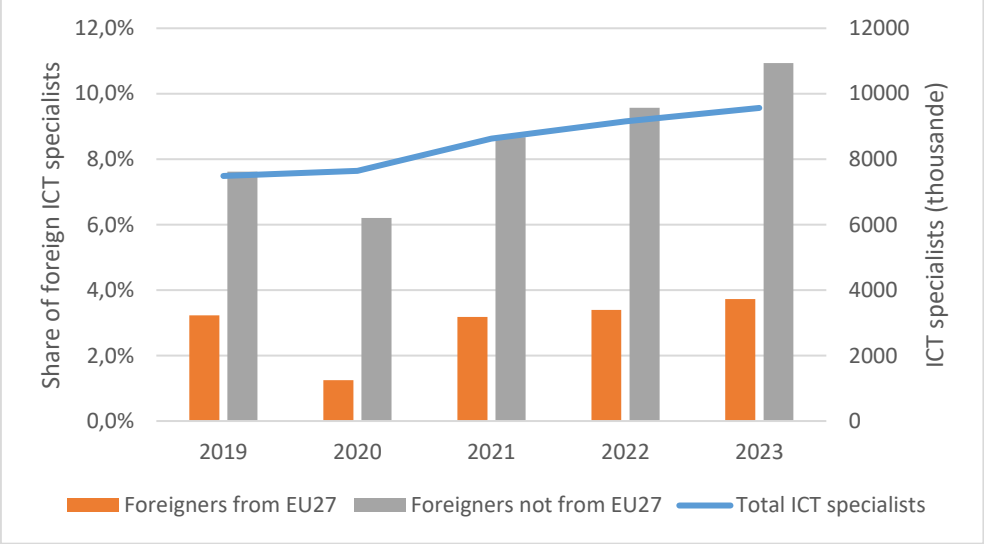
([319]) Eurostat, isoc_sk_oja1: https://ec.europa.eu/eurostat/databrowser/view/isoc_sk_oja1/default/table?lang=en&category=isoc.isoc_sk.isoc_sk_oja.

([320]) https://digital-skills-jobs.europa.eu/en/latest/news/brave-new-world-oecds-2023-skills-outlook-new-approach-skills.

([321]) https://advancedskills.eu/wp-content/uploads/2023/10/D2.2_LEADS_GAP_ANALYSIS_v1.0.pdf.

([322]) Eurostat, ad hoc elaboration on Labour Force Survey data.

Figure 53. Nationality of ICT specialists in the EU, 2019-2023



Source: Eurostat, ad hoc extraction on Labour Force Survey data.

EU and Member State measures

The Commission has made enhancing digital skills across the EU a **priority** during its 2019-2024 mandate. The adoption of the **Council Recommendation on improving the provision of digital skills and competences in education and training** ([323]) has been a cornerstone of the Commission's strategy. The Council Recommendation covers, inter alia, the development of a strategic and systematic approach to addressing the shortage of ICT professionals, in particular by recommending that Member States should forecast and assess future needs for digital skills, provide comprehensive career and study guidance, and prioritise the tackling of the gender bias in order to close the gender and pay gaps ([324]) in ICT. Furthermore, the Commission intends to support Member States in creating conditions conducive to developing advanced and specialist digital skills among students, researchers and lifelong learners; and to build (in close cooperation with Member States) on its commitments in the Women in Digital Declaration ([325]). In addition, on 20 March 2024, the Commission presented an **action plan on labour and skills shortages in the EU** ([326]) and proposed to work together with Member States and social partners to address these shortages – including shortages in digital skills – over the coming months and years.

The Commission also provides numerous funding opportunities to boost advanced digital skills in the EU via the **Digital Europe Programme (DEP)**. This support includes various initiatives, including the development of **specialised educational programmes** at different academic levels (such as bachelor's, master's and doctoral programmes ([327])); as well as **short-term training** courses that cover diverse key digital areas (e.g., including AI, data science, cybersecurity, IoT, cloud computing, HPC, quantum technologies,

([323]) Council Recommendation of 23 November 2023 on improving the provision of digital skills and competences in education and training, OJ C, C/2024/1030, 23.1.2024, ELI: http://data.europa.eu/eli/C/2024/1030/oj.
([324]) Gender pay gap in unadjusted form by NACE Rev. 2 activity – structure of earnings survey methodology [earn_gr_gpgr2__custom_9896477].
([325]) https://digital-strategy.ec.europa.eu/en/news/eu-countries-commit-boost-participation-women-digital.
([326]) https://ec.europa.eu/social/main.jsp?langId=en&catId=89&furtherNews=yes&newsId=10790.
([327]) Or equivalents at ISCED levels 6-8.

blockchain, microelectronics, robotics and eXtended reality). These programmes also provide training opportunities in specific sectors such as healthcare, business, transport, agriculture, food chains and energy systems. By June 2024, 38 projects had been awarded to enhance education and training opportunities for acquiring advanced digital skills. A total of 435 organisations, representing nearly all the EU Member States, are actively participating in one or more of these education and training projects. The Digital Europe Programme also supports other endeavours to bolster the digital skills of young individuals, including the **EU Code Week initiative** ([328]), which promotes coding and digital literacy among people of all ages in the EU. The Commission also oversees the operation of the **Digital Skills and Jobs Platform** ([329]) and is building the **Cybersecurity Skills Academy**. Moreover, the Programme also facilitates actions that target specific sectors, such as initiatives to enhance skills in the **semiconductor sector** and efforts to address the **gender gap** in ICT professions ([330]). These activities are complemented by skills-related endeavours under the **EuroHPC Joint Undertaking** and the **Data Space for Skills**.

Erasmus+ provides additional funding to boost advanced digital skills (e.g., for the Alliance for Innovation ARISA ([331]), which is developing a sectoral skills strategy on AI in the context of the Pact for Skills). In the area of Vocational Education and Training, Erasmus+ supports the work on digital skills through the initiative on Centres of Vocational Excellence (CoVEs) ([332]). **Horizon Europe**, plays a significant role (including through the European Research Council (ERC) and the Marie Skłodowska-Curie Actions) in attracting and retaining ICT talent. As part of the New European Innovation Agenda ([333]), the **Deep Tech Talent Initiative** ([334]) will train 1 million European citizens in deep tech fields by the end of 2025.

In addition to the Digital Europe Programme, Horizon Europe and Erasmus+, the Commission has been mobilising additional **funding programmes** to boost advanced digital skills. These include the European Social Fund Plus (ESF+) and the Recovery and Resilience Facility (RRF).

The Commission has recently taken a set of mutually reinforcing actions to make the EU more attractive to **non-EU talent** as well as boost intra-EU mobility ([335]). On 15 November 2023, the Commission proposed, as part of its **Talent Package**, the establishment of **an EU Talent Pool** to facilitate the strategic international recruitment of non-EU jobseekers for occupations of EU relevance that are experiencing shortages of

([328]) https://codeweek.eu.
([329]) https://digital-skills-jobs.europa.eu/en.
([330]) More precisely, a Digital Europe Programme call included in the 2024 work programme aims at identifying barriers to girls and women in ICT pathways – showcasing steps that can be taken to boost their representation in the digital sector, and establishing an expert network to inform the Commission on effective practices for supporting female participation in ICT across the EU. On 8 March 2024, International Women's Day, a 'Women in Digital' high-level meeting discussed how to increase female participation in ICT in the EU, presenting success stories and featuring panels in areas of education and skills as well as digital entrepreneurship and careers.
([331]) https://aiskills.eu.
([332]) https://erasmus-plus.ec.europa.eu/programme-guide/part-b/key-action-2/centres-vocational-excellence.
([333]) Communication from the Commission to the European Parliament, the Council, the Economic and Social Committee and the Committee of the Regions of 5 July 2022 on a new European innovation agenda, COM(2022) 332 final, https://research-and-innovation.ec.europa.eu/strategy/support-policy-making/shaping-eu-research-and-innovation-policy/new-european-innovation-agenda_en.
([334]) EIT Deep tech talent initiative, https://www.eitdeeptechtalent.eu.
([335]) https://migrant-integration.ec.europa.eu/news/european-commission-adopts-skills-and-talent-mobility-package_en

workers ([336]). Furthermore, digital professions are generally unregulated, so can also draw on the **revised Blue Card Directive** ([337]), which has introduced equivalence as regards skills attested by professional experience and comparable higher education qualifications in some ICT jobs ([338]). Moreover, the Commission is launching, together with interested Member States, **talent partnerships** with key partner countries. These partnerships combine direct support for mobility schemes with capacity-building and investment in human capital. Talent partnerships are open to all skills levels and could concern various labour market sectors, such as ICT.

ICT specialists and advanced digital skills in Member States' national Digital Decade strategic roadmaps ([339])

24 Member States have provided a **target for the ICT specialists**. 1/3 of the national target values assumed for 2030 are in line with or above the EU target value (at least 20 million ICT specialists employed within the EU, while promoting the access of women to this field and increasing the number of ICT graduates). 13 Member States have assumed a target value below the EU target value and 1 Member Statehave assumed a target value above the EU target value. 11 Member States have stated that they aim to increase the share of female ICT specialists. 3 of these 11 Member States (Portugal, Slovakia and Sweden) have assumed national target values.

Member States have reported a total of 176 measures (with a total budget of EUR 9.5 billion) contributing to this target. Around 30% of this budget comes from EU sources, around 55% from national sources and the remaining 15% from private sources.

The roadmaps include several new impulses: around one third of the measures (with a budget share of around 30%) are reported as being new. Around **one third** of the measures focus on digital skills in **formal education and higher education**, including vocational education and training (VET). **Another third** focus on supporting the advanced and highly specialised digital skills of **people currently in employment**, including broad upskilling and reskilling programmes as well as (sector)-specific initiatives (e.g., in the area of cybersecurity). The **remaining third** of the measures are **governance and other support initiatives,** including the setting-up of strategies and action plans linked to advanced digital skills, **improving the gender balance** by boosting women's advanced and highly specialised digital skills, as well as attracting and retaining **ICT specialists from abroad.**

([336]) Proposal for a Regulation of the European Parliament and of the Council establishing an EU Talent Pool, COM(2023) 716 final, https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=COM%3A2023%3A716%3AFIN.

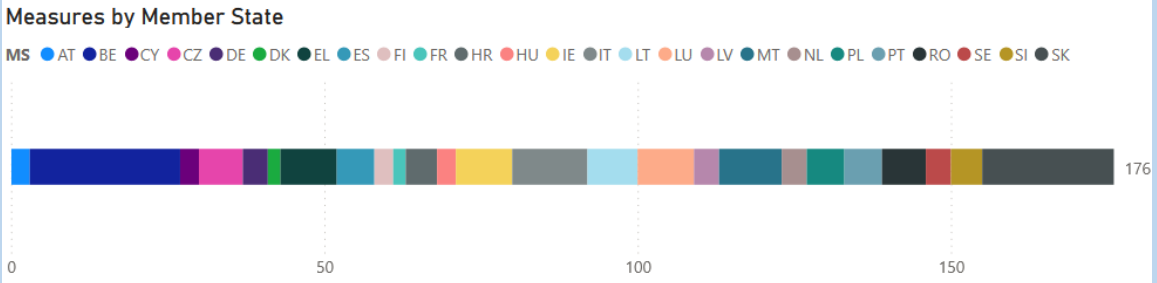
([337]) Directive (EU) 2021/1883 of the European Parliament and of the Council of 20 October 2021 on the conditions of entry and residence of third-country nationals for the purpose of highly qualified employment, and repealing Council Directive 2009/50/EC, OJ L 382, 28.10.2021, p.1.

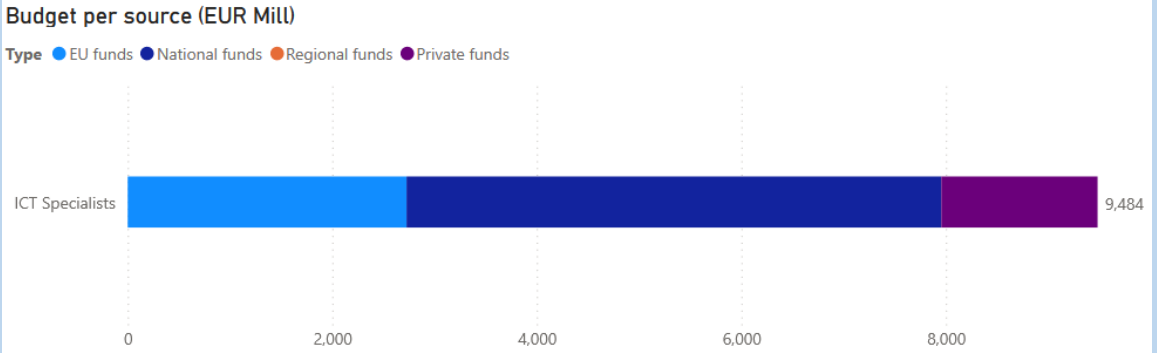
([338]) See Article 2(9)(a) and Annex I of the revised Blue Card Directive.

([339]) This analysis only takes account of elements reported by the Member States in their national roadmaps. The measures reported by the Member States were grouped into categories to provide a better overview of the types of measures taken.

Measures and budget (EUR Mill)

Target category	Measures	Budget
	4	677
1. Strengthening of advanced and highly specialised digital skills in formal education including vocational education and training and Higher Education Institutions	54	1,772
2. Strengthening of advanced and highly specialised digital skills of people currently in employment	48	4,811
3. Achieving gender convergence: Boosting advanced and highly specialised digital skills of women	19	107
4. Attraction and retention of ICT specialists and sector specialists possessing advanced digital skills from abroad, including via managed migration from 3rd countries	19	1,303
5. Governance and other support initiatives not covered in points 1-4	32	814
Total	**176**	**9,484**





Concluding remarks and future challenges

In an era characterised by **rapid technological advances**, the shortage of ICT specialists poses significant challenges across various sectors. From companies whose core services revolve around ICT on the one hand to the healthcare and finance sectors on the other hand, the lack of professionals with advanced digital skills is hampering innovation and progress. Proficiency in the latest advances in emerging technologies (e.g. (generative) AI, eXtended reality, data analytics, quantum computing, cybersecurity, robotics and HPC) will emerge as a pivotal driver of the EU's competitiveness and technological sovereignty. Member States have made massive investments in digitising public services (notably under the RRF), so there is also a high need to introduce adequate measures to reskill and upskill employees in the EU-wide public sector ([340]).

Academic and advanced vocational and professional education and training systems are beginning to address the increasing demand for training opportunities in advanced digital skills, but there remains a **shortage of specialised programmes** that provide adequate training. In addition, a major challenge for ICT specialists is that **learning pathways** (particularly those provided by higher education institutions) are currently not flexible enough, given the limitations in the structure and design of educational systems.

([340]) There are an estimated 9 million staff in central, regional and local administrations across the Member States and approximately 41 million employees in the EU-wide public sector. https://commission.europa.eu/system/files/2023-10/2023.4890%20HT0423966ENN-final.pdf.

One of the foremost challenges is the **high speed at which technology evolves**. Even highly skilled ICT specialists find it challenging to keep pace with these changes, let alone educational institutions tasked with training the next generation that will further develop and apply those technologies. In particular, the swift adaptation of academic programmes can pose challenges, because the formal education sector is frequently subject to legal and administrative constraints. Failure to adapt to the rapidly changing technological landscape will result in a severe **misalignment with industry needs** ([341]).

There remains a **lack of young people entering science, technology, engineering and mathematics (STEM) fields**, and this is perpetuating the shortage of ICT specialists. The shortage of young people pursuing STEM fields can be partly attributed to the insufficient level of **digital competence among teachers**, who play a crucial role in fostering student interest in these fields. The lack of interest is also linked to **misconceptions** by both young people and their parents concerning the **accessibility and attractiveness of ICT careers** and a lack of diverse **role models** (particularly among women and minorities). A lack of awareness and promotion of female mentors and role models can further exacerbate the issue. Addressing these misconceptions, strengthening the participation of young people in STEM classes starting at an early age in their educational journey and promoting diversity and inclusion in the ICT sector are essential for attracting a broader talent pool. In addition, biases in hiring algorithms (stemming partly from the lack of diversity in specialists' backgrounds) highlight the importance of attracting women and minorities to the ICT field in order to foster inclusivity.

The **growing global demand** for ICT professionals presents significant challenges for the EU. Many companies are already finding themselves in increased competition for ICT specialists and this is intensifying the strain on an already competitive job market. These challenges include not only attracting top-tier talent from outside the EU but also **retaining** such talent, particularly if non-EU countries offer more appealing incentives (e.g., higher salaries and potentially more favourable working conditions) and thus attract skilled professionals away from the EU. SMEs face the additional challenge of retaining young professionals with the requisite skills, as many are drawn to larger corporations offering more competitive salaries and benefits.

These complex issues require comprehensive and multi-faceted approaches. The box below sets out some ideas for reflection.

Approaches to boosting ICT specialists and advanced digital skills

Building on the recently issued **Council Recommendation on improving the provision of digital skills and competences in education and training**, alongside the suggestions put forward by the Digital Europe Programme LEADS project ([342]) as well as by experts in a recently conducted CONNECT University ([343]), approaches to boosting ICT specialists and advanced digital skills touch on several areas of action:

([341]) LEADS D3.1, First guidelines generated, 2024, https://advancedskills.eu/publications.
([342]) LEADS (2024): First guidelines generated, available at: https://advancedskills.eu/wp-content/uploads/2024/03/LEADS-D3.1-First-Guidelines-Generated.pdf.
([343]) CONNECT University (2024): How can the EU boost advanced digital skills? Available at: https://digital-strategy.ec.europa.eu/en/events/connect-university-how-can-eu-boost-advanced-digital-skills.

- **Early exposure to science, technology, engineering and mathematics (STEM)**: introduce STEM subjects (including the teaching of digital skills) at an earlier stage in the education cycle to inspire interest among young people.
- **Promotion of STEM (including via role models)**: actively promote STEM subjects to attract more young people (particularly women) by, for example, showcasing visible role models to break down social barriers, running targeted awareness-raising campaigns and promoting participation in relevant initiatives ([344]).
- **Boosting teachers' advanced digital skills**: incorporate digital skills training into teacher education programmes and ensure ongoing training for in-service teachers and school leaders in order to enhance teachers' competence and confidence in digital technologies and stay abreast of technological advancements.
- **Teach advanced digital skills via vocational education and training (VET)**: promote vocational education as an attractive and labour-market relevant choice, offering real-time learning experiences tailored to industry needs.
- **Increase the academic offer by higher education institutions and boost industry integration**: facilitate collaboration between universities to leverage expertise and resources and foster closer ties between industry and academic institutions (e.g., via adjunct professors, strategic partnerships and collaborative projects to provide students with real-world insights and experiences).
- **Lifelong learning initiatives and new pathways**: respond to the fact that supply will not be enough to support the current pace of technology development by supplementing formal education programmes with micro-credentials and fast-paced learning initiatives such as short-term courses and online learning options (offered by higher education institutions, training institutions and others) to meet the rapidly changing demands of the digital landscape.
- **Diversity and inclusion, particularly of women**: encourage diversity in the ICT sector, for example by running awareness-raising campaigns (e.g., in collaboration with the National Coalitions for Digital Skills and Jobs ([345])), providing scholarships, internships, education and training opportunities (e.g., summer camps) and other support (e.g. career days and study guidance events) to underrepresented groups, particularly women. In addition, improving workplace flexibility and narrowing the gender pay gap ([346]) would be crucial steps to attract more women to the ICT sector.
- **Sharing best practices**: foster knowledge-sharing between Member States and stakeholders to identify and replicate successful strategies for boosting advanced digital skills.
- **Foresight and market anticipation**: promote the anticipation of future market needs in order to respond to them by setting educational curricula and training offers that will equip people with the skills required for tomorrow's jobs.

([344]) E.g. EU Code Week, the Digital Education Hackathon.
([345]) https://digital-skills-jobs.europa.eu/en/about/national-digital-skills-and-jobs-coalitions.
([346]) Directive (EU) 2023/970 of the European Parliament and of the Council of 10 May 2023 to strengthen the application of the principle of equal pay for equal work or work of equal value between men and women through pay transparency and enforcement mechanisms.

- **Attract and retain talents from non-EU countries:** fully leverage the Blue Card Directive and talent partnerships; and share best practices between Member States for attracting ICT specialists and sector specialists that possess advanced digital skills to the EU.

4.1.2. Trusted solutions for online interaction: the EU eID

Considering the increased usage of electronic transactions, people in the EU more than ever need a **convenient, reliable and safe means for online identification, authentication, and electronic signatures**. This should be as convenient and as secure as it is offline. These issues are crucial in securing the right to digital citizenship.

The vision of the Commission is to provide tools that makes a difference for Europeans by solving real, recurrent problems they face in their daily lives. The solution put forward takes the shape of the **EU Digital Identity Wallet (EDIW)**, introduced in the Commission proposal of 3 June 2021 for a regulation establishing the European Digital Identity Framework. The regulation entered into force on 20 May 2024 and the EDIW will be rolled out to the public by the end of 2026.

The proposal for the EDIW has also to be seen in the context of COVID lockdowns, the restricted access to physical services, and the rapid move toward digital provision of services that further highlighted the urgent need for safe and secure digital identification and authentication means for all European people and businesses.

EDIWs are **mobile or web applications that will allow people and businesses to digitally identify themselves for the purpose of gaining access to public and private digital services**, only revealing the details required for the specific service, without sharing any extra identity information.

These applications will also enable people to **store and share information related to identity** (such as permits, titles, qualifications, etc.) in digital format in one single place. The range of documents includes personal items such as driving licences and university diplomas, as well as business-related certificates like environmental permits and businesses certifications.

The introduction of the EDIW will be a game changer in simplifying the life of people and businesses. The wallet will provide them with a convenient, secure and interoperable identification service. It is expected to substantially accelerate the take-up of digital identities, make key digital public services more accessible to all, and cut paperwork and red tape for people and companies in all their online transactions, with both public sector bodies and private digital service providers.

The swift implementation of the EDIW – by 2026 – is the condition for achieving the **Digital Decade target: by 2030 100% of Union citizens** have access to a secure electronic identification (eID) means recognised throughout the Union, enabling users' full control over identity transactions and shared personal data.

The EDIW is also a key enabler of different targets and objectives of the Digital Decade. Not only will it facilitate the use of key digital public services, but it will also provide secure and easy access to a range of private digital services, and play a crucial role in

protecting fundamental rights online, ensuring safety and privacy in all exchanges, giving citizens full control over the data they share, and avoiding profiling, tracing and tracking.

The EDIW stems from the amended eIDAS regulation providing for uniform specifications throughout the EU. This is a major step up from the previous cross-border legal framework for trusted digital identities, relying on the voluntary mutual recognition of eIDs between Member States.

State of play and progress towards the Digital Decade target

As mentioned above, the Digital Decade target will be achieved with the roll-out of the **EDIW by 2026**, providing all citizens with secure and interoperable means of eID.

However, some data help provide a picture of the current situation and progress made in terms of eID schemes across the EU.

In 2024, **notified eIDs are available in 22 Member States** (plus Norway and Lichtenstein), being **available to 93.16% of the EU population**.

This figure represents **slight progress compared to 2023, when 21 Member States had notified their eID schemes**. However, progress has been remarkable over the last 3 years: in 2021, at the time the regulation was adopted, introducing the European Digital Identity Framework, only 14 Member States had notified the Commission that they had an eID scheme, and one was available to almost 60% of the EU population. This figure increased to 18 Member States that had notified eID schemes in 2022. The need to progress in this area had been highlighted by the 2023 report on the State of the Digital Decade, which had invited Member States to notify the Commission that they had established an eID scheme in their country.

A comparison with selected non-EU countries shows that the EU is generally at the forefront in this area ([347]).

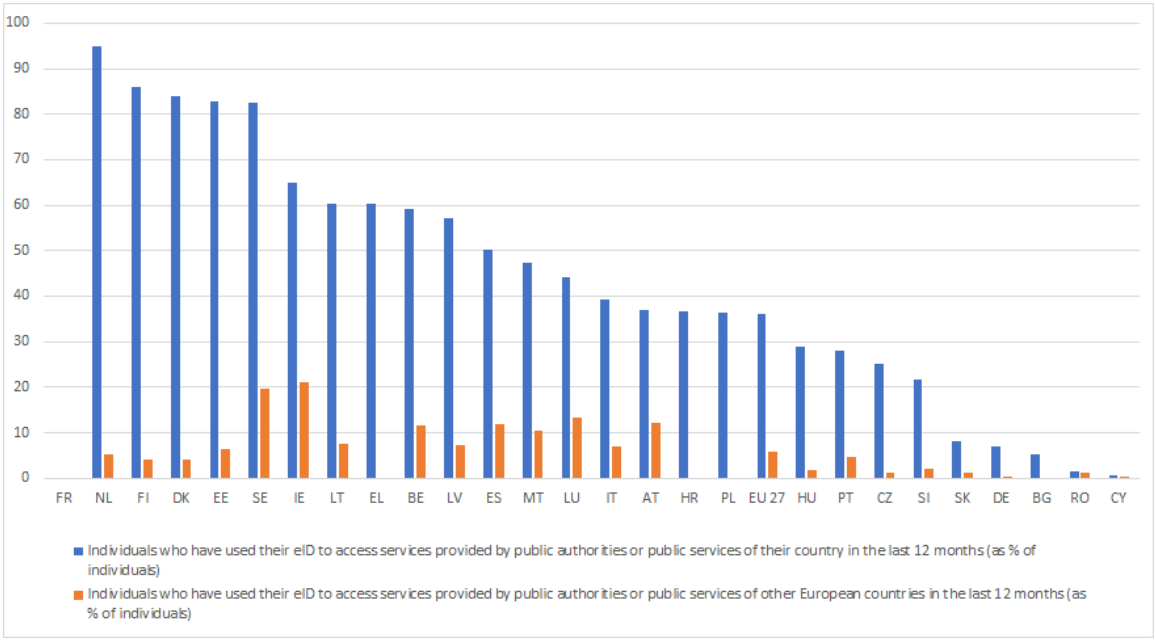
However, **take-up** of eIDs differs greatly between Member States. Data from Eurostat, collected for the first time in 2023, shows that on average **35.7% of people use an eID to access public services**. This figure differs significantly between the Member States. The Member States with the highest proportion of people using an eID to access services provided by public authorities or public services are **the Netherlands (95%) and Finland (86%)**. At the other end of the scale are **Germany (7%), Bulgaria (5%) and Cyprus (less than 1%)** (see Figure 54).

Looking at **access to public services across borders** using an eID, the data shows that high barriers exist. The most transactions were carried out by Sweden (20%) followed by Luxembourg (13%) and Austria (12%). At the lower end of the scale (where data exists) are Germany (0.29%), Cyprus (0.34%) and Romania (1.12%) ([348]).

([347]) According to the study 'International Benchmarking of the Digital Transformation 2024': (https://digital-strategy.ec.europa.eu/en/news-redirect/833343), 4 countries out of the 7 in scope implement an eID system (Australia, Israel, Japan and South Korea).

([348]) Eurostat, Use of electronic identification (eID); data not part of the DESI dashboard and accessed on Eurostat on 17/0/2024. Note: the Finnish and Romanian means of eID have not been notified under the eIDAS Regulation. The process for Romania has started.

Figure 54. Individuals who have used their eID to access services provided by public authorities or public services in their country and abroad in the last 12 months, % of individuals, 2023



Source: Eurostat

The roll-out of the **EDIW by 2026** is expected to increase the number of digital services available – both public and private – and in turn the uptake of digital means of identification.

EU and Member State action

Last year's report on the State of the Digital Decade called on Member States to prepare to set up and implement of the EDIW, in particular through pilot projects and by mobilising the digital ecosystem.

Already in 2021, the Commission, in close collaboration with Member States, started working on the development of the technical specifications and use cases for the EDIW, within the context of the Commission Recommendation on a common Union Toolbox for a coordinated approach towards a European Digital Identity Framework ([349]).

The collaborative work on the technical specifications has helped Member States develop new, innovative national solutions, while avoiding fragmentation on the market.

In March 2023 the EU Commission **started to develop an open source template for the EDIW**.

Since April 2023, the Commission is funding, under the Digital Europe Programme, **four large-scale pilot projects**, piloting different use cases for the wallet. The four pilot projects involve more than 360 public and private bodies throughout 26 Member States plus Norway, Iceland and Ukraine.

The wide participation by almost all Member States is a good testament to the take-up of the recommendations from the last Digital Decade report. These use cases involve storing and sharing **education credentials**; accessing **digital public services** (including cross-

([349]) Commission Recommendation (EU) 2021/946 of 3 June 2021 on a common EU toolbox for a coordinated approach towards a European Digital Identity Framework.

border); storing and sharing **travel documents**, such as boarding passes; storing and sharing your **digital driving licence**; accessing your **bank account,** opening a **bank account and authorising payments**; buying a **pre-paid SIM card**; **signing contracts**; and **proving your professional affiliations**.

Delivering on this will be a key measure in reducing administrative burden on enterprises in Europe, as it will be enabling a seamless experience, incorporating essential online identification and authentication services. The 2019 Digitalisation Directive ([350]) already relies on the eIDAS Regulation for e-identification and trust services in company law procedures, including fully online setting up of companies.

It will also enable the easy handling of business-relevant documents such as attestations and certificates and it will support payments, account opening and the management of corporate obligations in the financial sector. For instance, the multilingual digital EU Company Certificate with essential company data for companies to use cross-border and a multilingual digital EU Power of Attorney, which will be introduced by the forthcoming Directive on Upgrading Digital Company Law ([351]), will be both compatible and provided by the European Digital Identity Wallet. Furthermore, the wallet simplifies the assignment and use of specific business roles and responsibilities, improving business operations and digital interactions.

eID in Member States' national Digital Decade strategic roadmaps ([352])

eID and Digital Wallet trajectories and national target values are not widely present in the national roadmaps, as this target has a focus on the number of Member States that have notified at least one national eID scheme.

In total Member States reported 58 measures contributing to this target, with a total budget of EUR 0.9 billion. 80% of the total budget comes from EU funds, and 20% from national funds. 43% of the measures are considered new (budget of EUR 388 million).

58 measures on eID and Digital Wallet are present in the roadmaps. One third of them concern the deployment of Electronic Identification and Trust Services, including certification processes and regulation.

Another third of the measures focus on implementing the European Digital Identity Wallet, including proof-of-concepts and pilot projects. The remaining third are measures focused on the improvement of the eID framework.

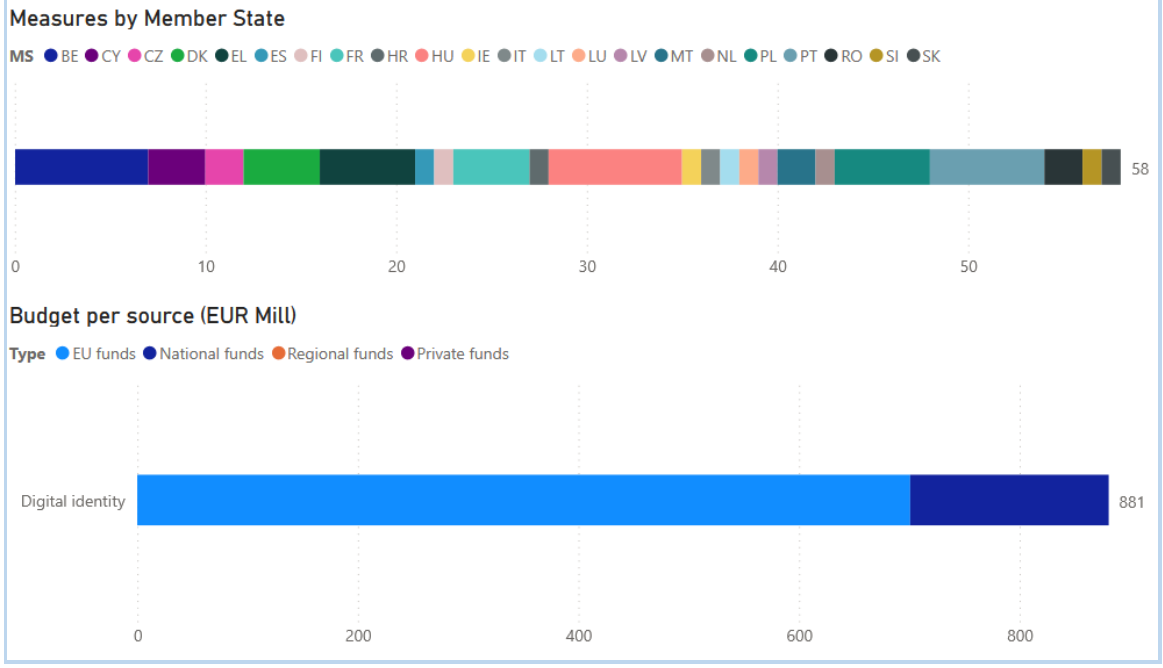
([350]) Directive (EU) 2019/1151 of the European Parliament and of the Council of 20 June 2019 amending Directive (EU) 2017/1132 as regards the use of digital tools and processes in company law, OJ L 186, 11.7.2019, p. 80–104.

([351]) https://www.consilium.europa.eu/en/press/press-releases/2024/03/13/council-and-parliament-strike-a-deal-to-expand-the-use-of-digital-tools-in-eu-company-law/.

([352]) This analysis only takes account of information reported by the Member States in their national roadmaps. The measures reported by the Member States were grouped into categories to provide a better overview of the types of measures taken.

Measures and budget (EUR Mill)

Target category	Measures	Budget
1. Deployment of Electronic Identification and Trust Services	21	575
2. Implementation of European Digital Identity Wallet	19	64
3. Improvement of eID framework	18	242
Total	**58**	**881**



Concluding remarks and future challenges

Overall, a single, secure, and privacy friendly digital identity is a key enabler for safe and convenient access to the digital world and therefore a necessary ingredient to complete the Digital Single Market.

The empowerment that the eID wallet will offer is threefold:

- First, the large **efficiency gains** that people and businesses will experience by the use of a single wallet for their daily online (and offline) **identification and/or authentication**, vis-à-vis authorities and the very large online platforms that are often the gateways to digital life, and for online transactions across all sectors of the economy. From issuing insurance online to renting a car or storing environmental permits for your business: the range is as wide as the economy itself.
- Second, the **full control of personal and sensitive data** that is offered to wallet users, on the basis of the unique privacy-centric architecture of the wallet, which offers the user control of which data are shared with who and allows users to retract data at any time, or to ensure that just the minimum necessary data are shared with third parties.

  This represents a real improvement compared to the current situation, specifically when we consider how often photocopies of passports are made in car rental agencies, hotels, etc. Building on this, the European Digital Identity Wallet has been identified as a promising tool to support the protection of children online. In this context, the Task Force on Age Verification, set up under the DSA, is currently exploring how to make

best use of the wallet for age verification purposes. This is also one of the priority use cases in the call for proposals for new pilot projects that are expected to start in 2025.

- Third, the significant benefits the EDIW will bring for the **EU single market**, by offering a uniform and highly secure means of identification and authentication for people and businesses and a platform for sharing digital attributes and certificates. Specifically for businesses, significant efficiency gains are expected, as they will be able to identify themselves as legal persons across the EU, and will be able to use public services in other Member States as they would in their home country.

In the coming period, following the entry into force of the Regulation, it will be **crucial to ensure swift implementation at national level, including with the help of large-scale pilot projects to develop** a **tool that is both safe and secure to use, while at the same time offering excellent user experience**. These aspects are key conditions for ensuring a high uptake by service providers and the public.

4.1.3. Key digital public services user-friendly and accessible to all

Delivering services efficiently and reducing the burden on both people and businesses is a key priority. In the recent Digital Decade Eurobarometer 2024([353]) five out of six Europeans (83%) think that by 2030 digital technologies would be important for accessing public services online, and 79% consider the same about accessing or receiving healthcare services (e.g., telemedicine and AI for diagnosing diseases)([354]).

At the same time, 88% of respondents think public authorities should ensure that people receive human support to accompany the transformation brought by digital technologies and services in their lives.

Key public services should be available online to people in any Member State without discrimination: fully user-centric, bringing tangible simplification (e.g., through the once-only principle) and striving for personalised and eventually proactive public services that work seamlessly across borders and languages.

To reach that goal, the Single Digital Gateway (SDG) Regulation sets the EU standards for e-Government and the digitalisation of public administration. Through the Your Europe web portal, the SDG sets up a one-stop shop that provides online information about the administrative steps of the public procedures and access to online access to a wide range of fully digital public services that are essential for people and businesses, thus making it easier for people to study, move, work and retire in different countries around the EU and for companies, especially SMEs, to do business across the bloc.

As regards company law procedures, which are not covered by the Single Digital Gateway, a major step forward in providing digital public services for companies was made by making it possible to set up limited liability companies across the EU, register branches and file company information with business registers fully online (through the Digitalisation Directive[355]) and by providing a harmonised procedure - with digitalised

([353]) Special Eurobarometer 551 'The Digital Decade' 2024: https://digital-strategy.ec.europa.eu/en/news-redirect/833351.

([354]) Special Eurobarometer 551 'The Digital Decade' 2024: https://digital-strategy.ec.europa.eu/en/news-redirect/833351.

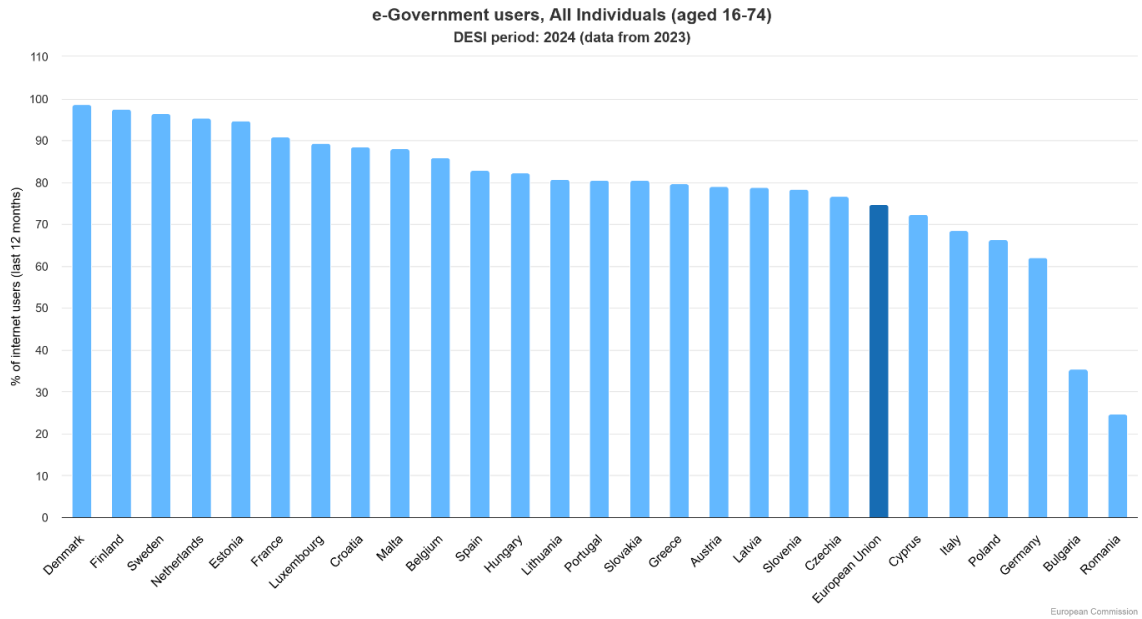
([355]) Directive (EU) 2019/1151 of the European Parliament and of the Council of 20 June 2019 amending Directive (EU) 2017/1132 as regards the use of digital tools and processes in company law, OJ L 186, 11.7.2019, p. 80–104.

steps - for important corporate restructuring operations, such as cross-border mergers, conversions or divisions (through the Cross-Border Mobility Directive [356]). Another important step will be made by the new digital by default solutions for companies under the forthcoming Directive on Upgrading digital company law, including the introduction of the "once-only principle" for setting up subsidiaries and branches in other Member States.

Interoperability, and in particular the newly adopted Interoperable Europe Act, is one of the key instruments for delivering on these objectives. The Act will help strengthen cross-border interoperability and cooperation in the public sector across the EU, which is essential for fully tapping into the public sector's transformation potential, avoiding fragmentation and improving data sharing.

These targets and objectives are becoming increasingly relevant in a context where most internet users in the EU use online tools for interacting with public administrations. In 2023, 75% of all internet users (aged 16-74) had interacted via a website or an app with public authorities in the previous 12 months. This represents an increase of one percentage point compared to 2022, when this share was 74%.

Figure 55. e-Government users interacting with public authorities via websites or apps in the last 12 months (% of internet users), 2023



Source: Eurostat, Community survey on ICT usage in Households and by Individuals.

The Digital Decade policy programme has set the **target of making 100% key public services for citizens and businesses accessible online**.

([356]) Directive (EU) 2019/2121 of the European Parliament and of the Council of 27 November 2019 amending Directive (EU) 2017/1132 as regards cross-border conversions, mergers and divisions, OJ L 321, 12.12.2019, p. 1–44.

Key digital public services for citizens– state of play and progress towards the Digital Decade target

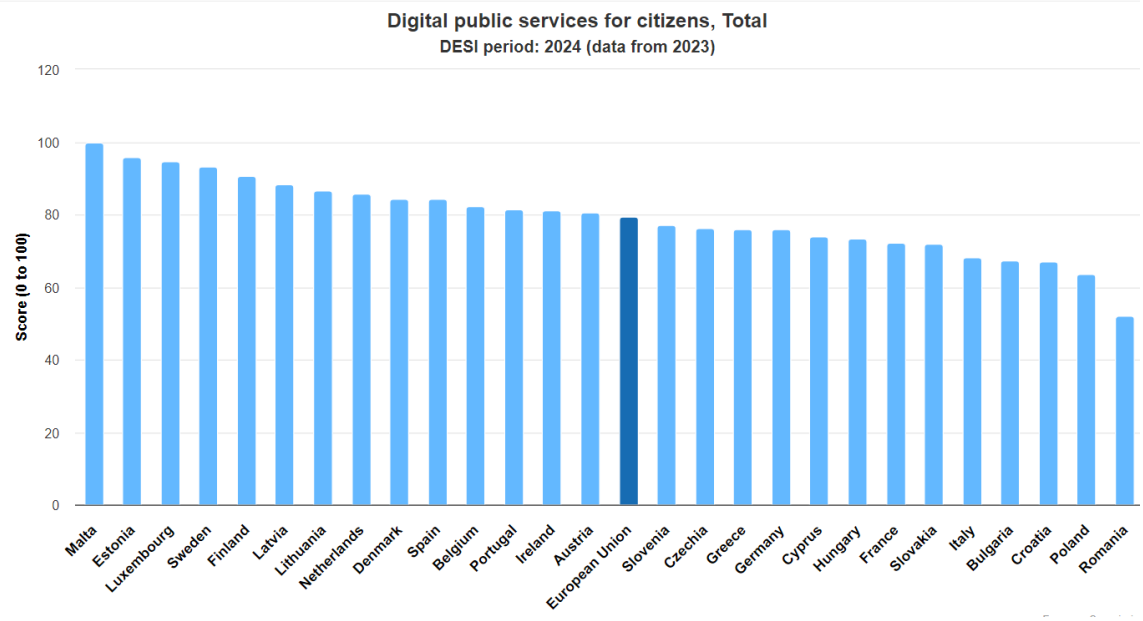
Regarding the **availability of key digital public services for citizens**, the related key performance indicator measures the extent to which a service, or information on a service, for people is provided online, and/or via a government portal ([357]).

The indicator measures the share of administrative steps that can be completed online in 'major life events' for people, for example the birth of a child. This encompasses the whole package of governmental or public services, usually provided by multiple agencies, that support people through key points of their lives.

The indicator considers seven major life events: Career, Studying, Family, Health, Moving, Transport and Regular business operations. The indicator is calculated as the average of the national and cross-border online availability for informational and transactional services ([358]).

In **2023, the average EU score was 79**, **increasing from 77 in 2022 and 75 in 2021**. As in the previous Digital Decade report, Malta, Estonia, Luxembourg, Sweden and Finland are the top five performers, with Malta having already achieved the Digital Decade target (Figure 56 below).

Figure 56. Digital public services for citizens (score 0 to 100), 2023



Source: e-Government Benchmark, Capgemini.

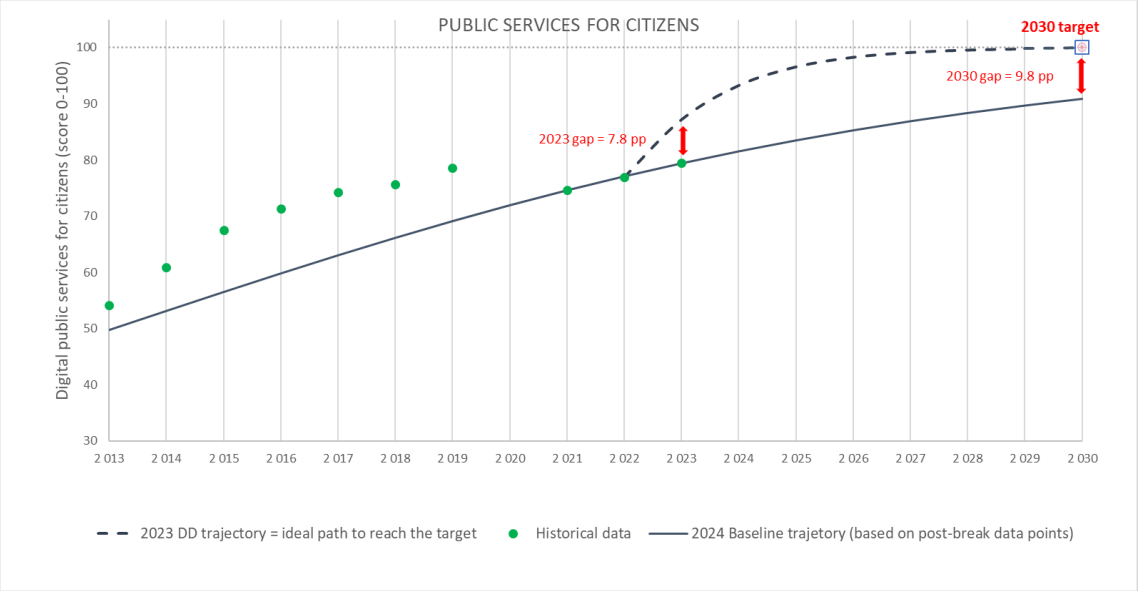
Despite the progress made, the **overall distance to the Digital Decade target is still significant**. In 2023 **the EU was 7.8 points below the value that would be needed to be on track towards the 2030 target**.

Overall, in a business-as-usual scenario, **achieving the EU target by 2030 remains a challenge**. Most Member States (starting from those 13 Member States that are below the

([357]) Services can be offered fully online, partially online, or offline only, and are classified accordingly.
([358]) Informational services: services and procedures that provide users with adequate and personalised insight into their situation. Transactional services: services and procedures needed to fulfil the essential requirements of a life event through online interaction.

EU average) will need to strongly improve their performance if they are to achieve the Digital Decade ambition.

Figure 57. Online service provision for citizens. Historical data, Digital Decade (DD) trajectory and baseline trajectory towards 2030



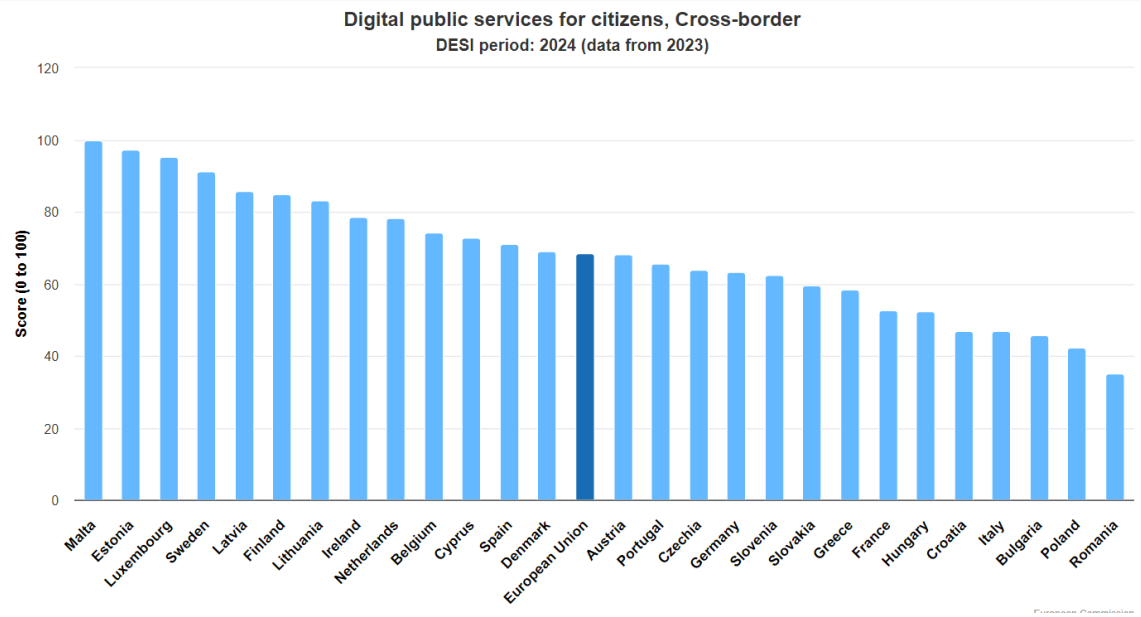
When focusing only on **cross-border use**, the picture is less positive. Cross-border users who want to live, work, study or enjoy a vacation abroad can face online difficulties due to their nationality. 150 million European people – close to 30% of the population – live in border regions in the EU ([359]), so accessing cross-border services is a necessary part of their daily lives.

The data, however, still shows big differences between Member States. But improving cross-border interoperability of digital public services could lead to annual cost savings for people of up to EUR 6.3 million ([360]).

([359]) https://commission.europa.eu/news/new-solutions-improve-citizens-lives-europes-cross-border-regions-2023-12-12_en.

([360]) Commission Communication on a strengthened public sector interoperability policy Linking public services, supporting public policies and delivering public benefits Towards an 'Interoperable Europe', November 2022, COM/2022/710 final.

Figure 58. Cross-border online availability of public services for citizens (score 0 to 100), 2023



Source: eGovernment Benchmark, Capgemini.

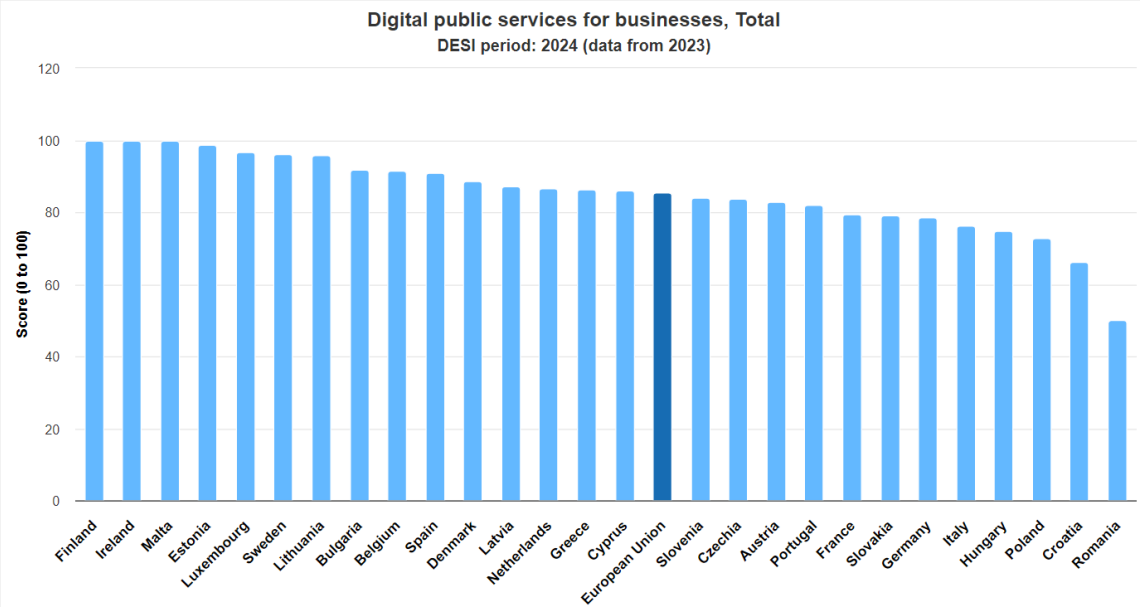
Key digital public services for businesses – state of play and progress towards the Digital Decade target

Regarding the availability of key digital public **services for businesses**, the related key performance indicator measures the share of administrative steps in a life event that can be completed online for the two major life events for businesses: starting a business and conducting regular business operations.

It is calculated as the average of the national and cross-border online availability for informational and transactional services. Services provided through a portal receive a higher score, while services that only provide information online, but require operations to be carried out offline receive a lower score. This indicator also measures the degree to which public services for businesses are interoperable and work across borders.

In 2023, the **EU average score was 85, a slight increase compared to 2022, when the score was 84**. Three countries (Finland, Ireland and Malta) have already achieved the Digital Decade target for 2030 (Figure 59 below).

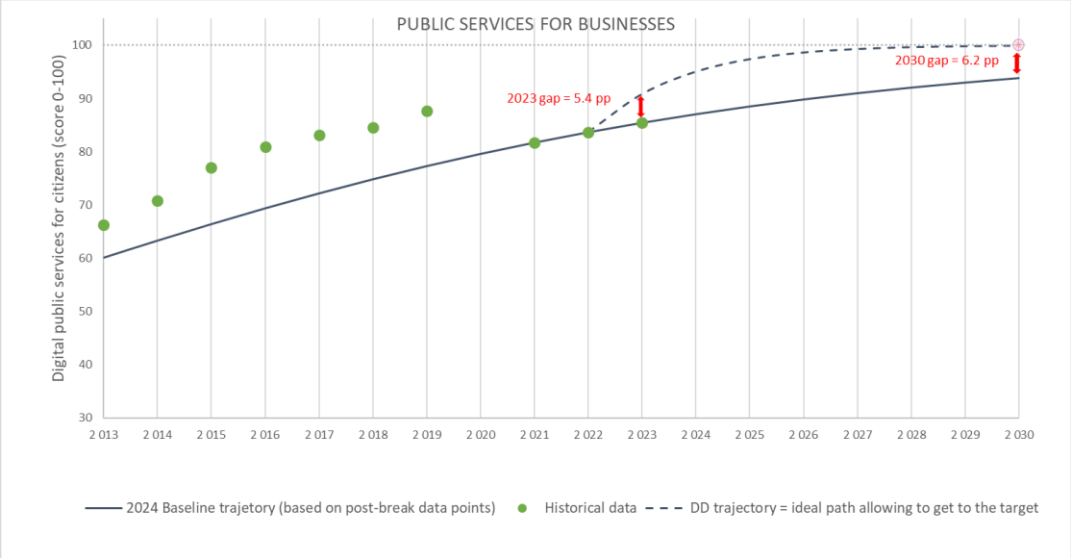
Figure 59. Digital public services for businesses (score 0 to 100), 2023



Source: e-Government Benchmark, Capgemini.

Most Member States **are relatively on track to achieve a score of 100 by 2030**. In 2023 **the EU was 5.4 points below the value that would be needed to be on track towards the 2030 target**. Improvements are still needed to ensure the EU target is fully achieved by 2030.

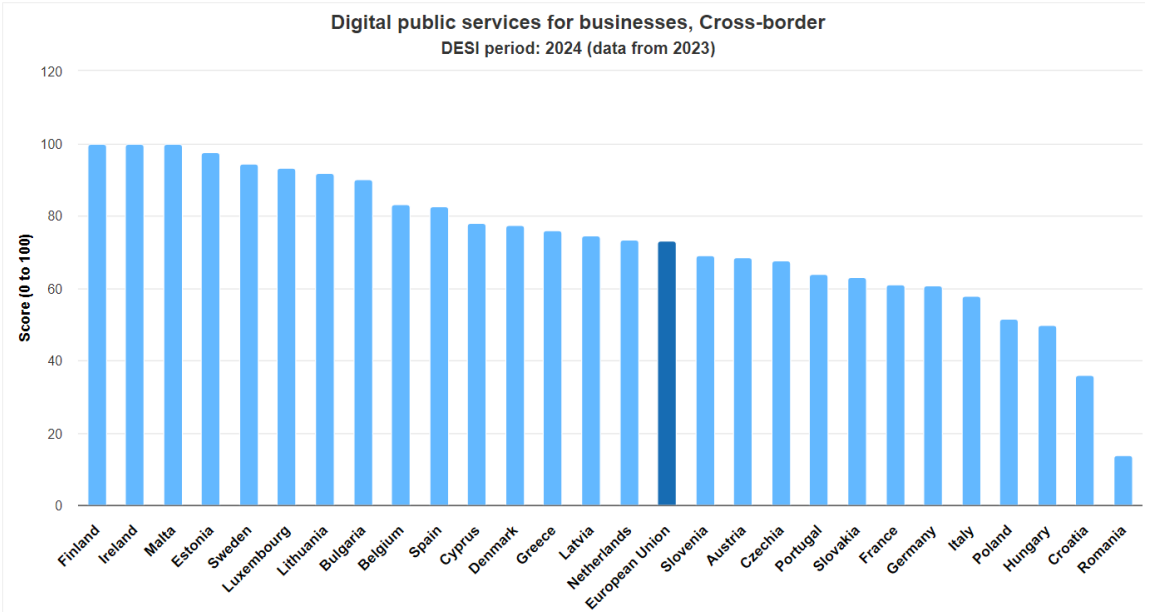
Figure 60. Online service provision for businesses. Historical data, Digital Decade (DD) trajectory and baseline trajectory towards 2030



While most EU Member States have made significant efforts to move their public services for businesses online, also in this case the availability and usage of these services **across borders** is still lagging behind, mostly because online services for domestic businesses are more mature than for their counterparts in other Member States.

The estimated annual cost savings credited to cross-border interoperability range between EUR 5.7 billion and EUR 19.2 billion for businesses ([361]).

Figure 61. Cross-border online availability of public services for businesses (score 0 to 100), 2023



Source: e-Government Benchmark, Capgemini.

The Single Digital Gateway (SDG) has certainly contributed to a large increase in the number of new cross-border digital public services, enabling people and businesses to interact with foreign governments online.

In 2023, the Your Europe web portal – the public interface of the SDG – was the most visited Commission website, with more than 32 million visitors. Thanks to the SDG, all public services in 23 areas have to be available fully online and accessible to cross-border users and the Once-Only Technical System has been established to allow the automated exchange of more than 1 200 types of official documents (e.g., birth certificates or business permits) between more than 80 000 authorities across the EU.

The new online procedures under EU company law, i.e., the fully online setting up of companies and branches, online filing of company information to business registers and online access to company information via the Business Registers Interconnection System, BRIS, have contributed to the digitalisation of public services, reducing costs for companies and providing a more secure way to transmit company data.

Mobile friendliness, user support, transparency and use of pre-filled forms

The e-Government Benchmark provides a number of additional indicators that measure:

- **Mobile friendliness**, assessing the extent to which services are provided through a mobile-friendly interface, i.e., an interface that displays in usable form on a mobile device. Compatibility with mobile devices is **an aspect of user-centricity**, which is becoming ever more important. The score on mobile friendliness for all EU countries

([361]) Commission Communication on a strengthened public sector interoperability policy Linking public services, supporting public policies and delivering public benefits Towards an 'Interoperable Europe', November 2022, COM/2022/710 final.

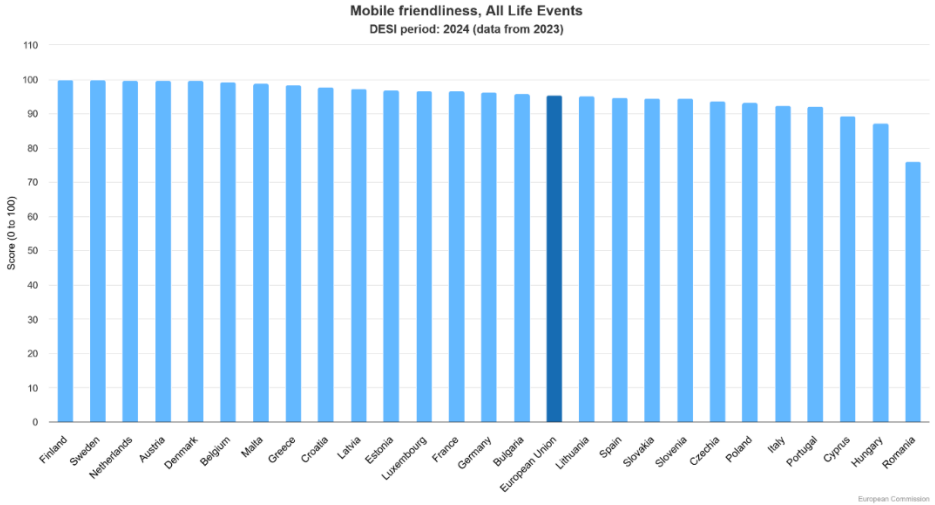
in 2024 is **95, a slight improvement on 2023**, when the score was 93. Sweden and Finland score 100 on this indicator.

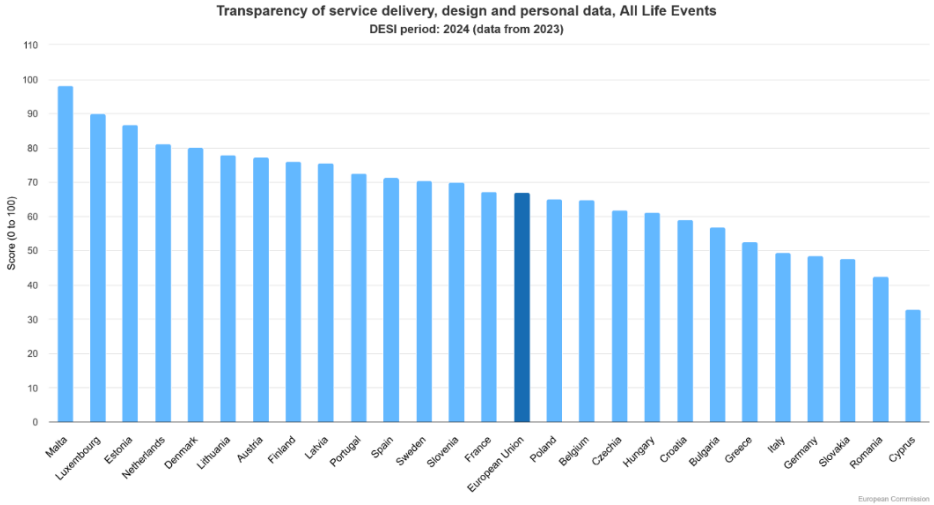
- **Pre-filled forms**, i.e., the extent to which data that is already known to public administrations is pre-filled in forms presented to the user. The score for this indicator in 2024 is **71, compared to a score of 68 for 2023**. The maximum overall score is 100.
- **Transparency** assesses the extent to which service processes are transparent, services are designed with user involvement and users can manage their personal data. The score for 2024 for this **indicator is 67 out of a maximum of 100, up from 65 in 2023**. This aggregate indicator includes the following three key elements:
    - 1. Transparency of **service delivery –** the extent to which the process and expectations involved in the service are clear.
    - 2. Transparency of **personal data** – the extent to which users can manage their personal data held by government organisations.
    - 3. Transparency of **service design** – the extent to which users are informed about and involved in policy and service design processes.
- **User support** measures the extent to which online support, help features and feedback mechanisms are available for users, both from within the country and from other European countries. For 2024, the indicator for user support has **a score of 86, an increase from a score of 84 in 2023**. User support is an essential element of **user centricity**.

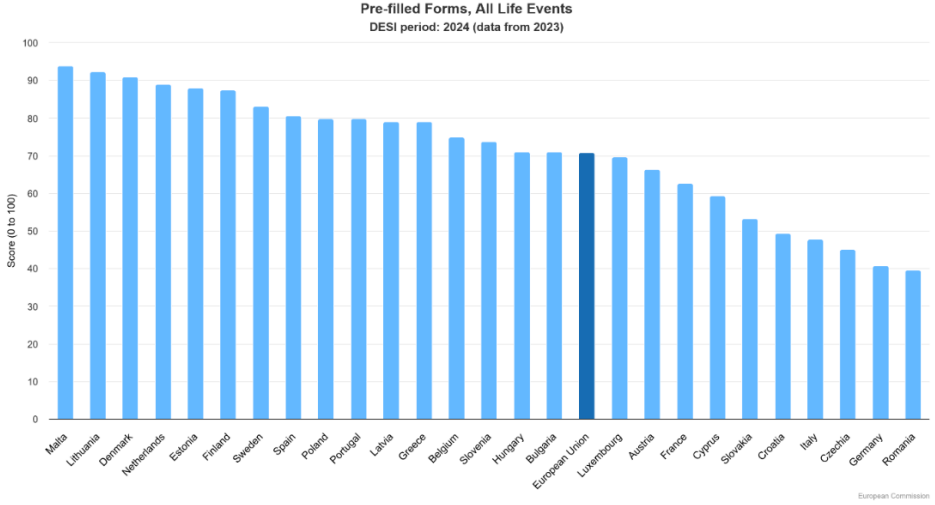
The Online Services Index offers an international comparison. It measures the scope and quality of online services ([362]). The EU average score is relatively low and lagging behind the other countries in the index (Australia, China, Israel, Japan, Republic of Korea, United States and United Kingdom). Although the index records a series of ups and downs over time (likely not least due to data collection bias – it is survey-based), all countries in the sample score relatively highly and the differences between them are quite small.

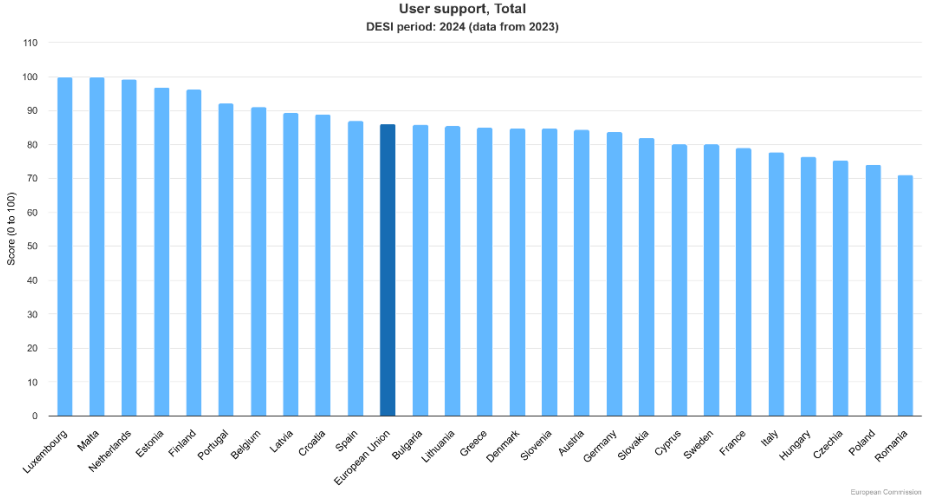
([362]) The indicator is part of the UN e-Government Development Index (EGDI). It is based on researchers' evaluation of the scope and quality of online services accessible through government websites in the native language (including the national portal, e-services portal and e-participation portal, as well as the websites of relevant ministries such as education, labour, social services, health, finance, and environment, where applicable). Study 'International Benchmarking of the Digital Transformation 2024': https://digital-strategy.ec.europa.eu/en/news-redirect/833343.

Figure 62. Mobile friendliness, user support, transparency and use of pre-filled forms, 2023









Toward more sovereign digital public services

The cloud is a central enabling technology for digital public services and plays an increasingly important role for data storage and processing by public administrations ([363]). For the provision of cloud services, public administrations in the EU rely on the dominant players in the EU cloud market, i.e., hyperscale cloud providers based outside the EU ([364]).

When negotiating contracts with these large providers, individual public administrations often lack the necessary bargaining power. On a systemic level, the high degree of concentration in the cloud market could lead to an over-reliance by EU public authorities on a small number of providers, causing challenges for the resilience of digital public services.

The dependence on non-EU providers raises concerns related to sovereignty and unlawful data access by non-EU governments, which is rooted in the extraterritorial application of non-EU security legislation to these providers. With many cloud providers offering integrated services, an increasing adoption of AI solutions will likely strengthen the role that hyperscale cloud providers play for the provision of public services in the EU.

EU and national initiatives

Significant **funding is devoted to the digitalisation of public services**, with this area significantly supported by both the Recovery and Resilience Facility and EU Cohesion policy. According to the study conducted by the Joint Research Centre (JRC) mapping the contribution of selected EU funding instruments against Digital Decade targets, the online provision of key public services represents the target that receives most of the support in the 2021-27 budget period.

The study estimates that some EUR 32 billion is funding the digitalisation of public services, with a large contribution coming from the Recovery and Resilience Facility (EUR 24.4 billion) ([365]).

The EU is acting to **mitigate concerns related to the dependency of public administrations on technological solutions provided by foreign vendors** like hyperscale cloud providers. As described in the chapter on '*Technological leadership for a competitive, sovereign and resilient EU*', a number of initiatives aim at developing EU capabilities in critical technological areas such as cloud and edge computing.

For example:

- the IPCEI-CIS will develop and deploy the next generation of data storage and processing that responds to the needs of the EU private and public sector alike;
- the Data Act defines minimum content for cloud contracts, thereby levelling the playing field for negotiating cloud contracts between large providers and individual public administrations;

([363]) https://www.edpb.europa.eu/system/files/2023-01/edpb_20230118_cef_cloud-basedservices_publicsector_en.pdf.
([364]) Commission Staff Working Document on strategy dependencies and capacities, SWD(2021) 352 final.
([365]) 'Mapping EU level funding instruments 2020-2027 to Digital Decade targets - 2024 update' (Signorelli et al., 2024).

- the Data Act also ends key practices of vendor lock-in and requires cloud service providers to facilitate service interoperability, thus making it easier for public administrations to freely choose the provider that best fits their needs and move to another provider if they wish;
- providers are also required to enact practices that would shield EU data from unlawful access by non-EU governments.

The Member State Cloud Cooperation Group within the EU Alliance for Industrial Data, Edge and Cloud brings relevant Member State experts together to share best practice, for example on the procurement of adequate cloud services. In this context, the Commission is currently conducting preliminary work on the possibility for public sector actors to pool their spare data processing capacity.

Public administrations are also engaged in several activities led by the Commission that aim at increasing the **adoption and reuse of emerging technologies in the public sector**: more than 1 000 use cases of **AI, blockchain and other technologies** are registered in the **Public Sector Tech Watch observatory**, which provides a 'one-stop' for all GovTech actors.

GovTech Connect provides a community where GovTech actors can share experiences and seize opportunities in developing, procuring and adopting GovTech solutions. A dedicated working group of **EDIHs on AI in the public sector** offers the involved parties the opportunity to share their experience in using AI in the public sector (e.g., ethical issues, procurement opportunities, sandboxing and piloting examples).

A **key factor** in for developing user-friendly and cross-border digital public services is **interoperability**. The **Interoperable Europe Act** ([366]), set to take effect from mid-2024, supports the Digital Decade target of achieving 100% online public services by ensuring these services can communicate seamlessly across Europe, fostering a more cohesive and digitally integrated continent.

This regulation covers digital public services that require cross-border data exchange and will apply both to the Member States and all EU bodies, institutions and agencies, ensuring that, over time, all EU legislation and its digital implementation will be interoperable-by-design.

Cross-border services rely on trust among stakeholders. Their implementation requires effective collaboration between countries, leading to public value creation, such as increased accessibility to services, improved efficiency in public administration and more opportunities for economic growth and innovation. Additionally, they contribute to empowering people, promoting social inclusion and broadly increasing the wellbeing and prosperity of a connected European society.

Since the Digital Decade 2023 report, Member States have reached a political agreement on the Interoperable Europe Act, which will enter into force in April 2024. The **Regulation**

([366]) Regulation (EU) 2024/903 of the European Parliament and of the Council of 13 March 2024 laying down measures for a high level of public sector interoperability across the Union (Interoperable Europe Act) OJ L, 2024/903, 22.3.2024. Examples of the multifaceted strategy envisioned by the act include mandatory interoperability assessments, collaborative efforts to develop interoperability solutions through GovTech partnerships and participation in interoperability sandboxes, and the proactive improvement of interoperability skills within the public sector.

will launch a new phase in digital government transformation, strengthening public sector interoperability and improving the accessibility of digital public services to users living in another Member State. The mandatory **interoperability assessments** will not only ensure the **cross-border** availability of key digital public services but will **also make them more user-centric**.

The regulation will also strengthen collaboration with Member States on interoperability (through its governance) and call for the **sharing and reuse of solutions, often open source**, powered by an 'Interoperable Europe Portal' – a one-stop-shop for solutions. The regulation is accompanied by a set of **innovation and support measures, including regulatory sandboxes for policy experimentation**, **GovTech projects to develop and scale up solutions for reuse, and training support**.

The act sets an enabling framework for cross-border interoperability and it is the future Interoperable Europe Board that will be in the driving seat to shape the content and develop the Interoperable Europe Agenda (strategic roadmap).

The Single Digital Gateway, once fully implemented and as its scope widens, will also greatly contribute to the delivery of user-friendly and cross-border digital public services. Importantly, the Once-Only Technical System (OOTS) will allow government websites and official sources of information from public authorities across the EU to automatically exchange official documents and data at people's and businesses' request.

Member States have continued to experiment with **innovative procurement** through the EU-funded GovTech4all incubator, and Member States are also stepping up their investment in shared digital infrastructure for connected and innovative public administrations. They are doing this through a Coordination and Support Action (under DIGITAL, WP 2024) and through collaboration in view of setting up an **EDIC in the field of connected public administration** (IMPACTS-EDIC).

Another **EDIC**, already established, will support further progress in this area: the European Blockchain Partnership and European Blockchain Services Infrastructure (**EUROPEUM-EDIC**), which will have its HQ in Brussels. It will establish the European Blockchain Services Infrastructure and operate it, to deliver EU-wide cross-border services, in particular public services ([367]).

Moreover, digital public services and interoperability are at the centre of Pillar 2, 'Capacity for Europe's Digital Decade', of the EU Communication 'Enhancing the European Administrative Space (**ComPAct**)', serving as the foundational framework for improving the digital capabilities and administrative efficiency of European institutions. ComPAct is the Commission's first ever comprehensive set of measures to support the modernisation of national administrations and to strengthen their cross-country collaboration so that they can address common challenges together.

Finally, **accessibility** is a key element of digital public services. An estimated 100 million people in the EU have some form of disability. Digital accessibility allows everyone, including people with disabilities, to perceive, understand, navigate and interact with the internet. It remains essential for making Europe fit for the digital age.

([367]) See Annex 2 for further information.

With the rapid growth of digital information and interactive services provided through the web and mobile devices becoming the primary form of communication, a significant part of the population risks being excluded from basic services provided by both the private and public sector. These include, but are not limited to, services for finding public information, grocery shopping, medical consultations, online banking, messaging and video-calling services, to name but a few.

Digital accessibility is a right for people with disabilities to access information and communication technologies on an equal basis with everyone else, to ensure their independence, social and occupational integration and participation in the life of the community. Accessibility is enshrined in the UN Convention on the Rights of Persons with Disabilities (UNCRPD) and guaranteed in the EU Charter of Fundamental Rights. The European Declaration on Digital Rights and Principles emphasises that **everyone** should have online access to key public services in the EU.

Before the Web Accessibility Directive was adopted in 2016 less than 10% of websites in the EU were accessible to people with disabilities. The Directive is recognised as a game changer. Now **all Member States have transposed the Directive into binding legislation**, and **created the necessary structures to monitor and enforce the rules, raise awareness and continuously improve digital communication**, ensuring that public sector websites and mobile apps are more accessible to everyone.

This Commission has also **aligned varying standards within the EU**, in particular through standard EN 301 549 v3.2.1, reducing barriers for developers of accessibility-related products and services. Even if there is still room for improvement by the public sector, considerable progress has been made across Europe, thanks to the Directive, as documented in the 2022 review of the legislation ([368]).

To assist the Member States, the Commission provides a **package of state-of-the-art language technologies**, free of charge, to the public sector, SMEs, NGOs and academia in the EU, via the portal https://language-tools.ec.europa.eu/. Initiated under the Connecting Europe Facility and now funded under Digital Europe, this includes the Commission's automated translation tool eTranslation, now embedded in more than 100 digital platforms. In just 1 week in March 2024, eTranslation processed over 34 million pages. This technology allows reliable and confidential access to high-quality automated translation in 31 languages at a scale that was inconceivable even a few years ago.

Language technologies are about much more than translation, offering savings and synergies across a wide range of tasks also in one language. The Commission's speech transcription tool (more than 2 000 hours transcribed) can be used for captioning to support non-native speakers as well as those with hearing impairments. Transcripts can in turn be used to produce minutes, just one of the many uses of the new eBriefing tool and summarisation tool that are also in the package.

As technology related to automatic language services improves at exponential speed, but is mostly delivered by non-European firms, the main challenge resides in ensuring that services are provided to Europeans with equal quality and efficiency, irrespective of the

([368]) See https://digital-strategy.ec.europa.eu/en/policies/web-accessibility.

language they speak. This goal can hardly be achieved by market-driven solution providers alone, as they often disregard markets with less spoken languages.

Key digital public services in Member States' national Digital Decade strategic roadmaps ([369])

23 Member States provided a trajectory for digital public services for people and businesses. 21 national target values are in line with the EU target value, which is to have 100% of key public services accessible online. Three countries do not provide any additional information, while three others, Hungary, Portugal and Sweden, provide targets somewhat below the EU one.

In total Member States reported 262 measures contributing to this target, with a total budget of EUR 14.1 billion. Around 52% of this budget comes from EU funds, 40% from national funds and 8% from regional/local funds.

One third of the measures are considered new (budget of EUR 2.2 billion).

40% of the measures focus on human-centric digital public services for all, including measures to increase the public's trust in and satisfaction with electronic services.

25% focus on making online public services more secure and resilient to the digital economy, including common data and digital services sharing platforms for the public sector.

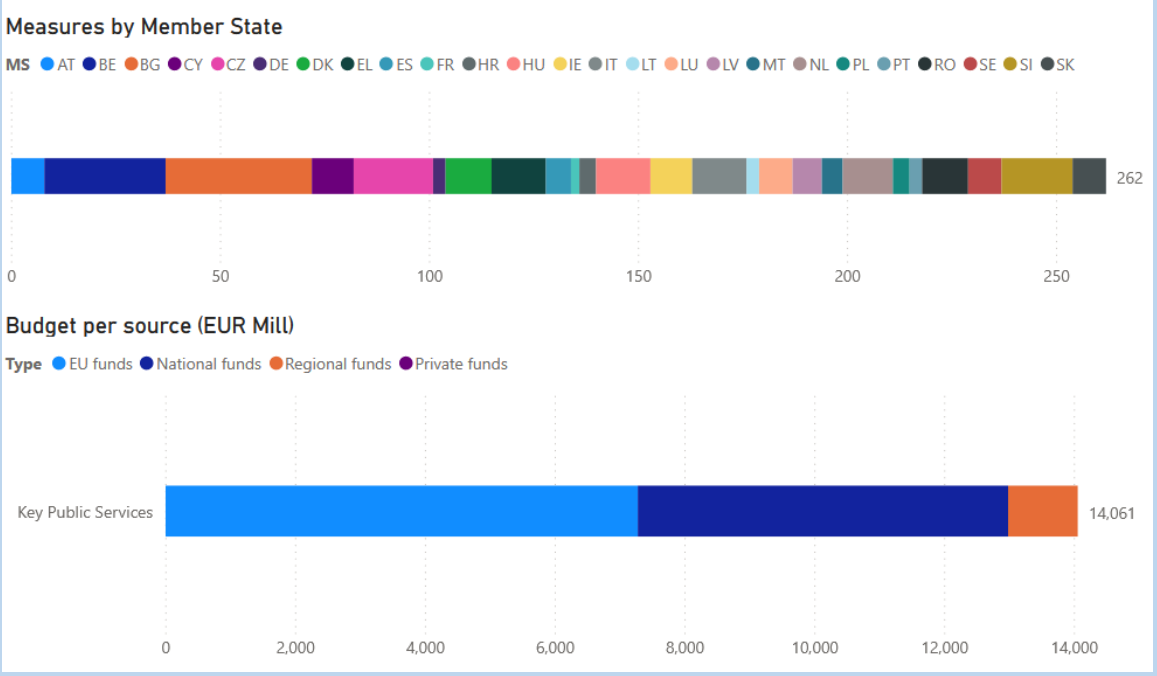
20% of the measures relate to interoperable digital public services by design, including the implementation of the Single Digital Gateway regulation.

15% of the measures are related to coordination and the strategic leadership necessary for a digital transition. These include national and subnational strategies, organisational and technical frameworks, and the launching of digital agencies, laboratories or observatories.

([369]) This analysis only takes account of information reported by the Member States in their national roadmaps. The measures reported by the Member States were grouped into categories to provide a better overview of the types of measures taken.

Measures and budget (EUR Mill)

Target category	Measures	Budget
	3	239
1. Human-centric online public services for all	107	5,505
2. Secure & resilient online public services to the digital economy	67	3,809
3. Interoperable digital public services by design	54	3,875
4. Digital transition through coordination and strategic leadership	31	634
Total	**262**	**14,061**



Concluding remarks and future challenges

Overall, Member States continue to progress in making digital public services available to people and businesses. Coordinated efforts at EU level are also ongoing to step up innovative procurement, testing innovative solutions and cooperate more, through multi-country projects. These efforts align with the general recommendation put forward by the report of the State of the Digital Decade 2023.

However, some concerns remain, including:

- the dependency of public administrations on non-EU technological solutions.
- the importance of strengthening interoperability to enable more effective, efficient, and proactive service delivery.
- the lag in cross-border digital public services, hindering their use despite the significant number of EU nationals living in other Member States and the presence of many small and medium enterprises operating across borders. The effective implementation by Member States of online procedures under EU company law and the forthcoming digital by default solutions for companies are important aspects in this regard.

  Member States must ensure that all public services that have to be digitised under the Single Digital Gateway are effectively accessible online and that public authorities are connected to the Once-Only Technical System, so people and businesses can fully benefit from the automated exchange of official documents across borders.

- the continued need for attention to accessibility, with opportunities for improvement highlighted in the Web Accessibility Directive review – including increased demand for digital accessibility expertise, promotion of accessibility curricula and certification awareness, advocacy for feedback and enforcement mechanisms and the growing use of AI and machine learning in digital accessibility tools.

4.1.4. Leveraging digital technologies for health

The interplay between digital and health, particularly mental health, is multifaceted.

The rise of new forms of work driven by digitalisation and accelerated by the COVID-19 pandemic, such as teleworking and platform work, while offering flexibility, have also posed new challenges. Drawbacks include excessive time spent online, blurred work-life boundaries, heightened work intensity and technology-induced stress.

Additionally, the increasing use of apps, software and AI for workforce management by employers presents novel challenges, such as technology-driven surveillance, real-time progress monitoring and privacy concerns (which, also in this case, can have a negative impact on workers' wellbeing[370]).

For children and teenagers, tablets and smartphones, social media platforms and messaging applications have become indispensable components of their daily existence, possibly to the detriment of their physical and mental wellbeing. In addition, concerns – affecting both adults, young people and children – include addiction diseases, exposure to inappropriate or violent content, cyberbullying, hate speech and aggressive marketing of unhealthy products or beauty standards.

These complex issues are addressed in the Communication on mental health published in June 2023 ([371]), and a comprehensive toolbox that the Commission has developed in recent years to protect users in the digital space, such as the Digital Services Act (DSA) and the Better Internet for Kids strategy (see Sections 4.2.1 and 4.2.2).

However, digital tools also bring positive impacts and a significant potential to improve healthcare and people's lives. **Digital health solutions** can improve access to health services, empower people to access their health data, including in cross-border situations, and contribute to patient-centric, increasingly personalised approaches to health and care.

The development of a European Health Data Space and improvements in health record and data interoperability can accelerate European technological leadership and innovation, including in AI. In addition to the benefits for people, healthcare professionals and society at large, the use of digital health technologies, including telemedicine, can bring meaningful cost savings for health systems as well as promoting active and health living and digital health equity.

([370]) These issues are the subject of the European Parliament resolution of 5 July 2022 on mental health in the digital world of work.

([371]) Commission Communication on a comprehensive approach to mental health, COM(2023) 298 final.

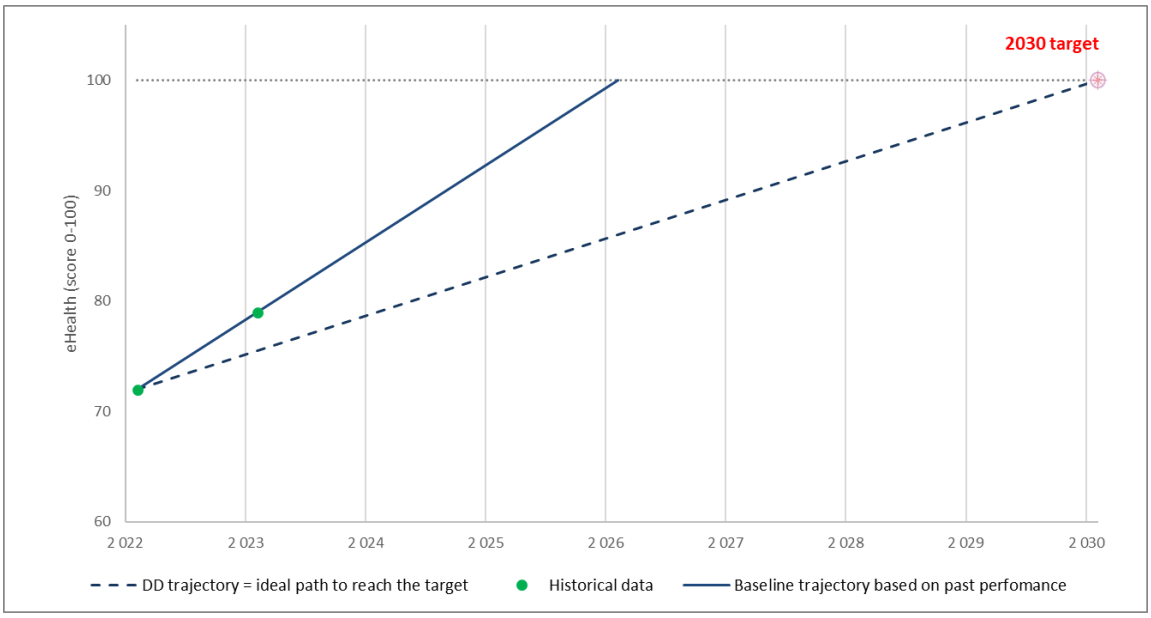
Access to electronic health records – state of play and progress towards the Digital Decade target

To give people more control of their **health data** at all stages of their life, the Commission and Member States are working to make it possible for all EU citizens to access their electronic health records.

The Digital Decade Policy Programme establishes the target: **'100% of EU citizens have access to their electronic health records'**.

Member States are progressing well on this target. In 2023, the EU scored 79/100, up from 72/100 in 2022. This corresponds to an annual growth rate of 9.7%. At this pace, the 2030 target will be reached in 2026 already.

Figure 63. e-Health composite indicator. Historical data and DD trajectory



Still, issues to be addressed remain, varying across Member States. They include expanding the number of connected healthcare providers, increasing the range of accessible data and encouraging the use of eIDAS-authentication to health data access services ([372]).

EU and national initiatives

The adoption of a proposal for a **European Health Data Space (EHDS) Regulation** in 2022 was an important milestone, further reinforcing progress in this area and developing secure **cross-border access and the (re-)use of health data for research, innovation and health policymaking purposes (i.e., secondary use of data)**.

The regulation will empower and benefit people, supporting **cross-border healthcare delivery** and improving the **quality and accessibility of health data for secondary use**. In Spring 2024, the co-legislators reached a political agreement on the text and the European Parliament approved it ([373]). Following formal adoption by the Council, publication in the Official Journal is expected for late 2024.

([372]) 'Digital Decade eHealth Indicator Study': https://digital-strategy.ec.europa.eu/en/news-redirect/833348.
([373]) https://ec.europa.eu/commission/presscorner/detail/en/IP_24_2250.

Moreover, the EHDS represents a key step in building a resilient digital infrastructure and ensuring safe access to and handling of health data. The principles of data protection and cybersecurity are all essential building blocks of the EHDS and are expected to increase people's confidence and trust.

The Commission supports (i) the development of the necessary technical infrastructure through projects under **Horizon Europe and Digital Europe** to facilitate secure and trustworthy health data access and reuse and (ii) the application of common technical specifications for interoperability (European electronic health record exchange format). When the EHDS Regulation was proposed, over 810 million EUR were set aside to support the implementation of the EHDS from EU4Health Programme, the Digital Europe Programme, the Connecting Europe Facility and Horizon Europe.

Electronic health records in Member States' national Digital Decade strategic roadmaps ([374])

23 Members States provided a trajectory for the e-Health composite indicator on the availability of electronic medical data. 21 national target values are in line with the EU target value, which is for 100% of citizens to have access to their electronic health records.

Member States reported a total of 90 measures contributing to this target, with a total budget of EUR 5.5 billion. One third of the measures are considered new (budget of EUR 1.2 billion). Around one third of the total budget comes from EU funds and two thirds from national funds.

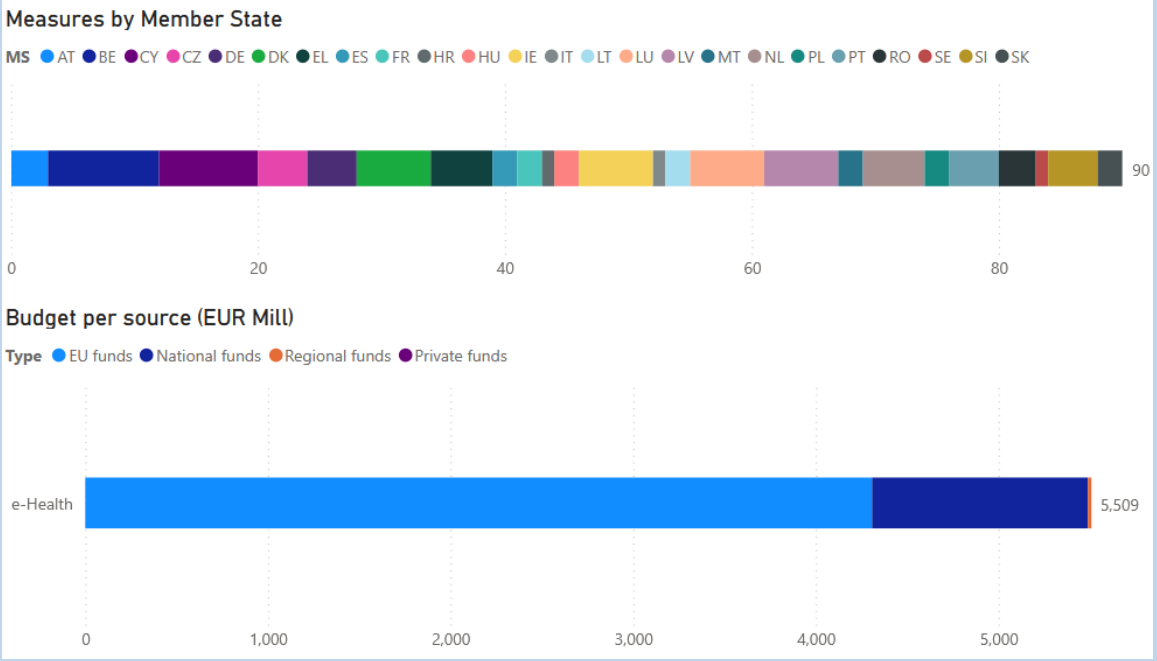
40 measures focus on health data access for the public, including portal solutions and applications for mobile devices. General measures, which account for one third of the measures, include the creation of regulations, roadmaps and cross-border projects.

Other measures include support action, like digitalising archives or data treatment, and the supply of data by healthcare providers.

([374]) This analysis only takes account of information reported by the Member States in their national roadmaps. The measures reported by the Member States were grouped into categories to provide a better overview of the types of measures taken.

Measures and budget (EUR Mill)

Target category	Measures	Budget
	3	5
1. Electronic health data access services for citizens	40	2,378
2. Support for required health data categories	9	1,303
3. Supply of data by healthcare providers	11	225
4.Horizontal actions	27	1,598
Total	**90**	**5,509**



Looking more broadly at the use of health data, as mentioned above, a crucial element is leveraging the **innovation potential of health data** by maximising the **use of existing and future health data initiatives and infrastructure**, including EU investment in high performance computing.

This goal is supported by the implementation of the European Health Data Space (EHDS) and targeted funding for research and implementation projects building on European health data infrastructure.

The Commission put forward several initiatives to advance on **health data infrastructure**. The **European Cancer Imaging Initiative**, launched December 2022, supports innovation in cancer care through improved clinical decision-making and prediction. The Cancer Image Europe infrastructure federates cancer imaging and clinical data across 12 European countries, facilitating the development and testing of AI-driven technologies in cancer.

Similarly, the **1+ Million Genomes Initiative**, launched 2018 and supported by 25 EU Member States and Norway, aims to provide secure access to genomic and linked clinical data across Europe and invests in establishing a European reference human genome, the Genome of Europe. Both the cancer imaging and the genomic data infrastructure will be operational by end-2026 and aligned with the EHDS legal and technical set-up.

The **European Virtual Human Twins Initiative**, launched December 2023, aims to accelerate personalised care through advanced modelling, with applications in drug discovery, clinical research, and medical training.

By establishing **health data infrastructure** and a **secure framework for health data reuse**, the Commission also **supports innovation in Europe**, while fully respecting and safeguarding people's privacy. This infrastructure – be it for cancer imaging, genomics or virtual human twins – hold enormous potential in **predicting and preventing diseases, optimising treatments and supporting healthcare professionals**, thus helping improve and personalise healthcare delivery.

How digital technologies for health helped during the pandemic: setting a global standard in digital health certificates.

In response to the outbreak of COVID-19, the Commission launched the EU Digital COVID Certificate (EU DCC) in record time. It significantly contributed to the global fight against the disease and protected EU citizens' health and their right to travel freely.

More than 2.3 billion certificates were issued EU-wide and a total of 78 countries were connected to this European solution. In June 2023, the World Health Organisation took up the EU DCC technology to create a Global Digital Health Certification Network (GDHCN), which will support global travel and protect from health threats, contributing to pandemic preparedness.

Concluding remarks and future challenges

Looking forward, there is a need to continue the efforts to ensure access to electronic health records, as well as to fully deploy the innovation potential of health data. In particular, there is a need to increase **trustworthy AI in healthcare** by prioritising European research, innovation and deployment of AI applications, enabling personalised healthcare. This includes supporting the training of AI algorithms for their safe, responsible and ethical use in clinical decision support, and upskilling relevant stakeholders in the use of AI in health.

Additionally, promoting international collaboration with like-minded countries, such as through the 'AI4Good' collaboration with the US, will be crucial for amplifying European leadership in this domain, in line with EU values.

Finally, promoting **cyber resilience in healthcare** is vital, with a focus on strengthening cybersecurity measures to protect sensitive private data.

4.2. Protect people and build safe and human-centric digital environment and technologies

DD cardinal points and targets

DD objectives: Human centred and protecting fundamental-rights (promoting a human-centred, fundamental-rights-based, inclusive, transparent and open digital environment).

Digital rights and principles: Putting people at the centre of the digital transformation; safety and security and empowerment (including privacy and individual control over data; protecting and empowering children and young people in the digital environment), freedom of choice (interactions with algorithms and AI systems), solidarity and inclusion (especially fair and just working conditions).

The Digital Decade promotes a '*human-centred, fundamental-rights based, inclusive, transparent and open digital environments*'. These objectives also have a central role in the Declaration on Digital Rights and Principles. This chapter takes the stock of the challenges inherent to the rise of digital technologies and online platforms, and actions put forward to promote a safe online environment, for both adults and children, and human-centric and fundamental-rights based technologies.

4.2.1. Build safe digital environments and safeguard fundamental rights online

Safety and protection of fundamental rights online

As the internet continues to permeate our life, the issue of creating safe digital environments and safeguarding human rights online has emerged as a crucial policy matter in the European Union. The digital realm, marked by interconnectedness and ubiquitous access, has fundamentally altered the way individuals communicate, work, and engage with society. Yet, this digital transformation has brought with it a new set of challenges and threats, including the proliferation of illegal content, the need to ensure that online advertising is transparent, addressing the misuse of personal data, consumer protection in online marketplaces, and dealing with the spread of disinformation.

The recent Digital Decade Eurobarometer 2024 revealed that **46% of EU citizens are apprehensive about their online data being misused , followed by the fear of the personal impact of fake news and disinformation (45%) and concern about insufficient protection of minors (33%)** ([375]). This highlighted the urgent need to address data privacy, information integrity and child protection concerns ([376]). Additionally, Europeans are concerned about non-trustworthy online sellers, hate speech and inappropriate advertising, **underlining the urgency of efficient content moderation and better consumer protection**.

The online environment also gives space to **hate speech, violent extremism and terrorist content**, directed not only at individuals but also at specific target groups. This content can be amplified by the misuse of online platforms' algorithmic systems and can contribute to offline violence and threaten public order ([377]). The Israeli-Palestinian conflict is one of the most recent examples of how online platforms can become vehicles for incitement to terrorism, illegal hate speech, praising of killings and disinformation.

In 2023, Eurostat collected statistics on individuals encountering hostile or degrading online messages in the EU. Although this data cannot be considered an approximation of illegal content or hate speech, it gives an insight into the scale of the issue. In 2023, 33.5% of people encountered messages online that were considered to be hostile or degrading towards groups or individuals.

([375]) Special Eurobarometer 551 'The Digital Decade' 2024: https://digital-strategy.ec.europa.eu/en/news-redirect/833351.

([376]) Other sources confirm the growing concerns about the misuse of personal data among consumers. For example, the 2023 Consumer Conditions Scoreboard (89ea35fe-728f-4749-b95d-88544687583c_en (europa.eu)) found that 70% of consumers are concerned about how their personal data are used and shared, which amounts to a 21 percentage point increase compared to 2018.

([377]) European Union Agency for Fundamental Rights, Online content moderation – 'Current challenges in detecting hate', 2023; Joint Communication to the European Parliament and to the Council, No place for hate: a Europe united against hatred, JOIN(2023) 51 final.

In most cases, respondents believed these messages were targeted at groups of people because of their political or social views (24.5%), racial or ethnic origin (17.9%) or sexual orientation (LGBTIQ identities) (17.5%) ([378]).

These **statistics underscore the necessity for robust policies** that ensure the safety, transparency, and respect for fundamental rights in the digital realm. As policymakers grapple with these issues, their focus remains on upholding the fundamental values of human dignity, freedom, democracy, and equality in the digital sphere.

EU and Member State action

In recent years, the Commission has placed a strong focus on addressing these issues.

A key achievement of the current Commission mandate has been the adoption, on 29 September 2022, of **the Digital Services Act (DSA)**. With the DSA, the EU has put in place a whole new set of safeguards for users of digital services operating in the EU, regardless of where those services are based.

It introduced a number of rules to protect fundamental rights online, such as the freedom of expression and information, the protection of personal data, the right to non-discrimination, the rights of the child, and the right to a high-level of consumer protection. The law ensures, among other things, transparency of **content moderation**, a **ban on targeted advertising** using profiling based on special category data or the data of minors, and **greater transparency and control for users on their flow of information**.

One of the significant accomplishments of the DSA is better **child protection**. It requires providers of online platforms accessible to children to adopt special privacy and security settings by default, protecting their privacy, security and mental and physical wellbeing. The DSA has also significantly improved **consumer protection**. Providers of online marketplaces are now required to identify their business users and clarify who is selling a product or service, helping track down rogue traders and protect online shoppers against illegal products.

Furthermore, the DSA has introduced new tools to counter the **spread of illegal goods and content online**, including hate and violent speech or intellectual property rights' infringements. Online platform providers are obliged to put in place notice and action mechanisms to allow users to report content and are required to cooperate with 'trusted flaggers'. The subject matter in question can range from illegal hate speech to counterfeit products.

Another significant accomplishment of the DSA is in the field of **content moderation transparency**. Platform providers are obliged to notify users of any decisions taken and the reasons for them, and to provide a mechanism to contest the decisions.

Lastly, the DSA helps **combat systemic risk online** in the EU, such as, for example, the safety of elections, by requiring very large online platforms (VLOPs) and very large search engines (VLOSEs) to analyse and mitigate risks stemming from their services.

The DSA officially came into force on 16 November 2022 and started to apply to **all** online intermediaries on 17 February 2024, irrespective of their size. However, **important**

([378]) Eurostat, Individuals encountering hostile or degrading online messages: https://ec.europa.eu/eurostat/databrowser/view/isoc_ci_hm$defaultview/default/table?lang=en.

milestones have been already achieved. Since April 2023, the Commission has designated 24 VLOPs and VLOSEs. These are providers with over 45 million monthly users, which are now subject to higher requirements, including the annual identification, analysis and assessment of systemic risks linked to their services. For 19 of these **platforms and search engines rules started to apply at the end of August 2023**.

The Digital Services Act (DSA) bestowed a **substantial amount of regulatory, supervisory, and legislative responsibilities on the Commission**, which directly oversees VLOPs and VLOSEs and is equipped with wide-ranging investigatory and supervisory powers, including the power to impose sanctions and remedies ([379]).

Numerous pieces of secondary legislation have been adopted since the DSA came into effect ([380]) and there **has been active supervision of VLOPs and VLOSEs**.

Starting autumn 2023, the Commission has been sending inquiries to their providers to get more information, to assess their compliance with the specific obligations under the DSA.

In December 2023 and April 2024, the Commission opened formal proceedings respectively against **X** and **Meta** (for both Facebook and Instagram), which, among others, concerned the dissemination of illegal content in the EU and the effectiveness of measures taken to mitigate risks to civic discourse and electoral processes.

Formal proceedings were also opened against **TikTok** (in February and April 2024) and Meta (for both Facebook and Instagram, in May 2024) in areas related to the management of risks related to negative effects on physical and mental health and children's rights, notably as a result of addictive design, 'rabbit holes' and access to harmful content.

In the second case against TikTok, concerning addictive features of TikTok Lite service, the Commission notified TikTok of its intention to suspend the relevant features in the EU pending the assessment of their safety: as a result, TikTok announced that it would unilaterally withdraw these features; the non-compliance case remains nonetheless open and the investigation is ongoing.

In March 2024, **AliExpress** was also added to the group of VLOPs against which the Commission opened formal proceedings. The proceedings focus on AliExpress' lack of enforcement of the terms of service prohibiting certain products posing risks for consumers' health, such as fake medicines, as well as compliance with the DSA obligation to allow all users to notify illegal content on the platform and certain transparency obligations.

Finally, in June 2024, following a request for information from the Commission, LinkedIn decided to voluntarily discontinue a functionality on which there was a suspicion that it

([379]) In response, the Commission has worked to build up its capabilities. A new directorate has been established within the Directorate-General for Communications Networks, Content and Technology (DG CONNECT) for this purpose. By 2024, the Commission's DSA enforcement team will comprise 123 full-time equivalent staff members, who are tasked with enforcing and ensuring compliance with DSA rules. Further technical support is provided by the European Centre for Algorithmic Transparency (ECAT).

([380]) Including three Implementing Regulations, the Article 83 DSA Procedural Regulation, the Article 43(3) DSA Implementing Decisions on the Annual Supervisory Fees, and the Article 85 DSA Regulation on the 'Agora' information-sharing system. Additionally, two Delegated Regulations have been adopted: the Article 37 DSA Regulation on Independent External Audits, and the Article 43(4) DSA Regulation on the supervisory fee methodology.

would violate the DSA ban on targeted ads based on sensitive personal data, like sexual orientation, political opinions, or race.

Moreover, in October 2023, in view of the unprecedented period of conflict and instability affecting the EU, the Commission issued a **recommendation setting out mechanisms of preparedness, cooperation and coordination between the Commission and the Member States**, ahead the full application of the DSA on 17 February 2024.

The recommendation focuses, specifically, on incidents arising from the dissemination of illegal content online ([381]). The new incident response mechanism was first activated by the Irish authorities following violent incidents in Dublin on 23 November 2023.

Throughout these processes, the Commission has maintained close collaboration with its partners in **civil society**. In June 2023, it hosted the first ever Digital Services Act stakeholder event, featuring 14 workshops, each exploring different aspects of the DSA. Hundreds of participants attended to discuss the lessons learned in digital regulation and to brainstorm how the DSA can help promote a democratic, vibrant and inclusive internet of the future.

Furthermore, the Commission hosted two round tables with civil society groups last year, one in June 2023 and another in February 2024, to discuss expectations concerning risk assessments of VLOPs and VLOSEs, and to explore ways in which these groups can contribute to the implementation of the Digital Services Act.

Since its implementation, the DSA **is already having a profound impact on the digital landscape**. However, the law is still in its early stages. It is essential that this momentum is maintained to ensure the continued effectiveness of the Act. The Commission, along with the European Board for Digital Services and the National Digital Services Coordinators, play a crucial role in ensuring that the DSA is robustly enforced and lives up to its expectations.

A key example of this is the yet-to-be-implemented **Article 40 DSA researcher** access to VLOP and VLOSE's data. The National Digital Services Coordinators and the Board will play a significant role in advancing this mechanism, with the corresponding delegated regulation scheduled for approval later in the year. Once established, this process will serve as a vital tool for ensuring industry accountability from the largest actors and will further aid in shielding the EU from systemic risks, and offering better understanding of the links between platforms' operations and issues such as political polarisation, spread of disinformation and impacts on users' mental health.

While the DSA concerns all types of illegal content online, another instrument was developed to **better protect EU citizens from being exposed to terrorist material online**. The **Regulation addressing the dissemination of terrorist content online** (TCO Regulation) entered into application on 7 June 2022. It aims to prevent terrorists from misusing hosting services to spread their messages to intimidate, radicalise, recruit and facilitate terrorist attacks.

([381]) Commission recommendation of 20.10.2023 on coordinating responses to incidents in particular arising from the dissemination of illegal content, ahead of the full entry into application of Regulation (EU) 2022/2065 (the Digital Services Act).

Concretely, the Regulation allows Member States to send removal orders to hosting service providers, which must take down or block access to the targeted terrorist content **within 1 hour**. Between June 2022 and 31 December 2023, at least 349 removal orders have been issued by Member States' competent authorities, including at least 249 since Hamas' terrorist attack on 7 October 2023. These removal orders led to the content being removed or access to it in the EU blocked by the hosting service providers.

Before the advent of the DSA, the **Audiovisual Media Services Directive (AVMSD)**, revised in 2018 and scheduled to be transposed by Member States by September 2020, has reinforced the rules protecting users and consumers. Broadcasters, providers of video on-demand services and of video-sharing platforms, cannot offer content that includes incitement to violence or hatred, or public provocation to commit terrorist offences.

The AVMSD also provides better protection for minors against harmful content (content that may impair their physical, mental or moral development). Additionally, influencers offering audiovisual content and meeting the criteria to be defined as (on-demand) audiovisual media service providers are required to comply with the AVMSD rules, in particular on advertising (audiovisual commercial communications), incitement to violence and hatred and harmful content for minors.

The above rules interact with each other, establishing a concentrated regulatory response to fundamental rights challenges in the digital realm. Their implementation and enforcement by cooperating authorities and with stakeholder support are paving the way for a safe and secure digital environment that ensures user rights and consumer protection.

Protect fundamental rights and empower democratic values online in national roadmaps ([382])

The Decision establishing the Digital Decade ([383]) and the related guidance document ([384]) specify that roadmaps should also encompass the general objectives. The national roadmaps, however, focus to a large extent on the Digital Decade targets and related trajectories. The measures to achieve the targets are also expected to cover and contribute to the general objectives of the Digital Decade, although the link is often indirect and coverage of the general objectives is more difficult to establish.

Protecting fundamental rights and empowering democratic values online is an aspect that a small number of Member States took into account in their roadmaps (Belgium, Croatia, Greece, Luxembourg, Netherlands, Romania, Slovenia). The measures include activities aiming to protect users from disinformation, manipulation and harmful content.

Please note that these issues are also relevant to section 4.3 below.

Concluding remarks and future challenges

The Commission has placed a strong focus on creating a strong regulatory framework to ensure that users are protected online and fundamental rights upheld. The adoption of the

([382]) This analysis only takes account of information reported by the Member States in their national roadmaps. The measures reported by the Member States were grouped into categories to provide a better overview of the types of measures taken.

([383]) Article 7 of Decision (EU) 2022/2481 of the European Parliament and of the Council of 14 December 2022 establishing the Digital Decade Policy Programme, OJ L 323, 19.12.2022, p. 4.

([384]) Communication from the Commission: guidance to the Member States on the preparation of the national Digital Decade strategic roadmaps, COM(2023) 4025 final, OJ C 230, 30.6.2023, p. 4.

Digital Services Act (DSA) represents a significant regulatory milestone in the EU's journey to create safer digital environments and safeguard human rights online. Marking considerable progress, the DSA has encouraged progress in areas like child protection, consumer protection and content moderation practices.

Despite these strides, vigilance is required to properly ensure the implementation and effectiveness of the EU legislation, including the DSA.

As also highlighted in last year's report on the State of Digital Decade, effective DSA implementation requires close cooperation between the Commission, the newly created European Board of Digital Services, national digital services coordinators (DSCs) and civil society. Although steps forward have been taken and the DSA is stimulating strong interest and involvement by civil society, collaboration and engagement will continue to be paramount to ensure its continued success.

More broadly, when it comes to protecting users, it will continue to be crucial to monitor trends in the online domain and deepen our knowledge of its complex mechanisms. For example, research into the dynamic interplay between digital tool usage, exposure to harmful content and mental health should be encouraged, as this can inform policy decisions and support initiatives aimed at protecting users' wellbeing.

Currently, the interaction between digital and wellbeing, including mental health, is a complex issue. Children and adolescents and their use of social media deserve particular attention. While there is general consensus in the scientific community that social media can have both positive and negative effects on children and adolescents, there are growing concerns about the risks and potential negative impacts. Risks stem from both excessive or problematic social media engagement, such as compulsive use, and exposure to extreme, inappropriate and harmful content. While empirical evidence on the harm of social media is not conclusive, there is still no evidence that the online space is sufficiently safe for children and adolescents ([385]).

4.2.2. Protect children (including age verification)

Unveiling children's vulnerability online

In the last decade, children and young people, alongside all Europeans, have seen their daily lives considerably changed by digital services, which have transformed the ways and tools they use to communicate, learn and express their opinions and ideas.

Globally, in 2023, adults and young people spent more than 6 hours daily looking at a screen ([386]). Daily screen time increased significantly – by as much as 50 minutes since 2013. While enabling opportunities and promoting inclusion, digital services may also become a source of new risks and challenges, as they are often used by children without parental supervision. Additionally, young people are now more active and independent digital consumers, often using digital products and services designed for adults. They are exposed to or targeted by a range of online marketing techniques.

([385]) https://www.hhs.gov/surgeongeneral/priorities/youth-mental-health/social-media/index.html#:~:text=Children%20and%20adolescents%20who%20spend,symptoms%20of%20depression%20and%20anxiety.

([386]) STATISTA statistics October 2023 – 16-64 years old: https://www.statista.com/statistics/1391355/daily-time-spent-online-europe-by-country/.

Consequently, **harmful and illegal content, conduct, contacts and consumer risks are frequently present for children online**. Digital services, from social media to interactive games, can expose children to risks such as unsuitable content, bullying, grooming, dangerous challenges, sexual abuse or radicalisation.

Globally **one in three children have reported being a victim of online bullying** ([387]). In the EU, **33% of girls and 20% of boys reported having experienced disturbing content online once a month** ([388]).

The latest statistics from the Insafe helplines run by the EU-funded Safer Internet Centres (SIC) show that there has been a **34% increase in the number of reports from young people about cyberbullying between 2022 and 2023**. In addition, **6% of all contacts made in Q4 2023 related to the online sexual coercion and exploitation of children** (sextortion), with 13% categorised as online sexual abuse and violence ([389]).

Other sources show a dramatic increase (+320%) in grooming reports, including financial sextortion, in the EU. This number doubled from one year to the next in 2020-2022 and more than quadrupled from 2022 to 2023, settling at over 32 thousand online enticement reports in the EU alone ([390]).

One in three of the children surveyed across 19 European countries, including several EU countries, reported being exposed to sexual images both on and offline in the previous year, with boys and older young people more likely to encounter sexually explicit materials ([391]).

Finally, as mentioned in the previous paragraph, the use of digital, and in particular social media, is raising ever more concerns for the negative effects on mental health of children and adolescents, due to excessive use and risks of addiction and exposure to inappropriate content ([392]).

EU and Member State action

These statistics are alarming, but the EU has a solid toolbox to address the problems, including a legal framework, policies and funding. The EU's long-standing commitment to support, protect, empower and respect children online is well reflected in the **EU Strategy on the Rights of the Child**, **Audiovisual Media Services Directive** (AVMSD), **Digital Services Act** (DSA), with its provisions on protecting minors) the **Better Internet for Kids Strategy (BIK+),** which supports their implementation, and in the **General Data Protection Regulation** (GDPR) which provides specific rules on protection of children's personal data online.

To protect children from harmful audiovisual content, the AVMSD obliges broadcasters and video-on-demand service providers to take appropriate measures to ensure that any

([387]) UNICEF, U-report, on 30 countries globally, age range 13-24 y/o: https://www.unicef.org/press-releases/unicef-poll-more-third-young-people-30-countries-report-being-victim-online-bullying.
([388]) ChildFund Alliance, Eurochild, Save The Children, UNICEF, World Vision, report Our Europe, Our Rights, Our Future, on countries across Europe, age-range 11-17 y/o: https://www.unicef.org/eu/reports/report-our-europe-our-rights-our-future.
([389]) INSAFE helplines trends: Quarter 4, 2023: https://www.betterinternetforkids.eu/practice/helplines/article?id=7218998.
([390]) See CyberTipline 2023 report: https://www.missingkids.org/gethelpnow/cybertipline/cybertiplinedata.
([391]) EU Kids Online 2020 Survey results from 19 countries.
([392]) See.: https://www.hhs.gov/surgeongeneral/priorities/youth-mental-health/social-media/index.html#:~:text=Children%20and%20adolescents%20who%20spend,symptoms%20of%20depression%20and%20anxiety.

content that may impair children's physical, mental or moral development is made available in such a way as to ensure that minors cannot hear or see it. Those measures include selection of the time of the broadcast, age verification tools and other technical measures.

Additionally, to protect children from harmful audiovisual content online, the AVMSD obliges providers of video-sharing-platforms (VSPs) to take specific measures related to audiovisual content which may impair minors' physical, mental or moral development. The list of required measures includes establishing and operating age verification systems and parental control measures. In practice, some studies cast strong doubts as to whether even major VSPs provide parental control measures and ensure their age verification systems are effective ([393]).

The AVMSD also obliges providers of video-sharing platforms to incorporate the EU content standards (protection from both illegal and harmful content, qualitative standards for audiovisual commercial communications) in their terms and conditions. This includes e.g., that the platforms must ensure that users have a possibility to report, flag and rate content if they consider that it may impair physical, mental and moral development of minors (for instance, pornographic content). Once the content is flagged to the platform, its provider should assess its compliance with terms and conditions and if needed, apply additional restrictions).

The DSA includes several provisions to protect children online. In particular, providers of **all online platforms accessible to minors** have to take appropriate and proportionate measures to ensure a high level of **privacy, safety and security for children and young people**. The DSA also **bans providers of online platforms from targeting adverts to minors based on profiling**.

Moreover, terms **and conditions must be child-friendly**, and platforms must put in place systems that make it easy for anyone using their service to signal illegal or inappropriate content, and they must act on those reports.

The largest platforms and search engines (i.e., those that have more than 45 million monthly users in the EU) must also assess any systemic risks of their services to the children's rights as well as any negative effects of their services on people's mental or physical wellbeing. Additionally, these platforms have to adopt risk mitigation measures, for example by putting in place age assurance, age verification and parental control measures.

The protection of children and young people is an enforcement priority for the Commission. Enquiries and formal proceedings started by the Commission have targeted measures related to the protection of minors (e.g., see above about formal proceedings against TikTok and Meta's Facebook and Instagram, in areas related to the management of risks related to negative effects on physical and mental health and children's rights).

Furthermore, the age verification tools used to prevent access by minors to inappropriate content may be inadequate to its intended purpose ([394]). Also, a second set of formal

([393]) See European Audiovisual Observatory, The protection of minors on video sharing platforms (VSPs): age verification and parental control, 2024: https://www.obs.coe.int/en/web/observatoire/-/the-protection-of-minors-on-video-sharing-platforms-vsps-age-verification-and-parental-control.

([394]) https://ec.europa.eu/commission/presscorner/detail/en/ip_24_926.

proceedings against the provider of TikTok, opened in April 2024, is investigating whether potential negative effects on minors' mental health, especially through features stimulating addictive behaviour, were duly assessed and mitigated when launching TikTok Lite in France and Spain ([395]).

These requirements complement the **GDPR** that applies to the processing of children's personal data both offline and online. The GDPR recognises that children deserve stronger protection of their personal data as they may be less aware of the risks and their rights. Therefore, controllers of these data should be aware of potential risks to the rights and freedoms of children when processing their personal data and take appropriate measures to mitigate these risks. The GDPR lays down conditions applicable to consent in relation to information services that affect children. These conditions include a requirement for processors of information to obtain consent for the processing of data belonging to that child under the age of between 13 and 16 depending on the Member State. The GDPR also grants a specific right to 'erasure' (the so-called right to be forgotten) regarding children's personal data collected from online services. GDPR clarifies that specific protection should be given to the personal data of children, in particular when these data: (i) are being used for the purposes of marketing or creating personality or user profiles; and (ii) are being used to offer services directly to a child. It also requires controllers to provide any information on personal data processing and communication in relation to a data subject's rights in a clear, transparent, understandable, and easily available style, particularly where recipients are children, to guarantee that these rights are easily understandable by them.

The **European Data Protection Board** is working on guidelines on children's data.([396]) The protection of children in online environments, in particular when interacting with very large online platforms, has been the subject of several decisions of the European Data Protection Board([397]).

In addition, to better protect children online, in May 2022 the **Commission adopted** a **proposal for a Regulation on preventing and combating child sexual abuse (CSA)** ([398]). The proposal would set out obligations to online service providers to prevent the dissemination of child sexual abuse material and the grooming of children through their services.

When prevention measures are not enough, the providers could be required to detect, report, remove or block online child sexual abuse. The proposal would replace the current voluntary action by the providers to combat those crimes with a regulated system incorporating the necessary safeguards to respect all fundamental rights that are at stake ([399]). The proposal would also create a European Centre to prevent and combat child

([395]) https://ec.europa.eu/commission/presscorner/detail/en/IP_24_2227.
([396]) European Data Protection Board (EDPB), EDPB Work Programme 2023/2024, 2023.
([397]) See for example in that context the EDPB Binding Decision 2/2022 on the dispute arisen on the draft decision of the Irish Supervisory Authority regarding Meta Platforms Ireland Limited (Instagram) under Article 65(1)(a) GDPR adopted on 28 July 2022, and the EDPB Binding Decision 2/2023 on the dispute submitted by the Irish SA regarding TikTok Technology Limited (Article 65 GDPR) adopted on 2 August 2023.
([398]) Proposal for a Regulation of the European Parliament and of the Council laying down rules to prevent and combat child sexual abuse, COM/2022/209 final.
([399]) Since 2021 the EU has an Interim Regulation in place to enable service providers to continue detection practices on a voluntary basis (Regulation (EU) 2021/1232 of the European Parliament and of the Council of 14 July 2021 on a temporary derogation from certain provisions of Directive 2002/58/EC as regards the use of technologies by providers of number-independent interpersonal communications services for the processing of personal and other

sexual abuse, to facilitate the implementation of the Regulation and boost EU action against these crimes.

In parallel to the implemented and proposed legislation, the **2022 Better Internet for Kids (BIK+) strategy** contributes to the vision of the EU's digital transformation by 2030. It is key for supporting the implementation of the provisions protecting minors in the Digital Services Act and reflects the digital principle on child protection and empowerment within the EU Declaration on Digital Rights and Principles.

To improve children's wellbeing online and ensure they are protected, empowered and respected, under BIK+ the Commission is implementing three types of action: 1) a safe, age-appropriate digital environment; 2) digital empowerment; 3) active participation of children.

BIK+ is effectively supporting the implementation of the DSA provisions protecting minors, in particular through the expertise and data gathered by **the network of Safer Internet Centres (SICs) and by the BIK platform** ([400]). It is also aligned with the AVMSD.

The BIK infrastructure is funded via the Digital Europe Programme. Together they develop awareness campaigns and provide resources on online risk for children, parents/carers and teachers in most official EU languages to support the responsible use of new technologies. The SICs also offer helpline services to offer support on a wide range of online topics, and hotlines the public can use to anonymously report suspected online child sexual abuse material.

In 2023, the network and the BIK platform:

- **reached more than 30 million users**, providing them with almost 1 500 new resources. Network resources address diverse online opportunities and challenges, including topics such as algorithms, AI, promoting respect and empathy in online communities, democracy online, violence in the digital environment, digital literacy and the lure of quick money online, alongside many others;
- on **Safer Internet Day 2023 reached 28 000 schools and involved nearly 4 500 other organisations** across Europe alone;
- organised more than **960 events involving youth participation**.

All these actions are driven as much as possible by youth participation and user/child-friendly supporting documents are also produced regularly.

The BIK+ strategy supports the implementation of DSA provisions protecting minors by actions such as:

- Developing an EU approach to age verification via a task force involving Member State authorities, the European Regulators Group for Audiovisual Media Services and the European Data Protection Board and involving the use of the EU Digital Identity Wallet.

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data for the purpose of combating online child sexual abuse). In February 2024 the European Parliament and the EU Council agreed to extend these interim rules for an additional 20 months until April 2026, to give more time for the negotiations on the long-term regulation to conclude.

([400]) www.betterinternetforkids.eu.

Last year's Digital Decade report placed the focus on the need to also use digital IDs and the EU Digital Wallet to prove a child's age, and to develop other age verification mechanisms. The Task Force on Age Verification is currently exploring the use of the EU Digital Wallet for an interoperable, EU-wide, privacy-preserving solution for people to prove their age.

- The DSA 'schoolyard guardians' initiative, to bring DSA into schools e.g., via a user-friendly booklet ([401]) on DSA provisions protecting minors ([402]) and an online course on online safety, including on the DSA. Pilots in some Member States are under consideration as result of a focus group with SICs, DSCs, teachers and young people.
- Information gathering via the Safer Internet Centres network.

Further work is ongoing in the form of action such as:

- requesting an age verification standard and toolkit on age assurance, to raise awareness among the public;
- young consumers working to raise awareness on consumer risk among children and young people – #AdWiseOnline;
- media literacy, to develop EU-wide campaigns – #MediaSmartOnline;
- monitoring the implementation of the BIK+ at national level through the BIK policy map (4th report, published in May 2023 for all EU Member States, Iceland and Norway) ([403]).

In general terms, in recent years, most countries have experienced notable policy developments concerning children's online safety, often in response to specific national events or concerns. For example, the COVID-19 pandemic lent increased political attention to issues such as children's wellbeing online, sexual exploitation and cyberbullying ([404]).

Protect children online in national roadmaps ([405])

Protecting children online is an aspect that a very small number of Member States (mainly Poland and Romania) took into account in their roadmaps. The measures include legislative action and developing relevant strategies.

Concluding remarks and future challenges

Overall, a **balanced approach to protection and digital empowerment measures**, as promoted by BIK+, is key. It is crucial to provide an age-appropriate digital environment, through effective age verification methods, enforcement of the DSA and other relevant legislation and supporting measures, including awareness-raising.

([401]) https://op.europa.eu/en/publication-detail/-/publication/f3556a65-88ea-11ee-99ba-01aa75ed71a1/language-en.
([402]) The Digital Services Act (DSA) explained – Measures to protect children and young people online: https://digital-strategy.ec.europa.eu/en/library/digital-services-act-dsa-explained-measures-protect-children-and-young-people-online. Booklet available in all official languages.
([403]) The BIK Policy Map was created to compare and exchange knowledge on policies and activities, to support children's wellbeing in the digital environment, including measures specified in the BIK strategy.
([404]) BIK Policy Map – BIK Portal: https://www.betterinternetforkids.eu/.
([405]) This analysis only takes account of information reported by the Member States in their national roadmaps. The measures reported were grouped into categories to provide a better overview of the types of measures taken.

While a lot has been accomplished so far under BIK+ strategy, continuous effort is needed to build a safe, respectful and inclusive online experience for current and future generations of children. **There is scope for improving communication and awareness in Member States about the new rules to protect children online** (DSA, AI Act) by contacting schools and establishing good cooperation mechanisms between DSA national coordinators (DSCs) and Safer Internet Centres (SICs). DSCs and SICs complement each other: the former providing legal and technical expertise on the DSA rules, the latter providing sound knowledge and outreach on child online safety matters.

Due consideration is **needed of the growing area of generative AI and the metaverse/virtual worlds**, to ensure that opportunities are maximised while potential risks are mitigated for young users.

In addition, **practical progress is needed on the issue of age verification within the broader range of age assurance approaches**, also continuing the work currently ongoing in the context of the Age Verification Task Force and in alignment with the European digital identity.

4.2.3. Promote responsible and human-centric AI systems

The risks and opportunities of AI

AI is developing fast. As a technology with multiple applications, it can improve our lives in a myriad of different ways. It allows for increased productivity and the creation of innovative business models, and brings great potential for addressing critical social issues in the area of health and climate change.

At the same time, AI entails a number of potential **risks for safety, such as malfunctioning machines** that could endanger humans physically and affect **fundamental rights**. AI-based systems can lead to **opaque decision-making**, where conclusions and decisions are reached on the basis of systems that are not fully understood, **intrusion of privacy (e.g., widespread face recognition surveillance)**, **use of data for criminal purposes (e.g. AI-generated voice clones calling elderly persons) and discrimination (e.g. in CV-sorting algorithms)**. Moreover, the issue of AI-generated disinformation, expected to increase, is becoming ever more prominent.

Both the potential and the risks have become multiplied by the emergence of general purpose AI models (GPAI). In this respect, the launch of ChatGPT at the end of 2022 was a turning point in the public debate, with many similar models developed since or currently under development. Given the pace of progress and the wave of investment pouring into GPAI, it is widely expected that much more capable models will emerge in the years to come.

EU and Member State action

Commission President-Elect Von der Leyen had announced a regulation on AI in the European Parliament in 2019. This regulation was prepared with broad participation by stakeholders in the follow-up to the White Paper on AI of February 2020. The Commission then adopted its legislative proposal in April 2021.

In December 2022 the EU Council and in June 2023 the European Parliament adopted their respective positions, so that interinstitutional negotiations could start. The negotiations

resulted in a political agreement between these two bodies in December 2023 which maintained the fundamental structure of the Commission's proposal. This includes a product safety legislation logic, risk-based approach, upstream conformity assessment and a post-market monitoring and market surveillance for AI systems classified into four categories. In addition, new targeted rules were included for GPAI, notably transparency obligations and copyright-relevant provisions. The most capable GPAI models carrying systemic risks will be subject to additional risk assessment and mitigation measures. The governance system was set up, composed of national authorities and EU-level bodies, including a strengthened role and regulatory powers for the European AI Office.

The regulation was officially adopted on 12 June 2024.

The European AI Act will be the world's first horizontal regulation of AI. It addresses risk to health and safety as well protecting fundamental rights from certain uses of AI systems. Many other countries have been inspired by the European approach and are now considering legislative measures.

The **Council of Europe (CoE) Framework Convention on AI, human rights, democracy and the rule of law**, adopted on 17 May 2024, will be an occasion for promoting some of the key concepts of the EU AI Act, fostering a human-centric approach to AI. The EU, represented by the Commission, and with the support of its Member States, participated very actively in the negotiations for this convention.

In addition to other CoE members, several non-CoE States participated in these negotiations as observers, including the US, Canada, Japan, Israel, Australia, Argentina, Peru, Uruguay and Costa Rica. The convention will also be open to countries around the world.

The AI Act **outlaws systems** that pose **unacceptable risks** such as by deploying 'subliminal, manipulative, or deceptive techniques to distort behaviour and impair informed decision-making,' or exploiting vulnerable people, those **that infer sensitive individual characteristics** such as political opinions or sexual orientation, and that use real-time facial recognition software in public places.

It also establishes quality requirements for **AI systems and use cases that pose a high risk.** In addition to the products already covered by the existing product safety legislation, such as medical devices and machinery, the high-risk AI use cases include AI systems that are not embedded in existing products but which could have significant impacts on **people's health, safety and fundamental rights** – such as in healthcare, education, and law enforcement.

AI companies developing high-risk AI in these sectors will have to develop a risk-management system and ensure high-quality data governance, ensuring human oversight and assessing how these systems will affect people's rights.

Europeans will be able to submit complaints about AI systems when they suspect they have been harmed.

The AI Act **ensures greater transparency**. People will be able to better detect and be informed if they interact with a chatbot or another AI system, by means of notifications and labels signalling deepfakes and other AI-generated content.

For those developing GPAI systems such as large language models (LLMs), requirements will extend to creating technical documentation on how the model was built, how it respects copyright, and the type of data used.

Promote human-centric and responsible AI systems in national roadmaps ([406])

Promoting human-centric and responsible AI systems is an aspect that a small number of Member States (Belgium, Germany, Greece, Netherlands, Sweden) took into account in their roadmaps.

The measures support the development of safe and non-discriminatory AI systems, including in social services, education and R&D projects in SMEs.

Concluding remarks and future challenges

After the adoption of the AI Act, the time has come to concentrate on its implementation. The focus of the immediate future must be the successful implementation of the act. The entry into application of the act will be phased in, with provisions coming into force between 6 months and 3 years after adoption.

Moreover, the European standardisation bodies will work intensively to develop the standards referred to in the act. Efforts to align technical standards, guidelines, model contractual terms and templates will be required. In addition, close cooperation with SMEs and relevant stakeholders, including in the area of fundamental rights, will be key to efficient implementation. Considerable work will be needed to provide guidance and common principles (including through implementing acts).

4.3. Promote and preserve our democracy

DD cardinal points and targets -

DD objectives: Promoting democratic life (making online participation in democratic life possible for everyone).

Digital rights and principles: Putting people at the centre of the digital transformation; safety, security and empowerment; participation in the digital public space.

The Digital Decade promotes online participation in democratic life for everyone. The Declaration on Digital Rights and Principles dedicates a chapter to 'participation in the digital public space' (Chapter IV), stating that 'everyone should have access to a trustworthy, diverse and multilingual digital environment'. It further states that access to diverse content contributes to a 'pluralistic public debate and effective participation in democracy in a non-discriminatory manner'.

Achieving these objectives builds on the availability of reliable information and protection from mechanisms that amplify disinformation, fuel polarisation and extremism and, ultimately, risk altering the civic discourse and electoral processes.

At the same time, preserving freedom of expression and pluralism are key EU values that are protected and have been enhanced by a number of recent initiatives.

([406]) This analysis only takes account of information reported by the Member States in their national roadmaps. The measures reported were grouped into categories to provide a better overview of the types of measures taken.

This chapter provides an overview of these issues.

4.3.1. Address disinformation and preserve election integrity

Tracing the surge in online disinformation

In recent years, both the EU and the global community have witnessed a surge in the spreading of disinformation. This troubling trend has been accelerated by the widespread use of social media platforms, where false narratives can quickly gain traction. Although disinformation has long been a concern, its prevalence has escalated significantly since 2020.

This rise was witnessed jointly with the outbreak of the COVID-19 pandemic and Russia's invasion of Ukraine. Disinformation and hate speech have emerged again as a serious threat in the context of the Israeli-Palestinian conflict. It is widely feared that with the rapid adoption of new technologies, such as generative AI, the risks will only grow.

Disinformation has been identified as on**e of the biggest destabilising factors for our societies going into the future**. The World Economic Forum's Global Risks Report 2024 ([407]) ranks disinformation as the number 1 risk in the short-term, with AI-generated mis/disinformation identified as a particular cause of concern. Disinformation will remain a grave threat even in the long-term, with ENISA's Foresight Cybersecurity Threats for 2030 ([408]) report listing **advanced disinformation and influence operation campaigns among the top 10 threats for this decade**.

A **mix of offline and online factors drive this phenomenon**. In recent years, the psychological and sociological elements have been further exacerbated by technological ones. According to the JRC report 'Understanding Our Political Nature' ([409]), people's thinking skills are challenged by the current information environment, making them prone to disinformation. Today's era has been labelled a 'post-truth' world, where appeals to emotion and personal beliefs are much more influential in shaping public opinion than facts.

We are seeing greater **societal and political polarisation**, not just in the EU, but around the world. While disinformation is not the only factor driving this, it does have a large impact ([410]). Research suggests that mis/disinformation is correlated to partisanship and hence political polarisation ([411]). This is because disinformation content is often structured to elicit negative emotions, especially anger, leading to strongly polarised environments in society, including political gridlock and even social unrest.

The widespread appearance of disinformation is highly correlated with the **rising distrust in institutions, including electoral processes**. A study by Eurofound found the level of

([407]) World Economic Forum, Global Risks Report 2024, https://www.weforum.org/publications/global-risks-report-2024.
([408]) https://www.enisa.europa.eu/publications/enisa-foresight-cybersecurity-threats-for-2030.
([409]) https://op.europa.eu/en/publication-detail/-/publication/6574c875-a90a-11e9-9d01-01aa75ed71a1/language-en/format-PDF/source-236656403.
([410]) https://www.ncbi.nlm.nih.gov/pmc/articles/PMC10106894/.
([411]) https://onlinelibrary.wiley.com/doi/full/10.1111/isj.12453.

trust towards institutions in the EU had fallen in recent years ([412]). The results show that from 2020 to 2022, trust in the main national institutions declined by 13.4% ([413]).

A decline in public trust can lead to an increase in support for authoritarianism, extremism, and even greater inclinations towards political violence. There is a growing fear the current trends could lead to greater political instability. In a survey conducted across 30 countries, 58% of respondents were worried about political violence in the coming year ([414]).

Disinformation is often listed as one of the biggest, if not the biggest, threats to **democratic processes** in the EU. According to the latest Eurobarometer survey ([415]), 38% of the EU citizens surveyed listed 'false and/or misleading information circulating online and offline' as the biggest threat to democracy. This means disinformation and false information in general are the top threat they perceive. Furthermore, 32% of respondents listed 'growing distrust and scepticism towards democratic institutions' as a threat.

While many disinformation narratives are spread and promoted internally by citizens, whether unintentionally (misinformation) or intentionally (disinformation), there is also a large aspect linked to **interference from malicious foreign actors**. ENISA's Threat Landscape ([416]) report noted that information manipulation is a key element of Russia's war against Ukraine. This is often utilised as part of a hybrid war strategy, where disinformation is used in conjunction with other cybersecurity techniques, as well as offline strategies. According to the EEAS 2nd report on *foreign information manipulation and interference* (FIMI) threats, much of the disinformation content is distributed through multiple online platforms and channels ([417]).

The advent of social media has played a large role in facilitating the spread of disinformation. One study found that false news tends to spread much faster than real news, often by a significant margin ([418]). These types of dynamics have resulted in disinformation being able to reach wide segments of the population.

The visibility of disinformation has been confirmed by the last Eurobarometer survey, which asked people how they perceive their exposure to it ([419]). Around 13% of respondents stated they had been exposed to disinformation 'very often' in the past 7 days, with a further 22% saying 'often', and 33% stating 'sometimes'. In addition, according to the recent special Digital Decade Eurobarometer 2024, 45% of respondents consider fake news and disinformation to be one of the online issues with a biggest personal impact on them([420]).

This exposure is particularly significant on online social networks. Around 64% of respondents listed these as the source where they are likely to encounter disinformation. Moreover, the report by Eurofound names social media as one of the key

([412]) https://www.eurofound.europa.eu/en/news/2022/trust-institutions-continues-fall-eu-despite-declining-unemployment-and-phasing-out.
([413]) https://www.eurofound.europa.eu/en/blog/2022/trust-national-institutions-falling-data-behind-decline.
([414]) https://www.weforum.org/agenda/2023/12/how-to-rebuild-trust-in-philanthropy-results-results-results/.
([415]) https://europa.eu/eurobarometer/surveys/detail/2966.
([416]) ENISA, ENISA Threat Landscape 2023, https://www.enisa.europa.eu/publications/enisa-threat-landscape-2023.
([417]) https://www.eeas.europa.eu/eeas/2nd-eeas-report-foreign-information-manipulation-and-interference-threats_en.
([418]) https://news.mit.edu/2018/study-twitter-false-news-travels-faster-true-stories-0308.
([419]) https://europa.eu/eurobarometer/surveys/detail/2966.
([420]) Special Eurobarometer 551 'The Digital Decade' 2024: https://digital-strategy.ec.europa.eu/en/news-redirect/833351.

drivers of the decline of trust in society ([421]). According to the study, the trust score for respondents who use social media as their preferred news source is 3 out of 10, while it is 4.2 for those who prefer traditional media.

Democratic societies rely on free and fair elections as fundamental pillars of their governance. Yet the proliferation of disinformation poses a significant threat to the integrity of electoral systems. Foreign entities have been implicated in orchestrating online campaigns aimed at influencing election outcomes across various nations. As trust in institutions dwindles, unfounded doubts about the fairness of elections have become prevalent narratives. Tragically, such narratives have incited instances of political violence, as witnessed in the US and Brazil. Recent findings from a report by the European Digital Media Observatory on disinformation narratives in 2023 elections confirm the presence of this narrative in EU countries too ([422]).

EU action

The **Commission's effort is based around combating the spread of false narratives**, while preserving freedom of expression. It does not aim to restrict any viewpoints, but rather to promote a healthy information ecosystem based on fact-checking and media literacy. The main pillars of the strategy against disinformation are the Digital Services Act and the Code of Practice on Disinformation.

The **DSA is a global legal standard for tackling disinformation and other risks to civic discourse and electoral processes**, while protecting freedom of expression and information. Its main regulatory tool is the supervised risk management framework for larger online platforms. This means for instance, if their content moderation tools or recommender systems are found to amplify disinformation, they will need to take appropriate mitigation measures to address such risks. Three formal proceedings for breach of the obligation to counter the spread of disinformation have already been opened under the DSA, notably against X and Meta's Facebook and Instagram.

Given the many elections taking place this year and the importance of protecting their integrity, the Commission has decided to also issue **guidelines for VLOPs and VLOSEs on the measures they have to take to mitigate risk for electoral integrity under the DSA** ([423]). The guidelines present best practices and recommend possible mitigation measures to the platforms. The measures cover several areas: from internal teams that should be in place, from authenticating official information on the electoral process to detecting watermarks so deepfakes and generative AI content can be labelled. Following a public consultation, the guidelines were published at the end of March 2024.

In 2022, based on the Commission's guidance document, **a new strengthened Code of Practice on Disinformation** was drafted ([424]). This code builds on the one from 2018. The new code contains different provisions on the demonetisation of disinformation, political

([421]) https://www.eurofound.europa.eu/en/news/2022/trust-institutions-continues-fall-eu-despite-declining-unemployment-and-phasing-out.
([422]) EDMO, Disinformation narratives during the 2023 election in Europe report, November 2023, https://edmo.eu/wp-content/uploads/2023/10/EDMO-TF-Elections-disinformation-narratives-2023.pdf.
([423]) Communication from the Commission – Commission Guidelines for providers of Very Large Online Platforms and Very Large Online Search Engines on the mitigation of systemic risks for electoral processes pursuant to Article 35(3) of Regulation (EU) 2022/2065, C/2024/2537.
([424]) https://digital-strategy.ec.europa.eu/en/policies/code-practice-disinformation.

advertising, integrity of services, user empowerment, researcher access to data, and fact-checking. The signatories include several VLOPs and VLOSEs, as well as different stakeholders from the private sector, non-governmental organisations and fact-checking organisations.

In January 2023, the first set of reports from the signatories of the Code was provided, which was followed up by a second set of reports from the VLOP and VLOSE signatories in September 2023 ([425]). This has resulted in a wealth of data on what the different stakeholders are doing to combat disinformation. An especially important step has been the provision of data on the different chapters by the large social media platforms. Although this has improved transparency, there are still some gaps when it comes to implementation. While most social media platforms have conducted a serious effort to combat disinformation, more still needs to be done.

To analyse and understand disinformation trends, the Commission has funded the **European Digital Media Observatory (EDMO)** and a network of corresponding hubs in the different EU Member States. These bring together a wide variety fact-checkers, media literacy experts and academic researchers.

EDMO has done significant work in mapping fact-checking organisations across Europe and ensuring they collaborate. It has built a public portal providing media practitioners, teachers and citizens with information and materials aimed at increasing awareness, building resilience to online disinformation and supporting media literacy campaigns. EDMO also helps public authorities monitor the policies put in place by online platforms to limit the spread and the impact of disinformation.

Apart from the work on the DSA and Code of Practice on Disinformation, there have been several other initiatives at EU level to better understand and facilitate the work of tackling disinformation. For instance:

- To better measure the impact of disinformation on society, a set of structural indicators has been drafted. A pilot study on structural indicators looked into the prevalence and sources of disinformation on several social media platforms, taking measurements in three countries, and on six platforms (Facebook, X/Twitter, Instagram, YouTube, TikTok and LinkedIn). The plan is to build on this pilot project, expanding it to include more indicators, countries and platforms.
- Research projects financed by the Directorate-General for Communications Networks, Content and Technology have resulted in tools facilitating the work of fact-checkers, AI-generated image detection tools, and different tools and services for coaching media professionals and citizens. As the technology is constantly evolving, the tools coming out of these projects will need to evolve with it.
- The EU and the US have adopted ([426]) a common standard for exchanging structured threat information on FIMI, through a more interoperable and machine-readable

([425]) https://disinfocode.eu/reports-archive/?years=2023.
([426]) https://www.eeas.europa.eu/sites/default/files/documents/2023/Annex%203%20-%20FIMI_29%20May.docx.pdf.

approach. This standard is comprised of the DISARM framework, the STIX 2 standard and the OpenCTI platform.

Finally, in December 2023, the Commission adopted the **defence-of-democracy package**, to address challenges such as foreign interference, to encourage civic engagement and democratic participation. The package includes: a proposal that addresses covert foreign influence and establishes common standards across the EU for interest-representation activities carried out on behalf of non-EU countries; a recommendation on strengthening electoral processes in the EU; and a recommendation on promoting the inclusive participation of citizens and civil society in policymaking.

Strictly interlinked with the digital domain are also the new rules on transparency of political advertising, for which a political agreement between the European Parliament and the EU Council was reached at the end of 2023. Under the provisional agreement, political adverts will need to be clearly labelled, must include certain information (e.g., who paid for them and how much) and strict limits are placed on the use of targeting and ad delivery techniques.

Concluding remarks and future challenges

Disinformation is and will continue to be a challenge into the future. While significant strides have been made to counter it, continued efforts are essential, particularly in the effective implementation of commitments outlined in the Code of Practice on Disinformation. Preserving citizens' trust in institutions and the electoral process, alongside safeguarding their freedom of speech, remains paramount.

Ensuring the integrity of elections will be a particular challenge in the coming years. With the rise of generative AI, elections scheduled for 2024 are particularly vulnerable. We have seen the first instances of the problem during elections in 2023, but AI-generated text, images, audio and video are predicted to become a more widespread phenomenon in the coming years.

There are two main categories of worries linked to generative AI and disinformation:

- **Chatbot hallucinations**: When prompted, chatbots can 'hallucinate', giving wrong answers to queries. One study found that when asked about issues pertaining to elections, chatbots would often respond incorrectly about election dates, candidates and other issues ([427]).
- Use of generative AI to facilitate the creation of disinformation: Large language models and chatbots can also be used to generate very persuasive messages and make the entire process of spreading disinformation more efficient and effective. Coupled with AI-generated images, audio and video which are virtually indistinguishable from real ones, we could be facing significant threats. While in the past, it would take a significant effort to create disinformation campaigns, generative AI has lifted these barriers.

Challenges such as generative AI feeding disinformation call for action under the existing framework. Initiatives such as the Code of Practice on Disinformation, the DSA and the defence-of-democracy package will guide the response to disinformation and information manipulation at European and Member State level, through public and private initiatives.

([427]) https://aiforensics.org/work/bing-chat-elections.

To enable true participation in the 'digital public space', as described in the Declaration on Digital Rights and Principles, it remains crucial to ensure that people remain alert to the mis- and disinformation risks posed by new technologies.

4.3.2. Access to media and media pluralism

The Declaration on Digital Rights and Principles for the Digital Decade has a chapter on 'participation in the digital public space', related to ensuring access to diverse content online, the right to freedom of expression and information and transparency in media ownership. It includes a commitment to continue safeguarding media freedom and pluralism online, among other things.

Mapping key trends in access to media

In the State of the Digital Decade (SDD) report 2023, the Commission made the case for 'empowering independent media actors to provide reliable information online and people to seek out such information'.

The first **European Media Industry Outlook report** ([428]), published in May 2023, shed light on several key trends explaining citizens' access to media content and information, both off and online. The report showed that media today operate under the logic of an attention economy, in which different forms of content (news, advertising, entertainment) compete to capture attention.

The available data (Eurobarometer survey on media use in the EU, EB98 Winter 2022-2023 ([429])) show that most Europeans consume media on a daily basis: 74% of Europeans watch TV using their TV sets, with other forms of consumption some distance behind: 47% use social networks, 44% read news on the internet and 41% listen to the radio. TV remains the most used media for consuming news, but online media are catching up, while the printed press is dropping to just less than 20% of the population consuming it.

Legacy and digital news media are still a more popular choice for **accessing news** than social media and related external providers when all population segments are considered. But these two kinds of sources are nearly at par among younger people. 7% of citizens do not follow the news at all.

Moreover, the 2023 Flash Eurobarometer survey on media & news ([430]) found a 4 percentage point decrease in the overall share of respondents mentioning TV as their most used media for accessing news in the past 7 days and an **11 percentage point increase when it comes to social media platforms**, **compared to the 2022** Eurobarometer.

Some ongoing trends explain the current evolution of media consumption: the development of new technologies enhancing the media consumption experience and increased access to digital media (connectivity, increase in interactive content and instant apps), or the emergence of new consumption patterns through social networks. In spite of the digital shift, the Eurobarometer survey revealed that people's **trust of digital sources**

([428]) European Media Industry Outlook, SWD(2023) 150 final, May 2023. The Commission is continuing the monitor the media industry, with the launch of a public survey to better understand consumption and access trends in the audiovisual, news and gaming sectors. The results are expected in in 2024 and will feed into the production of the new outlook report, which will be published in 2025.

([429]) European Commission, Media use in the European Union – Report, Standard Eurobarometer 98 – Winter 2022-2023, https://data.europa.eu/doi/10.2775/608948.

([430]) https://europa.eu/eurobarometer/surveys/detail/3153.

remains an issue. The most trusted media source is radio (56%), while just 35% of users trust internet media and 19% online social networks.

EU action

In its **Media and Audiovisual Action Plan** (December 2020) ([431]), the Commission decided to accompany the audiovisual and news media industries in their digital transformation. As part of the plan, it is proposed to bundle existing and new measures in the news media sectors. Support is offered to protect media freedom and pluralism, help the transformation and competitiveness of the news media sector, engage with the sector and increase citizens' access to information on EU affairs.

The Commission has allocated an unprecedented level of resources to work on these objectives. The **Creative Europe programme** has allocated EUR 75 million for the first time in support of actions such as media pluralism, media literacy and quality journalism. A further EUR 20 million per year is being spent on increasing professional media coverage of EU affairs, so the public can access reliable information on topics that interest them.

As more and more citizens are accessing news and other media content online, the cross-border availability of media services is increasing. Following initiatives related to viability, resilience and digital transformation of the media sector, adopted under the Media and Audiovisual Action Plan and revised copyright rules, the **European Media Freedom Act (EMFA)** ([432]) was presented by the Commission in September 2022 and officially adopted in April 2024.

The Act includes unprecedented safeguards for media and journalists against political interference, as well as rules ensuring that media can operate more easily across borders, without undue pressure and benefiting from the digital transformation of the media space.

The EMFA includes specific rules on the provision of and access to media services in a digital environment, such as protecting the content of media services providers on very large online platforms and users' right to customise content they receive via this media.

The rules will also provide more transparency about media ownership, including through online databases, and help consumers access a more diverse range of quality media content and contribute to pluralistic public debates, in line with the Declaration on Digital Rights and Principles.

The act builds on the revised Audiovisual Media Services Directive (AVMSD) ([433]), which provides for EU-wide coordination of national legislation for audiovisual media, taking into account technological development. The EMFA strengthens the already existing

([431]) Commission Communication, Europe's Media in the Digital Decade: An Action Plan to Support Recovery and Transformation, COM/2020/784 final, https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A52020DC0784.

([432]) Regulation (EU) 2024/1083 of the European Parliament and of the Council of 11 April 2024 establishing a common framework for media services in the internal market and amending Directive 2010/13/EU (European Media Freedom Act), OJ L, 2024/1083, 17.4.2024.

([433]) Directive 2010/13/EU of the European Parliament and of the Council of 10 March 2010 on the coordination of certain provisions laid down by law, regulation or administrative action in Member States concerning the provision of audiovisual media services (Audiovisual Media Services Directive) (codified version).

mechanisms for cooperation among national media regulators, including coordination of measures concerning non-EU media services.

EMFA also steps up cooperation within the European Regulators Group for Audiovisual Media Services (ERGA), set up by the AVMSD, by transforming it into a new independent European Board for Media Services, comprised of national media authorities and assisted by a Commission secretariat. The Board will be given a broader scope of action and additional tasks which will include, among others, promoting the effective and consistent application of the EU media law framework.

The proposal for the act was published together with a Recommendation ([434]) on internal safeguards for editorial independence and ownership transparency in the media sector, which allows specific features of media regulation and self-regulation to be taken into account at EU level and in the Member States.

The act also builds on the Platform-to-Business Regulation, Digital Services Act and Digital Markets Act, as well as the Code of Practice on Disinformation ([435]). It is part of the EU's efforts to promote democratic participation, address disinformation and support media freedom and pluralism, as set out under the European Democracy Action Plan ([436]).

The act complements the Commission's Recommendation ([437]) on the protection, safety and empowerment of journalists**,** the Directive on protecting persons who engage in public participation from manifestly unfounded claims or abusive court proceedings ('SLAPPs'), and an accompanying Recommendation to encourage Member States to align their rules on SLAPP with EU law, also with regard to domestic cases as well as criminal and administrative proceedings, along a range of other measures, such as training, awareness-raising and support mechanisms to fight against SLAPPs.

Concluding remarks and future challenges

The ongoing digital transformation of the media sector is gaining significant attention and keeps affecting all actors. Initiatives like the European Media Freedom Act and the Media and Audiovisual Action Plan are an important step towards **pluralistic media in viable markets, serving media-literate citizens by providing quality journalism**.

Apart from regulatory, political and funding initiatives, the Commission is also monitoring national action taken, in particular under the recommendations on the safety of journalists, including action to tackle online and cyber threats. It will be important to keep monitoring the use of media and its perception to understand further needs for concrete action.

Further work will eventually lie in the take-up of the rules in the European Media Freedom Act, including setting up the European Board for Media Services. It is thus important to ensure these rules are implemented swiftly and correctly.

([434]) Commission Recommendation (EU) 2022/1634 of 16 September 2022 on internal safeguards for editorial independence and ownership transparency in the media sector, C/2022/6536.
([435]) Platform-to-Business Regulation; Digital Services Act; Digital Markets Act; Code of Practice on Disinformation: https://ec.europa.eu/commission/presscorner/detail/en/ip_22_3664.
([436]) European Democracy Action Plan: https://ec.europa.eu/commission/presscorner/detail/en/ip_20_2250.
([437]) https://ec.europa.eu/commission/presscorner/detail/en/ip_21_4632.

5. LEVERAGING DIGITAL TRANSFORMATION FOR A SMART GREENING

5.1. Introduction to the link between the green and digital transitions

DD cardinal points and targets

DD objectives: More sustainable digital infrastructure

Energy and resource-efficient digital infrastructure and technologies, with a view to minimising their negative environmental and social impact and contributing to a sustainable circular and climate-neutral economy and society; **ensuring consistency and coordination**, for policies and programmes to fully contribute to the European green and digital transition.

DD objectives: Maximising the digital contribution to the green transition.

Demonstrating the positive impact of digitalisation on climate and environment.

Digital rights and principles: Competitiveness, sustainability.

The **synergistic alignment of the green transition and the digital transformation is a political priority of the Commission**, as announced by President von der Leyen in her political guidelines ([438]) and reiterated in her speech on 'Europe's new generation' in March 2020 ([439]).

This twin transition is a strategic approach to address both environmental and digital challenges, recognising both their conflicts and synergies, which were explained in the Commission's 2022 strategic foresight report ([440]) on 'twinning the green and digital transition in the new geopolitical context'.

The main goal of twinning is to minimise the environmental footprint of the digital sector, while maximising the potential of the ICT sector to advance environmental objectives.

5.1.1. Harnessing the Digital Decade for a smart and green transition

With the Digital Decade policy programme, the EU is focusing on increasing the deployment of digital technologies such as AI, cloud, edge computing, high performance computing, quantum technologies and the Internet of Things (IoT). While promoting a competitive and innovative European economy, these technologies can also help reduce our environmental footprint and stimulate a smart and green transition.

The Digital Decade sets the objective of ensuring that digital infrastructure and technologies become more sustainable and resource efficient and **includes several references to the sustainability of infrastructure targets**, in particular edge nodes and semiconductors.

The Digital Decade's objectives and targets as well as the **European Declaration on Digital Rights and Principles** are all seeking to promote sustainable digital technologies, products and services with a minimum negative impact on the environment and society. Also, access to

([438]) https://commission.europa.eu/system/files/2020-04/political-guidelines-next-commission_en_0.pdf.

([439]) 'Leading the twin transition in this changing world is the driving force of this Commission. This is our generational task and opportunity. And it is why, since day one, we have been determined to move fast to build a fair and prosperous, green and digital Europe that will last for our children.' Ursula von der Leyen, March 7, 2020. https://ec.europa.eu/commission/presscorner/detail/en/ac_20_417.

([440]) https://commission.europa.eu/strategy-and-policy/strategic-planning/strategic-foresight/2022-strategic-foresight-report_en#:~:text=The%202022%20Strategic%20Foresight%20Report,where%20action%20will%20be%20needed.

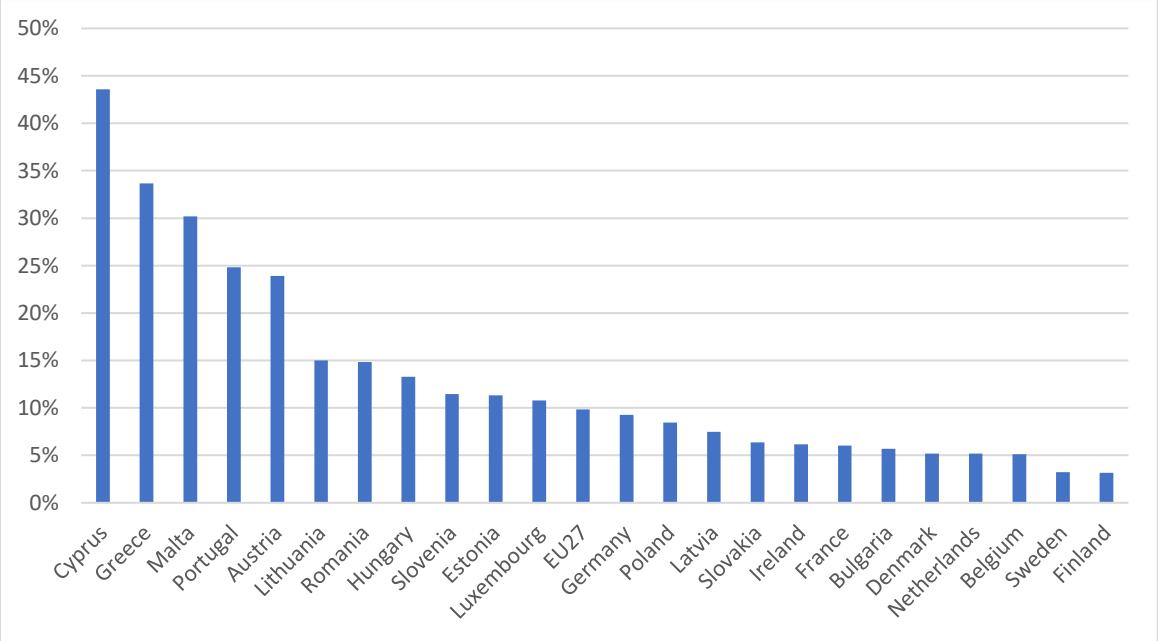
accurate and easy-to-understand information on environmental impact and energy consumption should be available to everyone.

5.1.2. Setting the scene: public perception

According to the Special Eurobarometer 'Digital Decade 2024'([441]), the twinning of the digital and green transitions is considered a key factor in Europe's digitalisation. **Four out of five people in Europe consider it important that the public authorities ensure that digital technologies serve the green transition**. In addition, the perception of the role of digital technologies in fighting climate change is increasing – **3 out of 4 Europeans consider that digital technologies will be playing an important role in helping fight climate change**, while this figure was only 2 out of 3 respondents last year, in the 2023 Eurobarometer survey.

At the same time, consumer and business awareness about reducing the environmental footprint of the ICT sector and supporting its transition to climate neutrality by 2050 remains uneven, as illustrated by recent Eurostat surveys presented below.

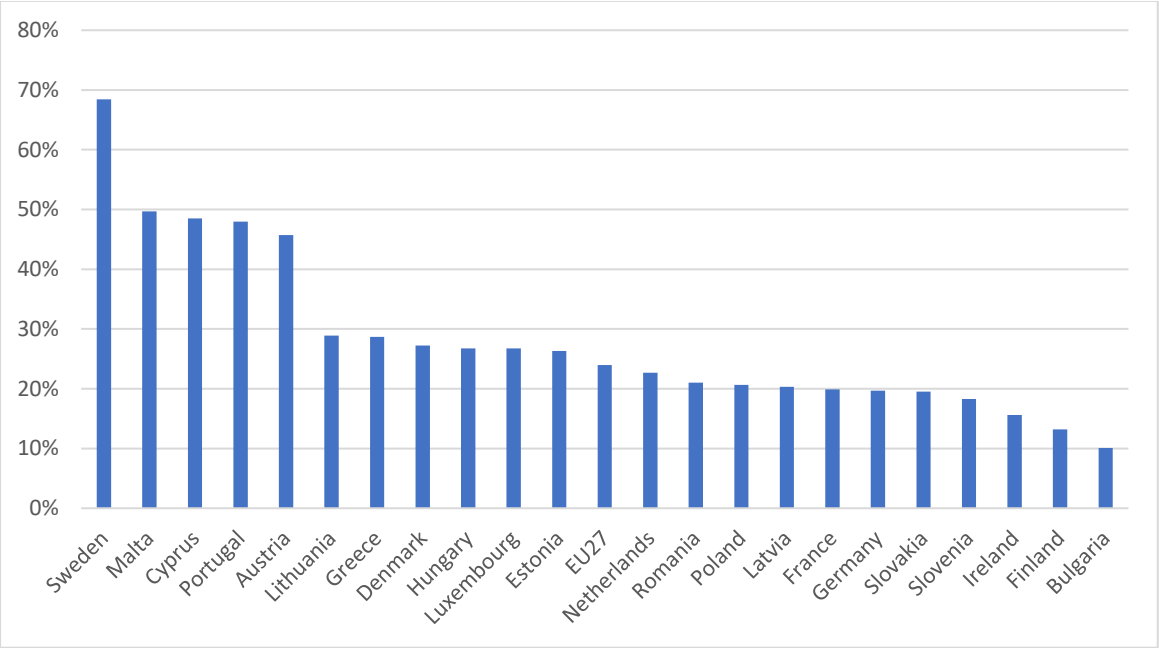
Figure 64. Device purchase: possibility of extending the life span considered important, percentage of individuals who used internet in the last 3 months.



Source: Eurostat, 2022

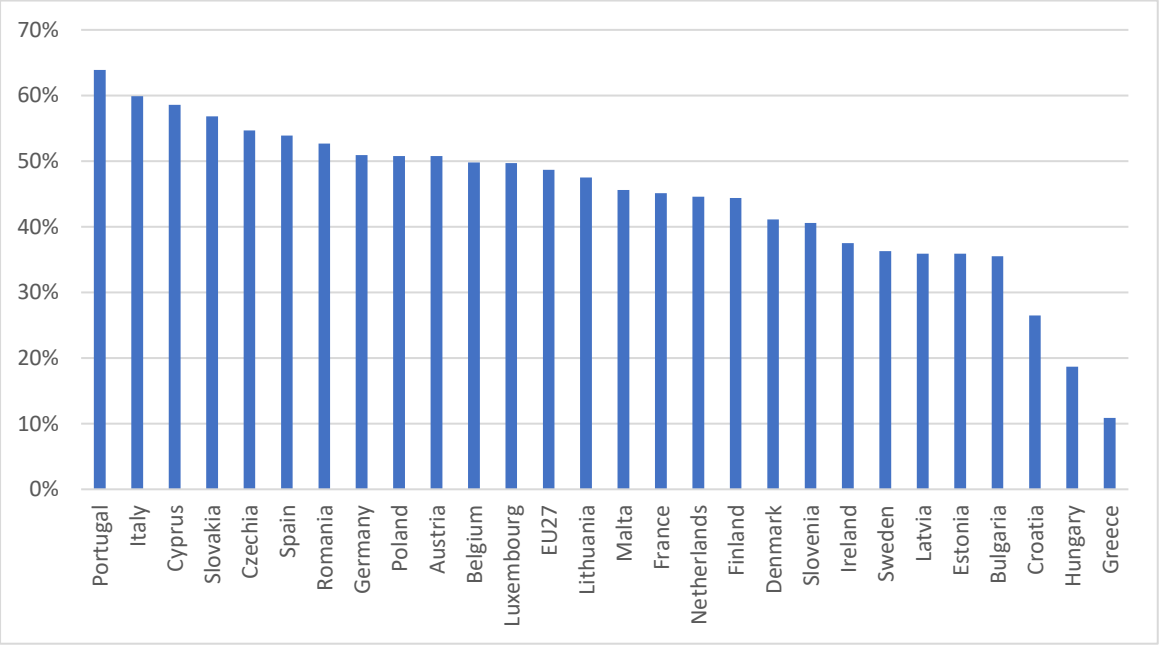
([441]) Special Eurobarometer 551 'The Digital Decade' 2024: https://digital-strategy.ec.europa.eu/en/news-redirect/833351.

Figure 65. Device purchase: energy efficiency considered important, percentage of individuals who used internet in the last 3 months.



Source: Eurostat, 2022

Figure 66. Enterprises that considered the environmental impact of ICT services, or ICT equipment, before selecting them and applying some measures, affecting the paper or energy consumption of the ICT equipment, percentage of enterprises with 10 employees or more.



Source: Eurostat, 2022

In this context, there is a clear need to promote awareness, including through transparency requirements and digital sobriety, as well as to develop solutions such as sustainability by design, so that businesses, the public sector and consumers can reduce their digital footprint and e-waste, to encourage consumption that is in line with the principles: reduce, reuse and recycle.

5.1.3. Member States commitments to date

In **December 2020, the EU Council conclusion** on '*Digitalisation for the benefits of the environment'* ([442]) was adopted under the German presidency, calling for a coordinated effort at Member State and EU level to both address the environmental footprint of digitalisation and maximise the benefits of digitalisation for the environment.

In March 2021, ministers of all Member States signed the Declaration on '***A Green and Digital Transformation of the EU'*** ([443]), to lead the digital transformation by investing more in green digital technologies and thus achieve climate neutrality. With the help of the EU funds NextGenerationEU and InvestEU, Member States committed to take concrete action in areas such as:

- setting up a digital twin ([444]) of the earth to help monitor climate change;
- making data available in common European data spaces;
- helping cities become greener and more digital;
- developing low-power hardware technologies;
- promoting eco-designed products;
- making green public procurement the default option overall;
- supporting smart and sustainable transport systems.

The following year, in June 2022, under the French presidency, Member States adopted the 'Toulouse Declaration' ([445]) on the future sustainability and decarbonisation of aviation. The Declaration was endorsed by 89 airport operators in 311 airports, which outlines several key principles and commitments towards achieving net zero CO_2 emissions in the aviation sector by 2050.

Acknowledging the essential role of aviation in regional and global connectivity, socio-economic development, and cohesion, the Declaration recognises the immediate need for cooperation and action to support and incentivise aviation decarbonisation, in line with international climate commitments ([446]). Recognising the need for cooperation, stakeholders committed to support initiatives for regular and constructive dialogue on decarbonisation between the authorities, industry and civil society, both in Europe and globally.

The EU Council Telecom conclusions adopted on 21 May 2024 include a section on sustainability calling for progress on:

- reducing the environmental impact of digital;
- developing and adopting a standardised and science-based methodology to estimate the environmental impact of digital solutions;

([442]) https://data.consilium.europa.eu/doc/document/ST-13957-2020-INIT/en/pdf.
([443]) https://digital-strategy.ec.europa.eu/en/news/eu-countries-commit-leading-green-digital-transformation.
([444]) https://digital-strategy.ec.europa.eu/en/policies/destination-earth.
([445]) https://www.economie.gouv.fr/files/files/2022/Call_for_Green_Digital_Transition_EU.PDF.
([446]) Paris Agreement and the Intergovernmental Panel on Climate Change 6th assessment report, the EU climate commitments for 2030 and 2050 and the Fit for 55 package of proposals, as well as similar commitments and initiatives from non-EU countries.

- using this methodology to drive further deployment of digital solutions for environment & climate;
- recalling the review of DDPP and the development of green digital targets.

Despite all these commitments and declarations – the digital and green constituencies continue to operate mainly in isolation.

However, there has been some progress on greening the digital sector. For example, the Commission has established measures to green datacentres and telecoms, some governments are looking into the footprint of datacentres and telecoms, and industry has made its own commitment to make data centres and telecommunication services sustainable.

Effort on synergies is so far focused on small scale pilots and initiatives.

5.2. Towards sustainable digital infrastructure and technologies

The Digital Decade policy programme requires digital infrastructure and technologies, including their supply chains, to become more sustainable, resilient and energy- and resource-efficient, with a view to minimising their negative environmental and social impact and contributing to a sustainable circular and climate-neutral economy and society.

On the basis of this, the Digital Decade commits to greening the digital sector, with particular focus on digital infrastructure, including datacentres, telecommunication networks and edge nodes. Some consideration will also be given to AI and semiconductor chips.

5.2.1. Setting the scene: environmental footprint of digital ecosystems

This section focuses on initiatives to make the key digital building blocks of the emerging digital ecosystem in the AI age more sustainable: data centres, edge nodes, AI, chips.

Other EU-wide measures to reduce the environmental footprint of the digital sector include the Directive on common rules promoting the repair of goods ([447]), Eco-design requirements for smartphones and tablets ([448]) and the Recommendation on improving the rate of return of used mobile phones, tablets and laptops ([449]).

According to the Digital Decade Eurobarometer 2024, only 50% of Europeans think the principle of getting access to the right information on the environmental impact and energy consumption of digital technologies is well implemented in their country([450]).

([447]) https://commission.europa.eu/document/afb20917-5a6c-4d87-9d89-666b2b775aa1_en.

([448]) Commission Regulation (EU) 2023/1670 of 16 June 2023 laying down ecodesign requirements for smartphones, mobile phones other than smartphones, cordless phones and slate tablets pursuant to Directive 2009/125/EC of the European Parliament and of the Council and amending Commission Regulation (EU) 2023/826, OJ L 214, 31.8.2023, p. 47–93.

([449]) Commission Recommendation (EU) 2023/2585 of 6 October 2023 on improving the rate of return of used and waste mobile phones, tablets and laptops, OJ L, 2023/2585, 20.11.2023.

([450]) Special Eurobarometer 551 'The Digital Decade' 2024: https://digital-strategy.ec.europa.eu/en/news-redirect/833351.

The digital sector is also a significant source of energy consumption, emissions and waste. Today, it accounts for approximately 7-9% of global electricity consumption, forecast to rise to 13% by 2030 ([451]), and, increasing amounts of e-waste ([452]).

More than **five billion mobile phones** are currently unused and could be recycled as part of a circular mobile supply chain. It is estimated that a refurbished phone can have 87% lower climate impact than a newly manufactured phone and that if properly recycled, these five billion mobile phones could recover EUR 8 billion worth of gold, palladium, silver, copper, rare earth elements, and other critical minerals, and cobalt for 10 million electric car batteries ([453]).

The fast-evolving nature of digital technologies and the possible sharp increase in digitally enabled services is likely to make this situation even more urgent. All analyses and studies agree that appropriate measures can limit or reduce the ICT sector footprint.

According to a recently published study by the JRC ([454]), the ICT sector is responsible for 2-4% of greenhouse emissions. Broken down, 20-80% of it is attributed to terminal equipment and devices such as laptops and smartphones, while 15% is caused by data centres, and 12-24% is attributable to networks.

Another study from the Shift project estimates that greenhouse emissions from the digital sector grow by 6% per year, already account for 3.5% of global emissions and could double between 2021 and 2025 ([455]).

([451]) According to the Strategic Foresight report 2022: https://commission.europa.eu/strategy-and-policy/strategic-planning/strategic-foresight/2022-strategic-foresight-report_en#:~:text=The%202022%20Strategic%20Foresight%20Report,where%20action%20will%20be%20needed.; the Action plan on Digitalisation of Energy Systems: https://ec.europa.eu/commission/presscorner/detail/en/QANDA_22_6229; and eWaste Monitor.

([452]) E-waste (electronic waste) is any electronic device or equipment that is obsolete, energy intensive or has reached the end of its life, such as old computers, mobile phones, tablets, smart TVs, telecommunication equipment and other electronic devices; GEM 2020 – E-Waste Monitor (ewastemonitor.info): https://ewastemonitor.info/.

([453]) https://www.gsma.com/newsroom/press-release/mobile-industry-eyes-five-billion-dormant-phones-sitting-in-desk-drawers-for-reuse-or-recycling/.

([454]) JRC Publications Repository – Identifying common indicators for measuring the environmental footprint of electronic communications networks (ECNs) for the provision of electronic communications services (ECSs) (europa.eu): https://publications.jrc.ec.europa.eu/repository/handle/JRC136475.

([455]) Environmental impacts of digital technology: 5-year trends and 5G governance. The shift project 2021.

Figure 67. Breakdown of contributions to greenhouse gas (GHG) emissions within the ICT sector

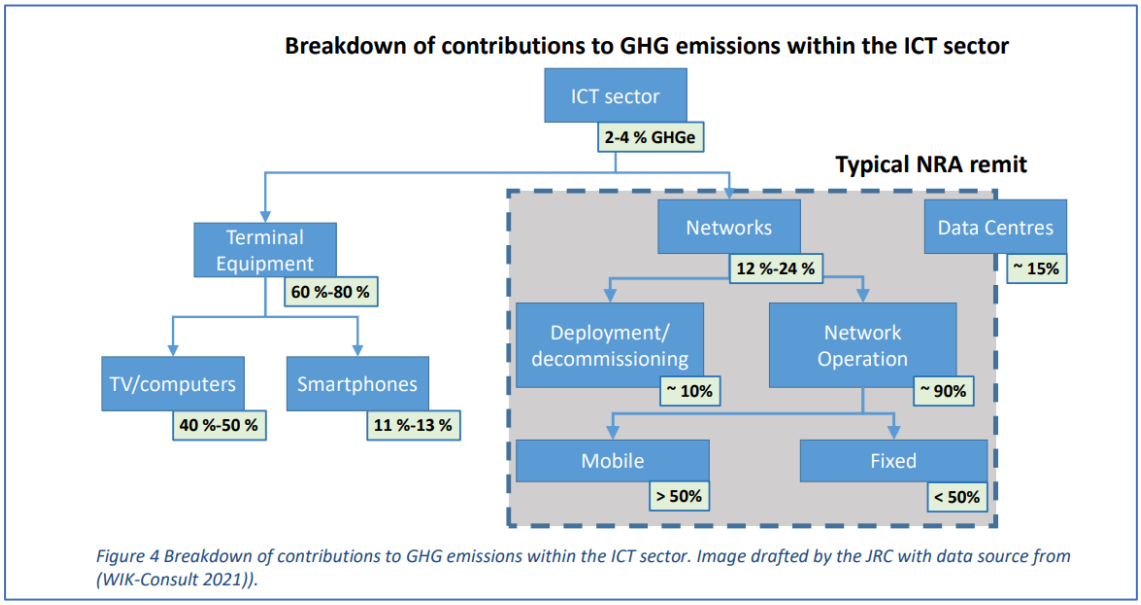


Figure 4 Breakdown of contributions to GHG emissions within the ICT sector. Image drafted by the JRC with data source from (WIK-Consult 2021)).

A study ([456]) by the French regulatory agency ARCEP and its environment agency ADEME shows that in France the vast majority (79%) of the digital sector's carbon footprint comes from electronic devices (smartphones, computers, tablets, etc.), especially at the production stage.

However, recent trends show that greenhouse emissions from device manufacturers are slowly decreasing (-5.4% between 2021 and 2022). However, while in the past datacentres produced only 16% of emissions, their footprint grew sharply over 2021-2022, with +14% of emissions, +15% of electricity consumption and +20% of water consumption.

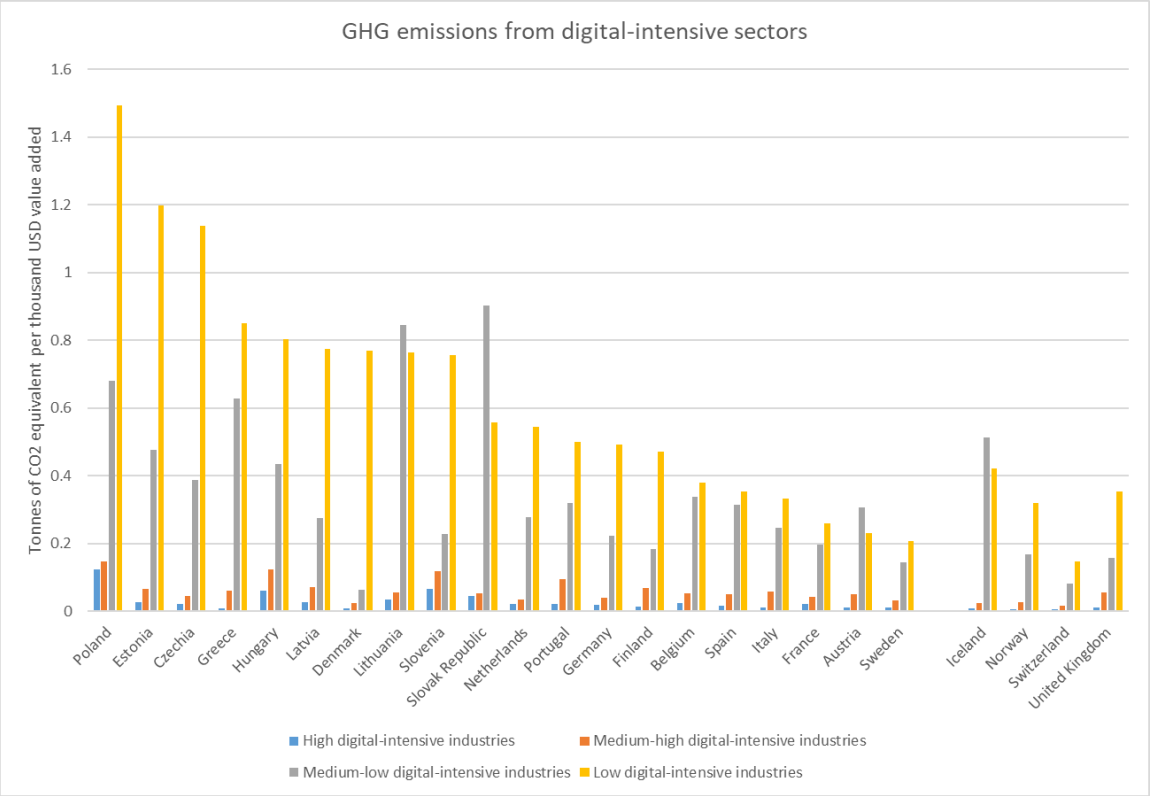
A prospective study ([457]) conducted by the same teams estimated that, in a no-policy-change scenario, the carbon footprint of the digital sector would increase by +45% by 2030 and by +187% by 2050.

This large increase is driven by the growth in the use of electronic devices, supported by a growing number of datacentres. These centres could represent 22% of digital emissions in 2050, even if they use technologies ensuring better energy efficiency.

([456]) Enquête annuelle 'Pour un numérique soutenable' – édition 2024 (données 2022) ARCEP-ADEME https://www.arcep.fr/cartes-et-donnees/nos-publications-chiffrees/impact-environnemental/derniers-chiffres.html.

([457]) Etude ADEME-ARCEP sur l'empreinte environnementale du numérique en 2020, 2030 et 2050 https://www.arcep.fr/la-regulation/grands-dossiers-thematiques-transverses/lempreinte-environnementale-du-numerique/etude-ademe-arcep-empreinte-environnemental-numerique-2020-2030-2050.html.

Figure 68. Greenhouse gas (GHG) emissions from digital-intensive sectors, OECD



Source: OECD ([458]), complete dataset, 2019

5.2.2. Towards climate-neutral data centres and edge nodes

Compared to traditional on-premises data storage, the use of centralised computing capacities in the cloud has historically driven financial and efficiency benefits for companies. The enabling effects of cloud computing for the green transition are significant: the move from on-premises data storage and processing to centralised cloud capacities already allows companies to become more sustainable by tapping into the resource-saving potential of increased workload flexibility, improved server utilisation rates and more energy-efficient infrastructure. In fact, a private sector study found that migration to the public cloud can reduce CO_2 emissions by 59 million tons per year, a number equivalent to taking 22 million cars off the road ([459]).

Cloud and edge computing enables more than just file storage and agile emailing. It is a key enabler for emerging technologies like AI, big data and digital ledger technologies. As such, cloud computing underpins many of the technologies that unlock innovative use cases for the green transition. This dynamic is underscored by the move to edge computing, which offers the potential to process data closer to the source. The boom in generative AI will unleash an unprecedented demand for data processing, including via cloud and edge computing.

In 2018, energy consumption by data centres in the EU amounted to 76.8 TWh/a, 2.7% of total EU electricity demand. Already before the emergence of generative AI, the energy

([458]) https://goingdigital.oecd.org/indicator/56.
([459]) Accenture (2020), The Green Behind the Cloud.

consumption of EU data centres was expected to reach 98.52 TWh by 2030, a 28% increase compared to 2018 ([460]).

The increase in data centre capacities over the past years has more than offset the significant efficiency gains achieved at the levels of hardware, software and infrastructure. As a consequence, the total energy consumption of data centres in Europe is increasing, although at a rate that is modest in relation to the overall increase in data processing.

Targeted policy intervention has the potential to unlock significant savings: studies suggest that by exploiting all policy potentials, **it will be possible to reduce the energy consumption of data centres to the 2010 level** ([461]). The integration of data centres into energy systems, namely how the excess energy, heat and water used by data centres can be used to contribute towards optimising the energy demand in local communities. A study ([462]) on this is ongoing.

However, the emergence of generative AI and the consequent large demand for data processing, may lead to a change in the outlook for the future: recent estimates predict that at global level, the electricity consumption of data centres could double between 2022 (460 TWh) and 2026 (1050 TWh) ([463]).

In parallel, the contribution of edge data centres to the overall energy demand of the EU's data centre sector is also on the rise: **by 2025, edge data centres are expected to account for 12% of the total data centres' energy consumption in the EU** ([464]). However, the full diversity of edge infrastructure and devices is not entirely represented by edge data centres. The analysis of sustainability for edge computing must also take into account the analysis of the energy usage and sustainability of medium and low-end edge devices and analytics processes, as well as their connection with energy consumption for network transmission.

Data centres also consume large volumes of water and produce significant amounts of electronic waste. And while the workload of data centres is growing rapidly, energy and water and other resources needed to produce electronic components are becoming increasingly scarce. In recent years, this dynamic has given rise to a public backlash against data centre investment projects.

Under the Digitalisation of Energy Action Plan, the Commission is evaluating how to best integrate the excess heat and water used by data centres into general energy systems. The aim of an ongoing study is to understand the drivers, obstacles and opportunities for data centre energy system integration, from the technological, regulatory and economic perspectives, including rising public opposition to the establishment of new data centres ([465]).

While the increased reuse of data centre waste heat offers important potential, stakeholders point to a lack of demand as well as the absence of the right framework conditions and a lack

([460]) https://digital-strategy.ec.europa.eu/en/library/energy-efficient-cloud-computing-technologies-and-policies-eco-friendly-cloud-market.
([461]) Montevecchi, F., Stickler, T., Hintemann, R., Hinterholzer, S. (2020). Energy-efficient Cloud Computing Technologies and Policies for an Eco-friendly Cloud Market. Final Study Report. Vienna.
([462]) https://digital-strategy.ec.europa.eu/en/news/survey-synergies-between-data-centres-and-energy-systems.
([463]) https://iea.blob.core.windows.net/assets/6b2fd954-2017-408e-bf08-952fdd62118a/Electricity2024-Analysisandforecastto2026.pdf.
([464]) https://digital-strategy.ec.europa.eu/en/library/energy-efficient-cloud-computing-technologies-and-policies-eco-friendly-cloud-market.
([465]) https://digital-strategy.ec.europa.eu/en/news/survey-synergies-between-data-centres-and-energy-systems.

of investment in modernising heating networks as key obstacles to the effective implementation of projects that reuse data centre waste heat at a large scale.

The adoption of the revised Energy Efficiency Directive in autumn 2023 was an important milestone on the way towards climate-neutral, highly energy-efficient and sustainable data centres. The Directive puts in place a structured collection of data from Member States on the key sustainability metrics of data centres on their territory.

As a first step, delegated act C(2024)1639 ([466]) lays down a common basis for defining and measuring the most important indicators for the sustainability performance of data centres. It creates the basis for EU-level data reporting that will provide a comprehensive picture of the key categories of data centre sustainability in the EU.

The EU has also set eco-design minimum efficiency requirements for servers and computers that are currently under review and is in the final stages of preparing new rules to monitor the energy performance of data centres, to collect and publish data, including also on their energy and water footprint ([467]). At the same time new planning and assessment rules have been adopted, with a view to encouraging new centres to be located where waste heat can be reused, and where energy and water needs for cooling can be reduced.

Increased data centre sustainability often implies direct cost savings, thus creating a natural incentive for operators to continuously improve their operations, notably with regard to energy efficiency. The Climate Neutral Data Centre Pact ([468]) records a growing number of certifications of adherence to the pact's sustainability commitments and is a key example of industry-led efforts towards climate neutrality ([469]). The European Code of Conduct on Data Centre Energy Efficiency constitutes a compendium of best practice that can guide data centre operators on the path towards greater sustainability.

While the reporting under the Energy Efficiency Directive will provide for a solid picture of the energy consumption of data centres in the EU, the rise of AI-related workloads is a new variable that needs to be factored into future measurements and reporting exercises. Based on an analysis of the data reported under the Energy Efficiency Directive, further policy action could aim to establish a labelling or rating scheme for data centre sustainability or even include the definition of minimum performance standards for the relevant key performance indicators.

Indicators and code of conduct for sustainable telecommunications networks

While digital connectivity can be a key driver to enable the greening of a wide range of sectors, networks also have a sustainability impact on their own. Therefore, networks must become more sustainable in future. To address this issue, and as a follow-up to its Digitalising the Energy System Action Plan (COM(2022) 552), in 2023 the Commission conducted a study led by its Joint Research Centre (JRC) to identify common indicators for measuring the environmental footprint of electronic communications services.

([466]) https://ec.europa.eu/info/law/better-regulation/have-your-say/initiatives/13818-Data-centres-in-Europe-reporting-scheme_en.
([467]) https://ec.europa.eu/info/law/better-regulation/have-your-say/initiatives/13818-Data-centres-in-Europe-reporting-scheme_en.
([468]) https://www.climateneutraldatacentre.net/.
([469]) https://www.climateneutraldatacentre.net/.

The final report ([470]), including a prioritisation of the identified indicators, was published on 11 March 2024 (ISBN: 978-92-68-13257-9 (online). It will serve as key input for the preparation of a future code of conduct for sustainable telecommunications networks, which should be finalised by the end of 2025.

As the EU moves closer to attaining its target of deploying **10 000 edge nodes** and as an increasing number of use cases require lower latency, the amount of data processed at the edge of the network will continue to grow. Edge computing is a complex and fast-evolving technology with many competing assumptions and projections on the impact it will have on the energy consumption of data processing.

While the move to the edge implies a reduction of the load on some network components, additional power consumption is generated by the decentralised computing units. Each unit may be subject to different framework conditions related to cooling, maintenance cycles and types of workloads. An assessment of the sustainability performance of edge nodes is thus highly complex and requires focused study.

5.2.3. The net environmental impact of AI systems

Energy and resource consumption has emerged as an increasingly important aspect of AI. In a recent report, the OECD notes that '*In the last decade, the computing needs of AI systems have grown dramatically'* ([471]). In this context, the purpose of the AI regulation has been amended and now includes environmental protection. It also expressly includes the possibility to draw up codes of conduct intended to promote the application to AI systems of requirements related to environmental sustainability.

The Commission is addressing the growing concern over the carbon footprint of AI through several initiatives. Key among these is the focus on developing energy-efficient AI technologies, supported by the EU research programme Horizon Europe and exemplified by projects like SustainML ([472]), dAIEDGE ([473]), and ELIAS ([474]). SustainML increases energy efficiency in machine learning applications throughout their life cycle. And dAIEDGE is centred on advancing green transitions through edge AI technologies, reducing energy use.

5.2.4. Towards greener semiconductor chips

Energy-efficient semiconductor chips are critical for reducing the energy consumption of electronic devices, playing a vital role in global efforts to decrease carbon emissions. The Commission is supporting the development of advanced semiconductor technologies that will help accelerate progress toward carbon neutrality.

1. **Miniaturisation**: energy efficiency improves with the increase of the density of transistors on a chip. For instance, the new 3nm node chips deliver 30-35% efficiency gains over 5nm ones. Such advances are made possible by European technologies such as the Extreme

([470]) JRC Publications Repository – Identifying common indicators for measuring the environmental footprint of electronic communications networks (ECNs) for the provision of electronic communications services (ECSs) (europa.eu): https://publications.jrc.ec.europa.eu/repository/handle/JRC136475.

([471]) OECD, Measuring the environmental impacts of artificial intelligence compute and applications: The AI footprint, OECD Digital Economy Papers No. 341, 2022, https://doi.org/10.1787/7babf571-en.

([472]) https://sustainml.eu/.

([473]) https://daiedge.eu/.

([474]) https://elias-ai.eu/.

UltraViolet lithography of ASML (Netherlands), and by the results of advanced R&D centres, such as IMEC (Belgium), both sustained by European R&D programmes.

In the Chips Joint Undertaking (JU), the EC is investing EUR 700 million in a Nano IC pilot line that is pushing chip technology down to 0.7 nanometres, and EUR 400 million in an FDSOI pilot line, to scale from the current 22nm down to 7nm ([475]).

2. **Low-power processors:** essential in **edge** computing, when embedded in IoT devices, these can save energy by processing data close to its source. AI is notoriously power-hungry but emerging technologies such as in-memory and neuromorphic computing (mimicking the human brain) can lead to groundbreaking energy savings in edge AI. Europe leads research in these fields, also thanks through several projects on ultra-low-power processors in its R&I programmes, including a European platform for testing and experimentation of edge AI hardware ([476]).
3. **Wide bandgap materials**: silicon carbide and gallium nitride significantly improve power device performance and energy efficiency, enabling the transition to electric mobility and renewable energy. European firms like Infineon (Germany), ST Microelectronics (France, Italy) and Bosch (Germany) are global leaders, backed by substantial Commission investment in power electronics and multiple European projects. These include Important Projects of Common European Interest (IPCEIs) ([477]), which mobilise several billion euro of investment ([478]). The Commission is also investing EUR 180 million in a pilot line for wide bandgap devices.
4. **Sensing:** instrumental in **energy conservation**, sensors enable smart monitoring and control in various applications, from smart buildings to industrial processes – facilitating efficient energy use and reducing waste. The Commission supports the development of advanced sensors through different R&D projects in the Chips JU, to extend the EU's leadership in this domain.

The Commission also supports several initiatives for sustainable and recyclable semiconductor development, emphasising sustainability and energy efficiency as core to the European semiconductor industry's future.

5.2.5. Channelling investment and finance

As shown by the 2023 EIB survey, the EU is a global leader in the development of new technologies that combine digital and green innovations. While Europe appears to lag behind the US for digital innovation and patents, the survey highlights EU's strength in developing new green technologies. A large share of EU patenting activities is concentrated in climate change technology and the EU leads on green innovation that incorporates digital technologies.

There is a clear link between business investment in the digital and green sectors: firms that make use of advanced digital technologies tend to invest more often in measures to build resilience and tackle challenges related to climate change.

([475]) https://www.chips-ju.europa.eu/Pilot-lines/.
([476]) https://prevail-project.eu/.
([477]) https://competition-policy.ec.europa.eu/state-aid/ipcei_en.
([478]) https://ec.europa.eu/commission/presscorner/detail/en/ip_23_3087.

If used in the right way, emerging digital technologies can be a competitive asset for business to tackle environmental challenges. The work of the European Green Digital Coalition (see below) provides a way to obtain the evidence needed by financial institutions to help with climate and green financing, for the deployment of digital solutions in the main sectors of economy.

Investment is indeed key to incentivising the move towards more resource-efficient digital technologies. Member States are using about EUR 158 billion from the Recovery and Resilience Facility, on top of other EU programmes and national funding, to boost their digital transformation and more than EUR 13 billion to speed up the deployment of more energy-efficient fixed and 5G broadband networks ([479]).

The **EU Taxonomy Regulation** delegated act on climate mitigation and adaptation has set clear criteria, in particular for green datacentres and green digital solutions that will help steer investment towards greener data centres and proven green digital solutions as a sustainable economic activity. Over the summer of 2024, the Commission will publish an EU Cloud Rulebook as a single point of reference for rules applicable to the cloud, including on sustainability.

In December 2023, the Commission approved the first Important Project of Common European Interest (IPCEI) in the cloud and edge computing domain (IPCEI Next Generation Cloud Infrastructure and Services, or IPCEI CIS). A total of 19 companies from seven Member States (France, Germany, Hungary, Italy, Netherlands, Poland, and Spain) participate in this project to develop the first interoperable and openly accessible European data processing ecosystem, the multi-provider cloud to edge continuum.

It will develop data processing capabilities and software and data sharing tools that enable federated, energy-efficient and trustworthy cloud and edge distributed data processing technologies and related services. The innovation provided by IPCEI CIS will enable a new spectrum of possibilities for European businesses and consumers, advancing the digital and green transition in Europe. The seven Member States will provide up to EUR 1.2 billion in public funding in the coming years, which is expected to unlock an additional EUR 1.4 billion in private investment.

In June 2023, the Commission approved the second IPCEI in the field of microelectronics, including communication technologies (IPCEI ME/CT). A first IPCEI on microelectronics had been adopted in December 2018. The new project was jointly prepared and notified by 14

([479]) Many RRF measures proposed by Member States, such as certain infrastructure investment and direct support for consumers, are not subject to State aid control. For such measures, prior notification to the Commission is not necessary. Other measures are likely to constitute aid but will be exempted from the prior notification obligation as they will fall within the scope of block exemption rules, in particular the General Block Exemption Regulation, or they will be covered by an existing approved scheme. These measures can therefore be immediately implemented by Member States, without notification.
The Commission has already approved several Decisions concerning those RRF measures that require its assessment, especially in 2023 an EUR 680 million Spanish scheme under the Recovery and Resilience Facility to support the roll-out of 5G mobile networks in rural areas (SA.104933 and SA.108821).
In addition, in 2023 Member States continued to also use other EU programmes, such as the European Regional Development Fund, to complement national funding for broadband networks. In addition to those measures not requiring notification, in 2023 the Commission approved an EUR 172 million Portuguese scheme to deploy fixed access networks (SA.105187).

Member States (Austria, Czechia, Finland, France, Germany, Greece, Ireland, Italy, Malta, Netherlands, Poland, Romania, Slovakia and Spain).

The project involves 68 projects from 56 companies, forming part of the wider IPCEI ME/CT ecosystem that involves over 30 associated participants. The project's overall objective is to enable the digital and green transformation by: (i) creating innovative microelectronics and communication solutions, and (ii) developing energy-efficient and resource-saving electronics systems and manufacturing methods.

They will contribute to technological advancement in many sectors, including communications (5G and 6G), autonomous driving, AI and quantum computing. They will also support companies active in the energy generation, distribution and use in their green transition. The 14 Member States will provide up to EUR 8.1 billion in funding in the coming years, which is expected to unlock additional EUR 13.7 billion in private investment.

The adoption of the **Temporary Crisis and Transition Framework** (TCTF) in March 2023 enabled Member States to support clean tech manufacturing, including its digital component. The Commission amendment of the framework in November 2023 adjusts its phase-out schedule but the sections covering the transition towards a net-zero economy are not modified and will remain in force until 31 December 2025.

Sustainable digital infrastructure and technologies in national roadmaps ([480])

The Decision establishing the Digital Decade ([481]) and the related guidance document ([482]) specify that roadmaps should also encompass the general objectives. The national roadmaps, however, focus to a large extent on the Digital Decade targets and related trajectories. The measures to achieve the targets are also expected to cover and contribute to the general objectives of the Digital Decade, although the link is often indirect and coverage of the general objectives is more difficult to be established.

Sustainable digital infrastructure and technologies is an aspect that only a small number of Member States (mainly Belgium, France, Germany, Greece, Netherlands, Luxembourg, Slovenia and Slovakia) took into account in their roadmaps. Most of the measures focus on developing and using energy- and resource-efficient technologies and infrastructure – ranging from reducing e-waste to measures that support circular and digital business models.

Developing measurements and monitoring the environmental impact of digital technologies, including in design of new e-services, is also taken into account in a small number of measures.

In December 2023, the Commission published its assessment of EU Member States' draft updated National Energy and Climate Plans (NECPs) ([483]) and issued **recommendations** ([484])

([480]) This analysis only takes account of information reported by the Member States in their national roadmaps. The measures reported were grouped into categories to provide a better overview of the types of measures taken.

([481]) Article 7 of Decision (EU) 2022/2481 of the European Parliament and of the Council of 14 December 2022 establishing the Digital Decade Policy Programme, OJ L 323, 19.12.2022, p. 4.

([482]) Communication from the Commission: guidance to the Member States on the preparation of the national Digital Decade strategic roadmaps, COM(2023) 4025 final, OJ C 230, 30.6.2023, p. 4.

([483]) Commission Communication '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 final, https://eur-lex.europa.eu/legal-content/EN/ALL/?uri=comnat:COM_2023_0796_FIN.

([484]) https://commission.europa.eu/energy-climate-change-environment/implementation-eu-countries/energy-and-climate-governance-and-reporting/national-energy-and-climate-plans_en#national-energy-and-climate-plans-2021-2030.

to help them raise their ambitions in line with EU energy and climate targets for 2030. The **final plans must be submitted by 30 June 2024**.

Several links between digitalisation were made in the assessment. While several Member States describe digitalisation as an enabler for integrating renewables into the grid, **cybersecurity** will be a key requirement for a secure and robust energy system. It is therefore positive that several Member States (e.g., Spain) included adequate references to the NIS-2 Directive ([485]) in their draft updated plans, or even elaborate on additional measures.

Overall, Member States' draft updated plans lack measures and funding to implement the **EU action plan on digitalising the energy system** ([486]). Nevertheless, there are positive examples, such as Italy's plans for cybersecurity research in the electricity sector, Slovakia and Czechia's project of common interest ('ACON Smart Grids') on the digitalisation of the distribution system and Portugal's measures to expand smart meters and develop smart grids.

The assessment noted also that **it is becoming increasingly important to tackle the skills shortages for the clean energy transition**, as noted in several Commission initiatives including the Pact for Skills and the proposal for a Net Zero Industry Act with its Skills Academies.

Several Member States such as Denmark, Spain, Estonia, Portugal and Slovakia clearly identify the sectors in which to focus actions on re/upskilling. However, most Member States have not put forward objectives or measures with dedicated funding to tackle the skills gaps identified in strategic sectors.

5.3.Contribution of digitalisation to the green transition

This section covers the main initiatives where digital applications and services (digital solutions) contribute to the green transition and to sustainability goals in other major sectors such as energy, transport, construction, agriculture, smart cities and manufacturing. It also highlights the competitive edge these digital solutions provide, increasing the efficiency and effectiveness of sustainability efforts across these sectors.

5.3.1. Digital technologies are essential for smart greening

Existing digital solutions have the potential to reduce total greenhouse gas emissions by 15%-20% before 2030 ([487]), if properly used and governed. They can, for example, enable more efficient resource use and energy management, or provide invaluable insights into environmental trends and patterns.

The link between the green and digital transitions is about navigating these conflicts and synergies, between the contribution of digitalisation to a 'smart' green transition and, conversely, the benefits of the green transition to the digital transformation, in particular through the support provided by sustainable finance to the Digital Decade.

([485]) Directive (EU) 2022/2555 of the European Parliament and of the Council of 14 December 2022 on measures for a high common level of cybersecurity across the Union, amending Regulation (EU) No 910/2014 and; Directive (EU) 2018/1972, and repealing Directive (EU) 2016/1148 (NIS 2 Directive), OJ L 133, 27.12.2022, p. 80 (consolidated version).
([486]) Commission Communication 'Digitalising the energy system - EU action plan', COM(2022) 552 final.
([487]) IPCCC Report 2022 (B.4.3) https://www.ipcc.ch/report/ar6/wg3/downloads/report/IPCC_AR6_WGIII_SPM.pdf.

So far, some sectors, such as the energy sector, have developed digitalisation action plans ([488]) to support decarbonisation. The Green Digital Coalition ([489]) has also delivered the methodology to measure the net environmental impact of digital solutions, enable the collection of evidence as a basis for developing policies and support digitalisation with green financing.

The digital transformation is playing an essential role in efforts to reduce our environmental footprint and achieve the European Green Deal, which sets the ambition for the EU to be climate-neutral by 2050. On maximising the digital handprint (i.e., digital enablement), the Digital Decade will focus on digitalisation initiatives that can not only deliver environmental and climate benefits but also support the competitiveness of EU industry (green digital tech) as well as other EU priorities such as sovereignty (e.g., by reducing dependencies in critical raw materials) and security and resilience of supply chains.

For example, significant investment in renewable energy, smart meters and electric vehicle charging infrastructure (EV and inductive) are being made, although their isolated operational monitoring results in inefficiency.

To be able to assess thes positives effects of digital transformation, it is critical to quantify the benefits of the twin transition in order to maximise them. What we can do today is to measure the environmental footprint of digital infrastructure and specific digital solutions. But how do we measure the handprint, such as emissions avoided by the use of digital solutions? By digital solutions we mean combined digital technologies such as fixed or mobile connectivity, AI, IoT, blockchain, quantum, etc. Examples of digital solutions include IoT-enabled smart grid solutions or precision farming, building energy management systems, mobility as a service, etc.

Many companies have developed their avoided emissions calculators, but an agreed and standardised science-based methodology to measure the reduction in greenhouse emissions due to specific digital solutions has so far been missing. The **European Green Digital Coalition** was established to encourage the main ICT stakeholders to develop science-based methodologies to estimate the net environmental impact of digital solutions, which could then be used by all climate-critical sector stakeholders to measure the positive climate impact of their digitalisation initiatives, and so in that way qualify for green financing.

5.3.2. The European Green Digital Coalition (EGDC)

The European Green Digital Coalition (EGDC) ([490]) is a key initiative that was launched by Commissioner Breton in 2021. The overall goals of the coalition were to demonstrate that the digital sector is a positive force for a climate action, and to provide the evidence needed for sustainable finance to support the deployment of proven digital solutions.

In particular, the aim was to develop a science-based methodology to quantify the net environmental impact of digital solutions, to demonstrate its usability in specific use cases and to develop guidelines for major sectors such as energy, transport, agriculture, construction, smart cities and manufacturing. **The EGDC successfully delivered all goals in March 2024.**

([488]) https://ec.europa.eu/commission/presscorner/detail/en/QANDA_22_6229.
([489]) https://digital-strategy.ec.europa.eu/en/news/measuring-impact-digital-solutions-climate.
([490]) https://www.greendigitalcoalition.eu/.

The coalition currently has 37 members (with others soon to join), 12 associated partners (professional associations, regions, investors) and other groups that support the work of the coalition and benefit from its work – as well as 45 SMEs, whose CEOs also committed to the coalition's goals by signing the EGDC Declaration ([491]).

5.3.3. EU action plan for Digitalising the energy system

The Commission has adopted an EU action plan for digitalising the energy system ([492]). The plan presents the main priorities and concrete actions needed to fully exploit the potential of digital technologies and accelerate the digitalisation of the EU energy system while addressing the challenges it brings.

For capturing and strengthening the opportunities, the plan includes actions in the following areas: (i) promoting investments in smart energy systems, (ii) facilitating seamless exchanges of energy-related data among the key players in the energy value chain, and (iii) empowering consumers to better engage in, and take advantage of the energy transition.

In this framework the common European energy data space aims to establish a data exchange framework and a governance structure, in order to broaden up the access to data and facilitate its sharing and reuse. The objective is to facilitate the provision of flexibility services in the energy markets and the improvement of the energy efficiency of buildings.

On the challenges side, the action plan looks at: (i) tackling the cybersecurity risks and building a cyber-resilient energy system,(ii) the need to keep in check the increasing energy consumption of the digital equipment and systems, so that we make sure that the benefits of digitalisation outweigh the costs in terms of energy consumption, and, iii) The need to develop, in cooperation with the European Green Digital Coalition, tools and methodologies to measure the net impact of enabling digital technologies in the energy sector.

The actions are designed to be implemented in co-operation between the Commission, the Member States and the stakeholders.

Future actions envisage using digitalisation to enhance flexibility in supply and demand by integrating distributed renewable energy assets. Digital tools can optimize asset placement and enable real-time monitoring and control, improving system security, reliability, and flexibility. Additionally, pairing renewable assets with technologies like EVs and heat pumps can further increase flexibility through demand-response integration.

5.3.4. Digitalisation for greener agriculture

The digitalisation of the European agricultural sector is set to transform traditional farming practices by incorporating advanced technologies such as AI, IoT and digital twins. This modernisation aims to increase the efficiency, sustainability and competitiveness of the agricultural sector.

By integrating these technologies, farmers will be empowered with real-time data and analytics, enabling precision farming, improved livestock management and optimised resource utilisation. The shift towards digital agriculture promises higher yields, reduced environmental

([491]) https://www.greendigitalcoalition.eu/declaration/.
([492]) https://energy.ec.europa.eu/topics/energy-systems-integration/digitalisation-energy-system_en

impact and more streamlined value chains, facilitating closer collaboration across the agricultural ecosystem.

However, progress towards a fully digitalised agriculture faces several challenges, including connectivity issues in rural areas, a digital divide between small and large operators, and concerns over data privacy and interoperability.

Addressing these challenges requires concerted efforts from policymakers, industry leaders and technology providers, to ensure that digitalisation benefits all stakeholders. Through targeted investment in research, development and infrastructure, alongside initiatives to increase digital literacy among farmers, Europe can pave the way for a more inclusive, efficient and sustainable agricultural future.

5.3.5. Harnessing AI for sustainability

AI has the potential not just to promote economic growth and social well-being, **but also to help achieve global sustainability goals**. AI applications can have a beneficial environmental impact on different levels, such as optimising existing processing, enabling new sustainable business models, supporting citizens in their green transition, improving our understanding of environmental and climate risks and supporting mitigation and adaptation efforts.

For instance, **AI can optimise existing processes to make them more efficient and environmentally friendly**. This includes examples such as optimising electric grid management, energy use in buildings, making mineral processing operations more efficient, or increasing use of public transport by planning routes based on passengers' needs.

It also helps minimise waste and reduce the use of pesticides in precision farming. In particular, generative AI is revolutionising the development of extreme weather and climate prediction systems, an area where the EU has been a frontrunner in employing traditional climate modelling and simulation algorithms. Generative AI has also improved our capacity to model the state of the environment (water, air, soil biodiversity) and assess the impact of the economy on natural resources. It can also make weather forecasting more accurate, detailed and adaptable, contributing significantly to disaster preparedness, agriculture, transportation and other sectors reliant on weather predictions.

At the same time, training and deploying AI systems requires massive amounts of computing resources, which have their own environmental impacts. While data centre energy use has remained flat at around 1% of (growing) global electricity demand, despite large growth in workloads and data traffic, it is paramount to develop energy-efficient technologies that can minimise the environmental impact and cost of training and deploying emerging models such as GPT-3, which include a number of parameters several orders of magnitude larger than their predecessors' (175 billion parameters).

In this context, the Commission is supporting a range of AI-driven projects through Horizon Europe and Digital Europe to optimise resource utilisation, minimise waste and curb energy use across various sectors. These projects stand at the intersection of cost efficiency and ecological responsibility, significantly improving environmental and waste management.

Promising examples include:

- ALCHIMIA, which is building an advanced AI-based platform to help big European metallurgy industries create more efficient, competitive and eco-friendly production processes;
- RECLAIM, which develops a portable robotic container that uses Al, data analytics and citizen science to automate materials recovery from mixed waste for smaller, less accessible land areas;
- CLARUS, which will develop an AI-driven platform that optimises resource consumption and logistics in the food industry;
- DIGIFOREST, which uses mobile robots to gather tree-level data, AI analyses for informed decision-making, and a supervised autonomous harvester robot to optimise selective logging;
- ROMAIN, which plans to develop a robotic system that can inspect and repair wind turbine blades using image processing and AI algorithms;
- DARROW, which aims to transform wastewater treatment plants into more autonomous and energy-efficient facilities, through an AI-powered ecosystem of software service;
- SMART DROPLETS, which utilises AI models, along with an AI-powered autonomous robotic tractor, to optimise resource use and minimise chemical waste in agriculture;
- TUBERS, which introduces innovative, AI-driven robotic platforms to tackle water wastage caused by leaks in the European water network;
- GRINNER, which is innovating in the electrical waste management field with an AI-powered robot designed to efficiently recognise and remove waste that contains batteries.

5.3.6. DestinE: a digital twin of the earth for the climate

Destination Earth ([493]) is a flagship initiative of the Commission to gradually develop a highly accurate digital model of the Earth (a digital twin of the Earth) – to model, monitor and simulate natural phenomena, hazards and the related human activities. These groundbreaking features help users design accurate and actionable adaptation strategies and mitigation measures.

DestinE unlocks the potential of digital modelling of the Earth system at a level that represents a real breakthrough in terms of accuracy, local detail, speed of access to information and interactivity.

By pushing the limits of computing and climate sciences, DestinE is an essential strand of the Commission's efforts towards the Green Deal and Digital Strategy.

In mid-2024, DestinE was launched and opened to users. Soon it will transition to Phase II. By the end of 2024, the first generation of all the components in the system (core service platform, data lake, digital twin engine) will have been developed and deployed, the platform and lake will have been transferred into operation and a number of services and tools will have been offered. What is more, major functionalities and features of the first two digital twins on

([493]) https://digital-strategy.ec.europa.eu/en/policies/destination-earth#tab_3.

weather-induced extremes and climate change adaptation will have been put in place, and the core platform will have been opened.

5.3.7. Common European Green Deal data space

The Green Deal Data Space will facilitate access to interoperable data combined with digital infrastructure, analytics and AI solutions. This is expected to boost evidence-based decision-making and expand our capacity to understand and tackle environmental challenges.

The Green Deal data space use-cases are driven by needs from the following fields and EU strategic targets: biodiversity (including forest-related strategies), zero-pollution targets, climate change mitigation and adaptation targets, and circular economy. Use-cases are being analysed and identified via several initiatives and ongoing Digital Europe and Horizon Europe projects.

For example, for the circular economy, the data space is encompassing smart circular applications, to make available the most relevant data for enabling circular value creation along supply chains such as the Digital Product Passport (DPP).

5.3.8. Climate-neutral smart cities

In 2023, 10 European cities were awarded the Label of the EU Mission for Climate-Neutral and Smart Cities, one of the EU Missions in Horizon Europe. The EU Mission Label is an important milestone as it recognises the cities' plans to achieve climate neutrality already by 2030 and aims to facilitate access to public and private funding towards that objective.

The cities that have received the label are: Sønderborg (Denmark), Mannheim (Germany), Madrid, Valencia, Valladolid, Vitoria-Gasteiz and Zaragoza (Spain), Klagenfurt (Austria), Cluj-Napoca (Romania) and Stockholm (Sweden).

The EU Mission Label is an acknowledgement of the successful development of Climate City Contracts, which outline the cities' overall vision for climate neutrality, and contain an action plan as well as an investment strategy. Cities co-create their Climate City Contracts with local stakeholders, including the private sector and the public.

Smart and green cities will also be built by the newly established ([494]) **European Digital Infrastructure Consortium for Networked Local Digital Twins towards the CitiVERSE** (LDT CitiVERSE EDIC) (cf. Chapter 5). The project is politically fully in line with the twin digital and green transition and the New European Bauhaus principle for creating modern, liveable cities.

5.3.9. European Digital Innovation Hubs in support of smart digital and green local ecosystems

To increase the sustainable digitalisation of European industry (in particular SMEs, but also local public administrations), in line with the Digital Decade objectives, the Commission supports a network of European Digital Innovation Hubs.

([494]) Commission Implementing Decision (EU) 2024/459 of 1 February 2024 on setting up the European Digital Infrastructure Consortium for Networked Local Digital Twins towards the CitiVERSE (LDT CitiVERSE EDIC), https://eur-lex.europa.eu/eli/dec_impl/2024/459/oj.

Operational since 2023, the **European Digital Innovation Hubs (EDIH) network** comprises over 200 hubs (151 funded through Digital Europe Programme, the others – Seals of Excellence (SoE) – funded through other means), each acting as a regional multi-partner consortium, bringing together public and private bodies, including research organisations, universities, industry associations, regional development agencies, and private sector companies.

EDIHs have sectoral and technology specialisations and many of them work on energy, smart cities, sustainable construction or other sectors related to the green transition. According to the database of the European Digital Innovation Hubs (including the Seals of Excellences), in 28 EU and associated countries there are **114 hubs addressing both the green transition and digital**, or derivatives of those policy priorities.

EDIHs promote a sustainable approach to digitalisation in all the activities and services that they provide at regional level to SMEs and local public administrations i.e.:

- **test before invest** allows businesses to experiment with technologies before investing;
- **skills and training** provides training programmes to equip employees with digital skills;
- **help to find investment** assists businesses in finding funding opportunities;
- **innovation ecosystem and networking** facilitates collaboration and networking among businesses, academia, research institutions and public authorities.

In 2023, its first full year of operation, the EDIHs network facilitated over 2 200 digital maturity assessments (DMAs) aiming to evaluate the level of digitalisation of companies and providing tailored support. In the same period, EDIHs organised over 800 events and provided over 2 400 services reaching almost 9 000 individual companies. The objective is to reach about 100 000 companies by 2027.

In addition to streamlining the sustainability of the digital transition in all its services, the EDIH network also has developed a **dedicated working group on sustainability** which is looking at three main topics:

- sustainability of IT itself
- the use of IT for sustainable solutions
- assessing in a quantitative and qualitative way the sustainability of digital solutions

5.3.10. Digital skills for the green transition

The lack of **advanced digital skills** is currently a **major barrier** to unlocking the potential of advanced digital technologies in the green transition, as well as to maintaining the EU's long-term competitiveness in a carbon-neutral economy. Many advanced digital technologies utilised in the green transition, such as the use of AI to support the optimisation of energy demand predictions, or robotics to improve smart recycling and waste management, require specialised knowledge and skills to operate effectively.

Without a **workforce** equipped with such advanced skills, companies may struggle to implement innovative solutions that leverage emerging technologies to address environmental challenges effectively. In fact, in a 2020 European Investment Bank survey (EIBIS) 59% of firms stated that the lack of availability of **staff with the right skills** negatively impacted their

investment in the green solutions ([495]). Moreover, the 2022/23 EIB investment report showed some 60% of municipalities reporting that the **lack of digital skills** is preventing climate change projects from progressing ([496]).

Overall, the lack of advanced digital skills poses a significant challenge to realising the full potential of advanced digital technologies in the green transition. Addressing this barrier will require investment in **education and training programmes** to train and upskill the workforce and ensure that organisations have the talent necessary to harness the power of digital technologies for the green transition.

As young people increasingly search for a **purpose-driven career** ([497]), the higher education sector in particular plays a crucial role in providing them with the skills needed to master the transition towards a low-carbon society.

In recent years, the Commission has significantly ramped up its efforts to enhance digital skills for the green transition through various initiatives. The **Digital Europe Programme**, for instance, supports specialised education programmes on advanced digital skills at different academic levels (such as bachelor's, master's and doctoral programmes), as well as short-term training courses.

Several of the selected projects build programmes to boost advanced digital skills for the green transition, such as the *DigiWind* project ([498]), which will offer a range of learning options (including micro-credentialed lifelong learning modules and master's programmes) to equip learners with a blend of advanced digital skills and specialised knowledge in wind and energy systems.

Another example of a co-funded project is *AGRITECH EU* ([499]) which focuses on delivering interdisciplinary programmes combining technological, agronomic and socio-economic skills in the area of digitalisation for sustainable agriculture.

Other examples are the *Skills4Deca* ([500]) project, addressing the skills needs of the housing decarbonisation sector and the *GreenChips-EDU* ([501]) project which aims to build a digitally-supported education ecosystem for next generation of microelectronics experts in sustainable chips and applications for a green and circular economy.

In addition to this, the upcoming 2024 work programme for the Digital Europe Programme further strengthens support for interdisciplinary programmes that will target the acquisition of advanced green digital skills (e.g., in the area of AI, data analytics, virtual/augmented reality,

([495]) https://data.eib.org/eibis/graph.
([496]) https://www.eib.org/en/publications/online/all/investment-report-2022-2023.
([497]) For instance, a worldwide study by Deloitte showed that about 4 out of 10 young people have rejected assignments due to ethical concerns, and more than 3 out of 10 young people have turned down employers that do not align with their values. For further information, see: https://www2.deloitte.com/cn/en/pages/about-deloitte/articles/deloittes-gen-z-and-millennial-survey-reveals-two-generations-striving-for-balance-and-advocating-for-change.html.
([498]) https://ec.europa.eu/info/funding-tenders/opportunities/portal/screen/how-to-participate/org-details/999999999/project/101122836/program/43152860/details.
([499]) https://ec.europa.eu/info/funding-tenders/opportunities/portal/screen/how-to-participate/org-details/999999999/project/101123258/program/43152860/details.
([500]) https://ec.europa.eu/info/funding-tenders/opportunities/portal/screen/how-to-participate/org-details/999999999/project/101123311/program/43152860/details.
([501]) https://ec.europa.eu/info/funding-tenders/opportunities/portal/screen/how-to-participate/org-details/999999999/project/101123309/program/43152860/details.

robotics, cloud computing, IoT, machine learning, etc.) in selected strategic sectors, including agriculture, transport, renewable energy and waste management.

In the context of advancing European competitiveness in AI, particularly through the lens of earth system science, Phase 2 of **Destination Earth** (DestinE), launching in mid-2024, includes an innovative training programme in a strategic move to harness the potential of machine learning in transforming earth system science, leveraging the high resolution and processing capabilities of the DestinE Digital Twins.

The aim is to empower users in public bodies and industry to harness the full potential of these new capabilities in their decision-making processes. Drawing on the success of previous educational ventures by the ECMWF (European Centre for Medium-Range Weather Forecasts, one of the entrusted bodies), such as the massive open online course (MOOC) on machine learning in weather and climate, the new training programme aims to deliver an in-depth understanding of machine learning techniques within the specific context of earth system applications.

To ensure the programme's effectiveness and relevance, a comprehensive curriculum will be developed to cover the spectrum of machine learning-related training needs identified across the DestinE user base, spanning the entire data value chain and including considerations of the ethical and political dimensions inherent to AI technology.

Central to the programme's objectives is the establishment of a robust framework of standards and best practice for the use and training of machine learning models in earth system science. This initiative aims to create a community of practice that not only increases the technical proficiency of European scientists, decision makers and practitioners in machine learning but also ensures that such advancements are aligned with European values, laws, and principles, and can be reproduced in other fields.

In addition to this, **Erasmus+** is currently also providing funding to boost the skills needed for the digital and green transitions. The D4Sustainability project ([502]), for instance, aims to design a new digital sustainability skills strategy and an innovative training programme that will provide companies with the advanced digital and green skills they need to build concrete environmental, social und governance (ESG) initiatives.

The contribution of digitalisation to the green transition in national roadmaps ([503])

The contribution of digitalisation to the green transition in national roadmaps is an aspect that a small number of Member States (mainly Croatia, Cyprus, Denmark, Germany, Greece, Romania, Slovakia, Slovenia, Sweden) took into account in their roadmaps.

The measures include various application fields, including edge computing and data centres, tourism, energy efficiency of buildings, high-speed connectivity networks and transport.

([502]) https://ec.europa.eu/info/funding-tenders/opportunities/portal/screen/opportunities/projects-details/43353764/101140316/ERASMUS2027.

([503]) This analysis only takes account of information reported by the Member States in their national roadmaps. The measures reported were grouped into categories to provide a better overview of the types of measures taken.

5.4. Future challenges and recommendations

5.4.1. Key challenges in realising the benefits of green/digital twin transition

Further effort is needed to realise the potential of the green/digital twin transition and to increase systemic synergies between these two megatrends. The recommendations will cover both aspects: to accelerate the transition of the digital sector to net zero and to support the sustainability transitions of major climate-critical sectors.

While the recommendations will focus on the environmental dimension of sustainability, it is important to note that measures need to also take into account the other two dimensions – economic and social. Only if all three of these dimensions are properly addressed can lasting progress that is supported by economic groups and society at large be achieved.

The challenge now is to develop policy measures to accelerate in a measurable way the delivery of the environmental and climate benefits of digitalisation.

In the case of **data centres**, recent work has made it possible to gain a comprehensive understanding of their energy consumption, facilitated by the JRC code of conduct on energy-efficient data centres. This understanding will be further improved by the delegated act under the Energy Efficiency Directive (EED). However, the rise of **AI,** for example, introduces a new variable that needs to be considered in future measurement and reporting exercises.

Also, the growing move towards **edge computing** provides a new dimension to measuring the energy use of the ICT sector. To date there are many competing assumptions on how energy efficient it is to move from cloud to edge, making it very hard to find a reliable answer, also reflecting the novelty and complexity of the sector. The challenge will be to make sense of these projections and the methodologies used, to come up with a reliable, comprehensive and uniform measurement framework to assess their energy consumption, as has been done in the case of data centres over the years.

While the environmental footprint of the digital sector has been subject to many studies, and the main challenges in greening the sector are well documented, the optimal use of digitalisation to ensure a positive environmental impact is still subject to research and competing opinions.

The major gap to-date was the **challenge in estimating the positive environmental impact of digitalisation** (the ‘handprint’). The European Green Digital Coalition has addressed this challenge and the results are available to be used by all sectors such as energy, transport, construction, agriculture, manufacturing and smart cities.

The coalition will build on the results delivered and will, as of Q4 2025, engage with stakeholders in climate-critical sectors (namely energy, transport, construction, agriculture, health, smart cities, manufacturing) to help measure the environmental benefits of digitalisation, and, based on this evidence and together with financial institutions, to develop eligibility criteria to support such digitalisation with sustainable finance.

5.5. Which way forward?

The EU Council conclusions of May 2024, the Toulouse call for a Green and Digital Transition ([504]) in the EU and the **Declaration of the 2021 Digital Day** ([505]) to lead the green/digital transformation are calling for concrete action to monitor the impact of digitalisation on the environment and contribute to the development of measurement tools.

There is in particular the opportunity to build on the European Green Deal and Temporary Crisis and Transition State Aid Framework to promote the transition towards a net-zero economy for digital solutions, in particular with regard to digital innovation hubs, testing and experimentation and ambitious connectivity projects, including backhaul networks and gigabit connectivity projects connecting socio-economic drivers like schools.

It is also critical to develop synergies between national Digital Decade roadmaps and the 2021-2030 National Energy and Climate Plans. The results of the European Green Digital Coalition to measure the impact of digitalisation are important to set up the monitoring framework, completed with the necessary evidence for green (climate) financing, to support digitalisation initiatives that have a proven positive climate impact.

Finally, there are important opportunities for improving cooperation and joint investment in the areas relevant to the twin transitions, such as transport and logistics data, or local digital twins, possibly also through the proposed EDICs in these fields.

5.5.1. Monitoring of ICT footprint, following up of the recommendations of the 2023 State of the Digital Decade

In cooperation with the Commission, a more detailed analysis of the environmental footprint of digital infrastructure and the first estimate of the net climate impact of the telecommunications network will be launched by the end of 2024 and results provided by 2026.

In the case of **data centres,** it is important to build on the tools provided by the EED delegated act, Member State initiatives, the JRC code of conduct, European Standards Organisations and nonregulatory, stakeholder-led initiatives. The goal being to develop future EU policy measures that incentivise data centre operators to continue to improve their energy efficiency performance especially in light of new technological developments.

For **edge computing**, as a first step, there is a need for focused research and analysis to better understand the energy efficiency of edge computing. The next step should be to develop a robust, reliable measurement framework to monitor the energy consumption of the edge, to develop targeted measures to improve its energy efficiency.

5.5.2. Harnessing finance

The green policies at local, regional, national and EU levels related to climate, biodiversity and pollution need, by design, to include in their development, implementation and monitoring a fit-for-purpose digitalisation.

([504]) https://www.economie.gouv.fr/files/files/2022/Call_for_Green_Digital_Transition_EU.PDF.
([505]) https://digital-strategy.ec.europa.eu/en/news/eu-countries-commit-leading-green-digital-transformation.

Public and private financial institutions and investors need a clear framework, guidelines and metrics to support digitalisation initiatives with green (climate) financing.

5.5.3. Monitoring the benefits of digital: what next after the EGDC?

Each Member State has now the possibility to use the EGDC methodology to measure the reduction of greenhouse emissions by using digitally-enabled solutions in sectors such as energy, transport, buildings, agriculture, health, smart cities and manufacturing.

5.5.4. Preparing the review of the Digital Decade policy programme in 2026

As part of the work to prepare the review, and in line with the reference in the DDPP about the need to develop targets related to the green transition, some preparatory work would be needed to set up a common target that takes into account the following dimensions:

- **digital footprint** – measuring progress in reducing the relative environmental footprint of digital infrastructure, AI and the main digital technologies;
- **digital handprint** – quantifying the proven reductions in greenhouse emissions resulting from the use of digital solutions and digitally-enabled innovation;
- **green digital financing** – tracking the annual increase in green financing allocated to digitalisation;
- **green digital skills** development.

6. BUILDING COHERENCE IN THE DIGITAL TRANSFORMATION AND PRIORITISING DIGITAL SPENDING

Over the last 5 years, the EU has strategically pivoted towards a more assertive digital policy framework, recognising the urgent need to shape the digital space with digital investment and robust regulatory mechanisms. This shift underscores EU's commitment to ensuring that technological advancements benefit European societies and foster economic growth while minimising risk for citizens. This approach has propelled the EU to the forefront of global digital governance and policy innovation.

This substantial increase in successful systemic regulation activities, **coordination and efficiency of implementation will be critical** in the years ahead.

This holds true for the **collaboration** within institutions and their governing bodies, including cooperation among the EU, Member States and national sectoral authorities, to **implement and enforce rules** pertaining to the EU regulatory landscape. Alongside efficiency objectives, there is also an increasing need to **reduce administrative burden for both private and public players** across Europe and ensure that the cumulative effect of new regulations does not hamper business activity, notably that of SMEs, nor impacts EU's competitiveness. This was indeed underscored as a priority by the Commission and the Member States in EU Council conclusions in May 2024 under the Belgian Presidency ([506]).

The need for greater consistency and cooperation also holds true for the way the EU works with other governance levels, especially with **regions and cities which are often in direct contact with the actors and the place where regulations are implemented.** Local authorities are indeed responsible for implementing more than 70% of EU rules ([507]), and cooperation with cities and communities is important for delivering an effective green and inclusive transformation.

Last but not least, a robust digital transformation for the EU in this decade will also mean having a **strategy backed by efficient funding – public and private** and setting a new paradigm for the future investment needed. This chapter is therefore taking stock of existing relevant instruments and programmes and proposes ways to increase synergies, thereby increasing their visibility – for instance, in a manner that facilitates the access of businesses to innovation and digitalisation.

6.1. Linking the Digital Decade with cooperation across governance levels

6.1.1. The key role of EU regions and cities in the digital transformation

The success of EU's digital transformation will not be possible without the involvement of all actors at all levels. Institutionally, the multiple references to regions in the policy programme demonstrate the importance that co-legislators have placed on ensuring an inclusive approach that goes beyond EU and national level**.**

Through co-creation with citizens, the EU's objective is to bring the economic and social benefits of this transformation to all local communities and implement an inclusive Digital

([506]) The Future of EU Digital Policy - Council Conclusions (21 May 2024).
([507]) See Mons Declaration by the European Committee of the Regions, March 2024: https://cor.europa.eu/en/Documents/Declaration-Mons-Summit.pdf.

Europe, with powerful digital services, technologies, infrastructure and skills. As 70% of EU legislation needs their intervention to be implemented, local and regional authorities play a major role in making the EU work ([508]).

Regions and municipalities also share many of the key challenges obstructing the digital transformation at national and European level. For example, a recent survey ([509]) by the EIB shows that **access to digital and technical skills represents a major obstacle to the digital transformation of more than half (58%) of municipalities** in the EU. Other major barriers identified include a shortage of technical capabilities needed to access public or EU funds and increase investment and a lack of environmental and climate assessment skills.

Regions and cities have a key role to play in EU's digital transformation by embracing digital innovation across various sectors, including governance, infrastructure, services and community engagement. Here are some ways they can get involved:

- **digital infrastructure** – invest in high-speed internet connectivity and digital infrastructure to ensure that all residents have access to digital resources and services.
- **smart governance** – implement digital platforms and tools to increase transparency, efficiency and citizen participation in decision-making processes. This can include online portals for accessing public information, digital voting systems and platforms for civic engagement.
- **smart mobility** – integrate digital technologies into transportation systems to improve traffic management, reduce congestion, and promote sustainable modes such as public transport, cycling and walking. This can involve the use of real-time data, smart traffic signals and intelligent transportation systems.
- **digital economy** – promote innovation and entrepreneurship by supporting digital start-ups, creating incubators and accelerators and providing access to funding and resources for tech companies. Encourage the growth of digital industries, such as software development, data analytics and digital marketing.
- **skills development** – invest in education and training programmes to equip residents with the skills needed to thrive in the digital economy. This can include coding classes, digital literacy workshops and vocational training in emerging technologies.
- **open data initiatives** – promote the sharing of government data through open data initiatives, allowing developers, researchers and entrepreneurs to leverage data for innovation and economic development.
- **digital sustainability** – embrace digital solutions to address environmental challenges and promote sustainability. This can include smart energy management systems, digital monitoring of air and water quality and the use of renewable energy sources.
- **digital inclusion** – ensure that digital initiatives are inclusive and accessible to all residents, including those from marginalised communities and under-served populations. This may

([508]) See Mons Declaration by the European Committee of the Regions, March 2024: https://cor.europa.eu/en/Documents/Declaration-Mons-Summit.pdf.
([509]) 2022-2023 EIB municipality survey.

involve providing subsidies for internet access, offering digital skills training programmes to vulnerable groups and designing user-friendly digital services.

By actively engaging in these areas, **regions and cities can leverage digital technologies** to improve quality of life, stimulate economic growth and create more inclusive and sustainable communities as part of EU's digital transformation.

The DDPP as an opportunity to improve regions and cities' contribution to the EU's digital transformation

The Digital Decade policy programme (DDPP) provides a comprehensive framework with objectives, targets and a governance mechanism that creates **new opportunities** for **Member States, regions and cities** to intensify their contribution. 1 year into its adoption, **the DDPP has been aiming to embrace cooperation across more levels of governance. Its design can help it act as common guidance for all Member States and their regions and cities**, to discuss and build the future of digital transformation through 2030 in a more comprehensive, aligned and thus efficient way.

First, the DDPP is genuinely centred on cooperation as an essential tool for achieving a successful digital transformation. It promotes **synergies across different levels of governance** by encouraging collaboration, coordination and information-sharing among EU institutions, national governments, regions, and cities.

In particular it includes **possibilities for consultations** at various steps of the governance mechanism, such as with the annual State of the Digital Decade Report, national strategic roadmaps and other specific consultations (see box below). Synergies across governance levels also facilitate the sharing of experience and best practice, allowing regions and cities to learn from each other and adapt successful approaches to their own contexts.

Digital Decade governance in action

The DDPP offers opportunities for the Commission and the Member States to collaborate through a robust monitoring and cooperation mechanism, which aims to ensure that the Digital Decade objectives and targets are achieved through a combination of EU initiatives and relevant national policies and measures.

- The Commission submits to the European Parliament and the EU Council an **annual report** on the State of the Digital Decade (SDD).
- The Commission meets the **Digital Decade Board (DDB)** 4 times a year. The Board is composed of representatives appointed by the Member States. During those meetings, the Commission and Board members take stock of the progress on the Digital Decade targets and discuss ways to move forward with solutions to encourage this progress. In 2023 this was done by developing working groups on best practices to share experience, and by further defining the role of the DDB.
- Each Member State delivers to the Commission its **annual National Digital Decade Strategic Roadmap**, to explain which policies and measures were adopted and how they will help deliver on the targets. In their reporting, countries may also include progress made at regional level, if applicable – this is for instance the case with Belgium, given its federal structure and the various powers of its regions.

- The Commission organises **annual fact-finding meetings** with representatives of Member States' authorities and with stakeholders from industry and civil society. These meetings serve to strengthen links with EU countries, improve knowledge and understanding of country-specific situations, and identify and qualitatively assess countries' assets, the progress on their Digital Decade journey, potential issues and best practices. Local actors, including regions and cities, may also be involved in these consultations.

Second, the Digital Decade creates a new shared set of references enabling the alignment of strategies and priorities by establishing shared objectives and targets underpinned by the Declaration on Digital Rights and Principles. The Digital Decade then enables all actors to look in the same direction, adopt a common language and facilitate contributions from local strategies in a broader setting.

In times when regions, cities and local communities are looking to digital solutions to tackle a growing range of interconnected challenges, **the Digital Decade can boost regional efforts by showing the 'European way'**, especially with the guidance of the Declaration on Digital Rights and Principles, ensuring that digital solutions support the creation of places where people are fully respected and enjoy living and working.

This includes approaches to smart urban mobility, energy efficiency, sustainable housing, digital public services and civic-led governance. Large-scale uptake and the upscale of these solutions are crucial to help our cities and communities meet their climate targets and reduce their environmental footprint, while promoting participation by the public and bringing prosperity to all types of business, including SMEs and start-ups.

Third, the decade has established new types of cooperation projects with the European Digital Infrastructure Consortia (EDICs), where regions and cities can be integral partners and actors, as demonstrated with the newly created LDT-CitiVERSE-EDIC, presented in the next section.

With the mainstreaming of all the tools contributing to the EU's digital transformation, the Digital Decade creates new opportunities for regions and cities to access funding, expertise and technical assistance from the EU and national governments to support their digital agendas. By **aligning their strategies** with EU priorities and collaborating with other stakeholders, regions and cities can attract investment, stimulate innovation and create jobs in the digital sector.

Finally, the specific experience and capacities of regions and cities are critical for a successful Digital Decade. Considering for instance the objective to address the digital divide, local governance levels are **well positioned** to help the EU and Member States, by implementing specific initiatives to accompany people into the digital transformation and bring it closer to their needs.

While national-level figures are not always enough to shed light on the detail of the digital divide, **data collected at local level through e.g., consultations and data, can be used as a critical complement. Regions and cities have a wealth of practical experience and are in touch with citizens every day.** They have expertise, knowledge, specific resources and innovative solutions that can help tackle issues such as the digital divide and ensure that the benefits of smart technologies can reach all segments of a city or a region.

Local observatories, for example, are one of the channels through which some regions and cities are creating a treasure trove of information. Through the active participation and the consultation of the public, they collect and share information on practical questions such as: How do citizens use the physical and digital mobility infrastructure? Or 'What are the hardware needs of a local industry to enable experimentation with advanced technologies?'.

This information helps better target the investment that would be needed to where it can make the most difference. **Observatories of Digital Divide at local level** specifically are a rich mechanism for addressing digital gaps: they provide a more precise understanding of who the people are who are least comfortable with digital, where they are located and what are their characteristics. This data can be used to create personas and profiles based on those people's characteristics, etc. ([510]).

Regions and cities' modes of disseminating best practice and success stories tend to lack the efficiency of a framework and the internal engineering needed to effectively share experiences and knowledge. Indeed, dissemination currently consists merely of explaining simply the 'context, objective, actions carried out, results obtained in our project'. This is not a sufficient form of dissemination, and does not immediately allow another city to measure the effectiveness, costs or complexity of a project. Nor does it help that city design its own way to replicate it.

This is why cities need actual **dissemination projects,** which would include deadlines, financial means, and, by design, a mechanism to replicate the best practice – for following, non-leading and/or smaller cities. These projects would not only allow each city to know where to start and what steps should be taken: it would provide them with well-thought-out guidelines and a budget to kick-start implementation, providing they have internalised the relevant skills needed.

The Digital Decade is thus creating new opportunities for regions and cities to share views and learn from each other's experience.

In sum, there is room to improve and strengthen the connections between the Digital Decade and the various layers of governance – from EU level to national governments, regions, city authorities and local communities – so as to further seize and connect the opportunities of both the DDPP and local actors' initiatives. In particular, regions and cities need more channels and resources to connect with each other more consistently, discuss with EU decision-making levels and share best practice more efficiently. This requires **greater involvement from the EU and Member States**, so that the digital transformation can deliver benefits that meet the needs of all people across the bloc.

Over the last year, there has been **growing interest** for the Digital Decade among local actors. The time is therefore ripe for **envisaging more and new types of EU action** and refining the ways the EU liaises with cities and actors in local communities.

6.1.2. State of play on harnessing regions and cities to the Digital Decade

As a framework, the DDPP can be adapted and used at all governance levels: to facilitate discussions and decisions through the **networks** supported by the EU, such as Living-in.EU or

([510]) https://eurocities.eu/latest/a-digital-divide-observatory-by-european-cities/.

Eurocities; to provide support to those networks as they require additional coordination efforts or resources; to enhance and broaden **existing tools and databases** that could be further developed, such as LORDIMAS (see below); and to enable concrete cooperation through the DDPP's existing initiatives such as the **EDICs.**

More can be done to develop these initiatives further and to identify more and new paths for action, to work together more closely with regions and cities' digital ecosystems.

6.1.2.1. Reinforcing local networks: Living-in.EU

Regional and city-level networks are important for supporting the Digital Decade through the collection and dissemination of data and best practice.

At local the level, the **grassroots Living-in.EU movement** embraces the Digital Decade as the European way of digital transformation in cities and communities. It is led by regions, cities and communities, who are themselves supported strongly by the Committee of the Regions and by the Commission via the Digital Europe Programme. Set up by cities in 2019, the movement is growing constantly and today boasts more than 150 signatories and 130 institutional supporters, already representing 10% of the EU population.

Living-in.EU, drives Europe's digital transformation according to European values, **involving all levels of local and regional governance.** Living-in.EU makes sure that regions and cities can reuse and upscale available digital solutions, as well as share best practice and guidance.

The movement invites stakeholders to get involved through several dedicated sub-groups. The technical sub-group, for instance, has been progressing on interoperability-oriented initiatives by coordinating the uptake of the EU Data Act by smart cities and communities.

The Living-in.EU community has succeeded in aligning initiatives and sharing results emanating from the vast smart communities ecosystem. Its stakeholders, including Eurocities, Cities Coalition for Digital Rights, Digital Mayors Assembly, Committee of the Regions, Scalable Cities and DigiNEB, will be able to **collaborate further together through the new LDT-CitiVERSE-EDIC.**

6.1.2.2. Monitoring Local and Regional Digital Indicators Maturity Assessment (LORDIMAS)

Gaining awareness of the needs of people and businesses and understanding what action is needed can be a learning process based on observing and mapping these needs. For instance, how citizens use the physical and digital mobility infrastructure; or what are the hardware needs of local industry to enable experimentation with advanced technologies. **Such monitoring is important for the Digital Decade as it enables the collection and sharing of fact-based policies.**

LORDIMAS is a tool developed by the Living-in.EU movement to **measure digital maturity** at local level. It is an interactive, real time assessment tool that helps **local municipalities** understand where they stand in their digital journey, compare themselves with peers, access best practice and relevant material, as well as help national and EU-level policymakers provide better policy support and targeted funding.

The tool helps **promote data sharing, benchmarking and collaboration among local and regional authorities.** By doing so, it empowers users to unlock their digital potential and take decisive steps toward more efficient governance, while advancing open data initiatives across Europe. Officially introduced at the Smart City Expo in Barcelona in November 2023, it is available online and open to use by communities and cities.

The launch of LORDIMAS is a major achievement, as previously there was no methodology or instrument to measure and monitor the digital transformation at local level. The tool could in future feed into the Digital Decade monitoring system, such as the Digital Economy and Society Index (DESI).

Interactions through the LORDIMAS methodology and tool have created a very useful network, with rich capabilities. Its current main focus on e-government and infrastructure could be broadened to capture more issues that the DDPP aims to cover. Efforts to increase the value of the tool should include ensuring that its coverage becomes more relevant and representative, and that the actions of regions and cities it measures evolve in line with the narrative and strategy of the Digital Decade.

6.1.2.3. European Digital Infrastructure Consortia (EDICs)

The DDPP established multi-country projects (MCPs) to create impacts that no single schemes could achieve on their own, specifically also to reduce disparities in capabilities within and between Member States. Under the DDPP, MCPs are implemented in particular with the EDICs, which help in deploying joint infrastructure, delivering services and bringing together public bodies – including cities, private bodies, end users and industry. Two of those EDICs in particular provide opportunities for increased cohesion between the EU, national governments and local governance levels.

LDT CitiVERSE EDIC

The newly established European Digital Infrastructure Consortium for Networked Local Digital Twins towards the CitiVERSE (LDT CitiVERSE EDIC) is offering a major opportunity for local and regional authorities to engage in advanced digital transformation. It will own and operate common infrastructure for 'digital twins' (digital representations of a city or a communities' local environment).

These digital twins will enable urban planners to simulate and visualise projects that address real world challenges e.g., air pollution, congestion, energy grid optimisation, water management and recycling. This groundbreaking initiative opens the door for EU industry and SMEs to find innovative solutions to communities' common problems through open, interoperable, data-driven services, using trustworthy AI and virtual reality tools, on a shared EU digital infrastructure (i.e., through cloud-based platforms).

The members of the consortium are implementing this vision through a joint roadmap with cities, and public stakeholders, addressing common digital targets. The initiative will also stimulate the creation of an industrial ecosystem for digital twins and help develop a market for EU industry and SMEs to offer advanced digital transformation services. Since communities have varied levels of digital maturity, targeted smart city training activities will be offered to increase knowledge and access to the EDIC's services.

Belgium, Croatia, Czechia, Estonia, France, Latvia, Luxembourg, Portugal, Slovakia, Slovenia and Spain have joined the EDIC as founding members. **It is expected that further Member States will join on an ongoing basis**. **Regions and cities from all EU Member States will be able to join the EDIC** once the first General Assembly is held, before the end of 2024.

Several European cities are already actively involved in shaping this new instrument. Valencia has been chosen as a seat for the EDIC and its nominee will chair this multi-country project. Barcelona City Council will nominate the deputy-chair of the EDIC. Its Super Computing Centre will provide high-performing capabilities to develop and run powerful city digital twins.

Improving digital infrastructure for cities: EU Local Digital Twins (EU LDT) toolbox

The EU Local Digital Twin toolbox, funded through the Digital Europe Programme, is identifying and developing advanced, reusable, AI-based tools to support the **efficient management of cities.** It will be composed of open-source software components, reference architectures, open standards, and technical interoperability specifications under the EU Smart Communities Data Space architecture. The tools will become the first common infrastructure to be adopted and maintained by the LDT-CitiVERSE-EDIC.

New cross-cutting services will be embedding extended reality (XR) technologies, with digital twins for improving visualisation frameworks facilitating user interaction and immersive experiences.

Although the EU LDT Toolbox is a set of advanced tools designed to facilitate the creation of local digital twins (LDTs), with a primary focus on cities that have already initiated the creation of data spaces in their cities, **all municipalities in Europe, regardless of size, can benefit from this resource.**

The inclusive focus of the EU LDT Toolbox will (i) ensure a wide uptake among the EU's smart communities ecosystem under a common umbrella, implementing shared improvement projects, (ii) analyse their impact, (iii) make decisions about implementation plans, and (iv) measure their efficiency and progress concerning the sustainability criteria required by the society they serve, as outlined in the EU Green Deal.

6.1.3. EU funding for the digital transformation of cities

The Recovery and Resilience Facility is a significant source of funding for the digital transformation (see Section 6.2) which is also having impact on regions and communities, for example through measures to develop smart transport systems at local level, on smart cities, healthcare (with the digitalisation of specific hospitals), connectivity in schools and support to build digital ecosystems. Some examples are given below.

Belgium – smart transport: the 'SmartMove' ([511]) investment initiative aims to develop a mobility-as-a-service IT system within the Brussels-Capital Region. It featured an application interface providing users with comprehensive and accurate information on available transportation modes, including their respective costs. Special attention was given to addressing congestion and environmental concerns. The investment includes various

([511]) Investment I-3.15: 'Smart move' of the Brussels-Capital Region, https://nextgenbelgium.be/fr/projet/smartmove-la-taxe-kilom%C3%A9trique-intelligente-vise-%C3%A0-r%C3%A9duire-les-d%C3%A9placements-en-voiture-2.

components such as back-office tracking, website development, authentication protocols, pricing software, simulation tools and data cross-referencing capabilities (using automatic number plate recognition).

Greece – smart cities: the Greek 'Smart Cities' ([512]) investment initiative aims to gradually transform 11 Greek cities into 'smart cities' by developing new infrastructure, digital platforms, and IT systems. The solutions implemented will enable the cities to use technology, information, and open data to improve their infrastructure and e-services and promote community-driven economic growth. Additionally, the projects include facilities such as smart parking systems to optimise parking management and accommodate diverse user needs.

Spain – entrepreneurship ecosystem in Spanish Regions: the RRF is helping the regions Andalusia, Navarre, Extremadura and Madrid to develop a scalable digital reference framework for entrepreneurship ecosystems ([513]). The project leverages digital innovation as a catalyst for entrepreneurship development in these Spanish regions. Through targeted training and support measures, the project aims to increase digital literacy, facilitate access to digital resources and promote collaboration between stakeholders in the digital ecosystem. Ultimately, the goal is to position these regions at the forefront of the digital economy, driving sustainable growth and resilience in the face of evolving challenges.

The **EU's cohesion policy and funding** provides a unique opportunity to support local and regional digital transformation efforts. By focusing in particular on areas where private investment is not able to deliver**,** it can help ensure **a fair and inclusive** digital transformation, so that digital connectivity is available to **all regions.** For example, the **European Urban Initiative**, set up in September 2023, is testing new solutions to promote digital governance and improve public services, making interactions with public authorities faster and simpler. It has a budget of EUR 450 million.

The **Horizon 2020 project AURORAL** focuses on increasing connectivity and delivering a digital environment of smart object interoperable services platforms, able to stimulate the creation of dynamic rural ecosystems of innovation chains, applications and services. In this way, the projects help create cross-field applications through large-scale pilots **in seven European regions**. Its main impact is to bridge the interoperability gap at local level and create markets for services in rural areas.

Similarly, the **Horizon 2020 project dRural** aims to create new opportunities for the development of European rural areas and communities. The project aims to co-develop and roll up a digital marketplace of innovative services and business models to improve quality of life and prosperity. An important aspect of the dRural project lies in the ambition **to overcome the digital divide between rural and urban areas** by exploiting the potential offered by connectivity and digitalisation in rural areas.

Finally, the **European Parliament Preparatory Action DT4REGIONS is another example of regional collaboration on the digital transformation**. It aims to create a European

([512]) Investment 16854 'Smart cities', https://greece20.gov.gr/en/?projects=smart-cities-16854-18.

([513]) Overcoming barriers for innovation in entrepreneurship ecosystems in Andalusia, Navarre, Extremadura and Madrid – European Commission (europa.eu): https://reform-support.ec.europa.eu/publications-0/overcoming-barriers-innovation-entrepreneurship-ecosystems-andalusia-navarre-extremadura-and-madrid_en.

Platform for Regions to enable the creation of collective solutions using AI and big data and to improve public administration efficiency and effectiveness in user-centric services.

By bringing together 14 partners from across Europe into a community of practice, the project showed how to put the everyday needs of a network of regions at its heart. It established partnerships with related initiatives (e.g., Living-in.EU and projects Go Li.EU and AURORAL), and provided recommendations to extend AI platforms with AI functionalities for regions.

6.1.4. Moving forward: challenges and avenues for improving common projects for local communities

Regions and cities can act as accelerators of digital ecosystems by adopting policies that attract start-ups and entrepreneurs, at a time when the consolidation of those ecosystems is critical for the digital transformation to happen at local level. This potential could be further harnessed and integrated into the DDPP in several ways:

First, **the DDPP as a framework could be developed and extended to regions and cities**, which could be encouraged to set-up and/or align their strategies with the programme. They could **contribute to the DDPP** through consultations, or be given a **decision-making role** on targets, objectives and reporting. The EU could also incentivise regions and cities to take **some or further ownership** of the DDPP, through **more opportunities to join EDICs.**

The DDPP and regions/cities could also engage in more precise frameworks of cooperation to address local needs for resources and to share experience more effectively, such as by financing specific projects. One such framework could be **multi-city projects or city consortia, to effectively disseminate best practice among cities.**

Second, **the DDPP could harness the work of regions and cities by supporting and building on the ways in which they collect information –** existing databases, monitoring initiatives by local activities and programmes, Observatories – and reusing this information.

In particular, LORDIMAS could be used by the DDPP as a complementary element to DESI. For this, **effort will be needed to gather more data and analysis from more cities**, to ensure the coverage increases, and **more alignment should be built** between the DDPP as a strategy and the actions of regions and cities. **The Commission, the Committee of Regions and the tool's developer have already started coordinating their efforts to meet these goals.**

- **In addition, the collection of qualitative measures such as best practices undertaken at local level could be improved and better organised. This could be achieved for instance with a compiled repository** matching Digital Decade priorities and including the Declaration on Digital Rights and Principles, and with better coordination and support, to ensure 'trickle-down' effects through mutual inspiration.
- **Reinforcing and organising the 'Local Observatories' as a network could provide one main vehicle through which best practices are being collected and shared across governance levels, from city to EU-level.** Many cities already carry out initiatives without the use of observatories, but those **initiatives could be pivoted and better targeted,**

streamlined and shared. This could help other levels of governance gain awareness of the issues and reality on the ground.

Third, **the Declaration of Digital Rights and Principles could be enriched by best practice and success stories from regions and cities** – showcasing how these rights and principles can be rolled out in practice. In addition, **the implementation process of EU rules could benefit** from regions and cities' feedback regarding the reality on the ground – i.e., potential obstacles or positive experience of enforcing these policies.

Fourth, **the DDPP could benefit from concrete ways to stimulate a closer dialogue with regions and cities**, including through existing networks. Such dialogue organised in the context of DDPP work would improve further the analysis made by the Commission, notably thanks to input from the networks of regions and cities on the ground.

A specific format could be created, such as **a 'Forum of the DDPP.'** Such meetings would convene representatives of organisations that address a wide range of topics, such as a working group or a 'forum' on digital e.g., the Committee of the Regions, Eurocities, the European Social Network, etc., or organisations focused only on digital (such as the Cities Coalition for Digital Rights). These gatherings would also need to include, and be co-created with, regions and cities themselves.

There are also opportunities to join forces through flagship events – such as the first **International Digital Rights Day** that will be organised on 11 December 2024 by the cities of Bordeaux and Maceio, via the Cities Coalition for Digital Rights, following the work of the city of Amsterdam.

Fifth, **there can be ways to promote concrete cooperation which links the digital and green transitions,** to ensure they both work on the ground. For example: with **Digital Twins, or through the New European Bauhaus projects** that aim to create liveable cities. Regions and cities could harness the opportunity of calls for local initiatives, with technical assistance to small and medium-sized municipalities to deliver the Green Deal provided by e.g., the European Regional Development Fund.

6.2. Funding the digital transformation: synergies between EU funding programmes

6.2.1. Ensuring synergy and better visibility of EU funding programmes

Policies that incentivise innovation have proven to be powerful and efficient for increasing the attractiveness of business (as seen with the Inflation Reduction Act in the US). As Member States face several investment gaps, finding ways to better prioritise EU spending, such as by targeting EU funds more efficiently and towards strategic sectors, could prove critical.

EU funding support for the digital transformation to ecosystems of stakeholders engaged in innovation, such as researchers, academic institutes and industry, is known to be diverse and supported by multiple programmes, including Horizon Europe, the European Defence Fund (EDF), the Connecting Europe Facility (CEF Digital) and the Recovery and Resilience Facility (RRF). This support is **invaluable, and further efficiency could be achieved through greater synergy among existing programmes.** Such efforts could ensure more visibility and easier access to funding, so these programmes' impact and benefits are more tangible, and they are

better directed. In addition, this will help deliver more to ensure the EU achieves its Digital Decade targets.

6.2.2. Digital across funding programmes

6.2.2.1. Digital tracking exercise

The digital transition is **one of the top political priorities of the Commission**, a key driver for the EU's prosperity, economic recovery and resilience, and a critical enabler of innovative solutions, to address global challenges. This chapter aims to **quantify the effort made through EU budget expenditure to funding the digital transition across all EU spending programmes**, as is done for other key general priorities such as climate, biodiversity and gender equality.

In 2023, a first stocktaking exercise across all the EU spending programmes was conducted for 2021 and 2022, with the objective of gaining a better understanding of each programme's contribution to the digital transition. The findings of this exercise show that **the EU budget**, including NextGenerationEU, **is channelling very significant contributions to all the key dimensions of the digital transition**.

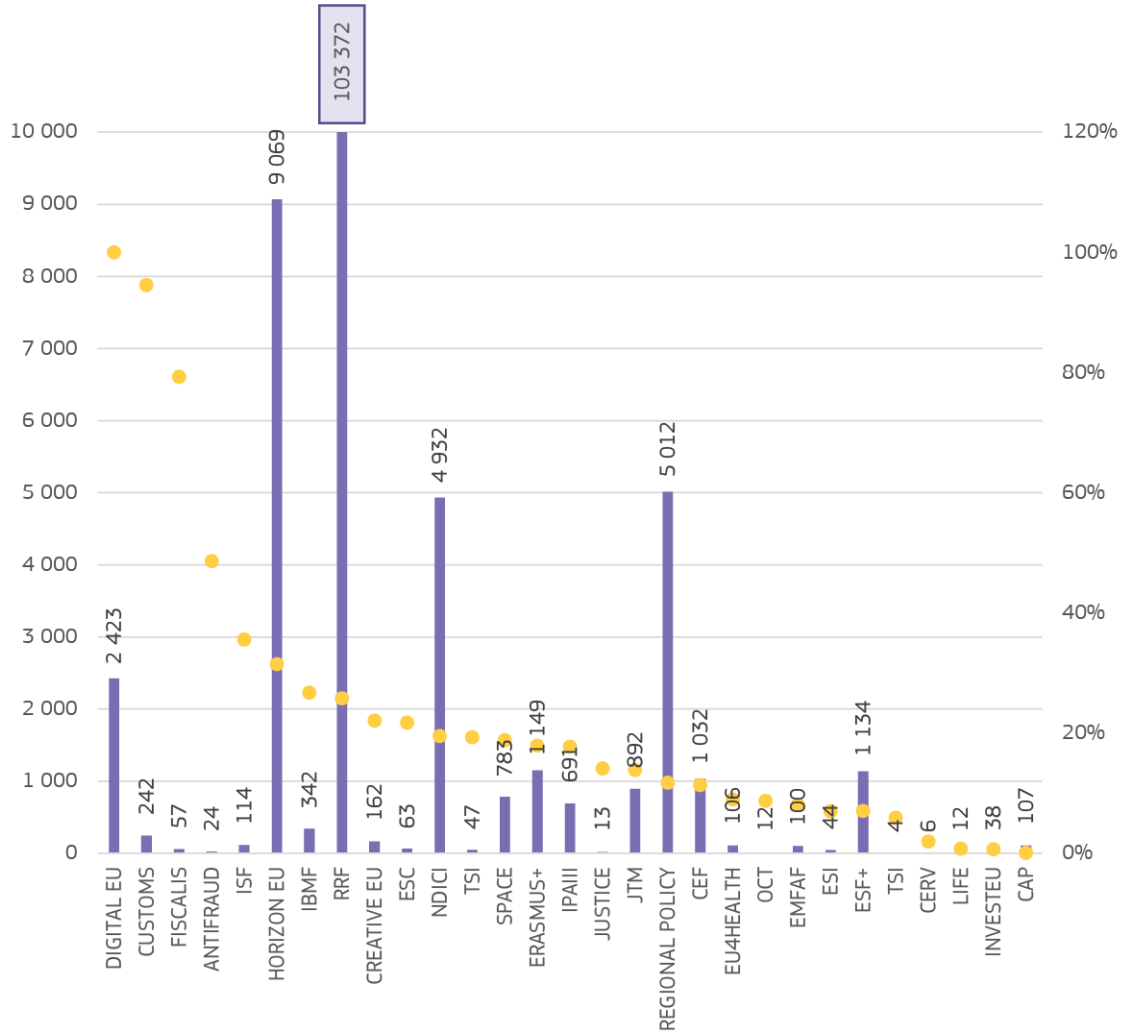
This stocktaking exercise – **'digital tracking'** ([514]) – is a crucial steppingstone towards a **dedicated tracking methodology for digital expenditure**, based on a fully-fledged, robust methodology, to be applied consistently across all programmes and providing a solid aggregate contribution, including a projection for the full 2021-27 EU funding period (multiannual financial framework).

This common methodology draws on the RRF intervention fields for digital tracking, described in Annex VII to the Recovery and Resilience Facility Regulation ([515]). It is based on a list of interventions with predefined coefficients of either 0%, 40% or 100% contribution to the digital transformation. The tracking is based on individual commitments made in a given year.

The **2023 stocktaking exercise** identified the contributions made by individual programmes to digital in 2021 and 2022. The results are presented in the following chart ([516]).

([514]) More information can be found at: https://commission.europa.eu/strategy-and-policy/eu-budget/performance-and-reporting/horizontal-priorities/digital-tracking_en.
([515]) Recovery and Resilience Facility Regulation: eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32021R0241.
([516]) https://commission.europa.eu/strategy-and-policy/eu-budget/performance-and-reporting/horizontal-priorities/digital-tracking_en.

Figure 69. First estimated contributions to the digital transition of the EU budget programmes including NextGenerationEU in 2021 and 2022 (cumulatively) in EUR million (left scale) and in percentages of their total implementation during the same years (right scale)



Note: For readability purpose, the scale is broken: the RRF provides more than 10 times more support to the digital transition than the most contributing programme.

Source: Digital tracking – European Commission (europa.eu)

The results show that almost all programmes that are part of the EU budget contribute to the digital transition. This first stocktaking exercise, which should be interpreted with caution, as no common methodologies could be applied across funding programmes, shows that **EUR 131.9 billion** of the EU budget (including NextGenerationEU) was **dedicated to the digital transition** in 2021 and 2022, which represents almost **17.4% of the total EU budget and annual spending of EUR 61 billion**.

6.2.2.2. Contribution to the Digital Decade targets

A **study** conducted by the Joint Research Centre (JRC) focused more specifically on mapping **the contribution of selected EU funding instruments against each of the Digital Decade targets.** For this exercise, the Recovery and Resilience Facility (RRF), Connecting Europe Facility (CEF Digital), Horizon Europe, the Digital Europe Programme (DIGITAL) and Cohesion policy were considered.

The exercise took the coefficients applied to programmes in the context of the digital tracking exercise into consideration. The results ([517]) of the mapping showed that these programmes play an important role in supporting the achievement of the Digital Decade targets. For 2021-27, a total of **EUR 177 billion** from the five funding programmes mentioned above are estimated to contribute to the Digital Decade targets, with the highest contributions going to the digital transformation of the public sector and business.

An additional **EUR 27.5 billion** is contributing to broader Digital Decade objectives. This leads to **a total effort of EUR 204.5 billion in recent years**. These estimates give broad indications on the targets that receive most support and the relevance of the different funding programmes ([518]).

The largest support amounts for the Digital Decade targets and objectives are paid out from the Recovery and Resilience Facility, with a total of EUR 150 billion dedicated to digital, followed by Cohesion policy with an estimated contribution of EUR 31 billion.

In addition, Horizon Europe (HE) provides an estimated EUR 13.8 billion of support for some of the Digital Decade targets and objectives, in particular for promoting innovation and technological advancement across various sectors. Furthermore, the Connecting Europe Facility (CEF2) - Digital and the Digital Europe Programme (DIGITAL or DEP), are estimated to contribute EUR 1.7 billion and EUR 7.9 billion respectively.

The table below and the following charts depict the funding distribution across various instruments and Digital Decade targets.

([517]) Joint Research Centre report 'Mapping EU level funding instruments to Digital Decade targets - 2024 update' (Signorelli et al., 2024).

([518]) The amount of funding considered under each programme and the distribution of funds across targets and cardinal points is strongly determined by the nature of the target, the assumptions made in the allocation, the possibilities of private funding and alternative public funding programmes, and the emphasis placed by Member States on certain areas over others.

Table 1. EU relevant budget for the Digital Decade targets (2021-2027 MFF, incl. RRF 2020-26, EUR million) ([519])

Fund		Total	RRF (2020-2026) ([520])	Cohesion (2021-2027) ([521])	DIGITAL (2021-2027)	Horizon (2021-2024)	CEF Digital (2021-2027)
Total funding		**957 422**	651 670	260 896	7 948	35 199	1 709
Digital funding		**204 583**	150 037	31 063	7 948	13 826	1 709
Digital funding %		*21%*	*23%*	*12%*	*100%*	*39%*	*100%*
Funding DD general objectives		**27 488**	14 129	4 392	1 275	7 320	373
Funding Digital Decade targets	**Total target budget**	**177 096**	135 909	26 672	6 673	6 506	1 336
	Basic digital skills	**15 405**	14 294	950	128	34	0
	ICT specialists*	**10 881**	9 506	633	661	73	8
	Gigabit networks	**14 003**	11 628	2 164	4	0	206
	5G*	**3 362**	1 967	115	4	396	879
	Semiconductors*	**18 200**	14 801	0	1 396	2 004	0
	Edge nodes*	**609**	0	0	220	355	35
	Quantum computing*	**1 918**	866	0	293	669	90
	Cloud computing*	**8 373**	6 019	1 584	370	337	63
	Data analytics*	**7 552**	4 718	1 584	546	678	26
	Artificial intelligence*	**9 386**	5 278	1 584	1 227	1 266	30
	Digital late adopters*	**19 885**	14 154	4 753	674	304	0
	Unicorns	**19 257**	14 158	4 753	159	187	0
	Online provision of key public services	**32 343**	24 449	7 271	616	6	0
	e-health	**15 233**	13 604	1 280	163	187	0
	e-ID	**688**	466	0	212	9	0

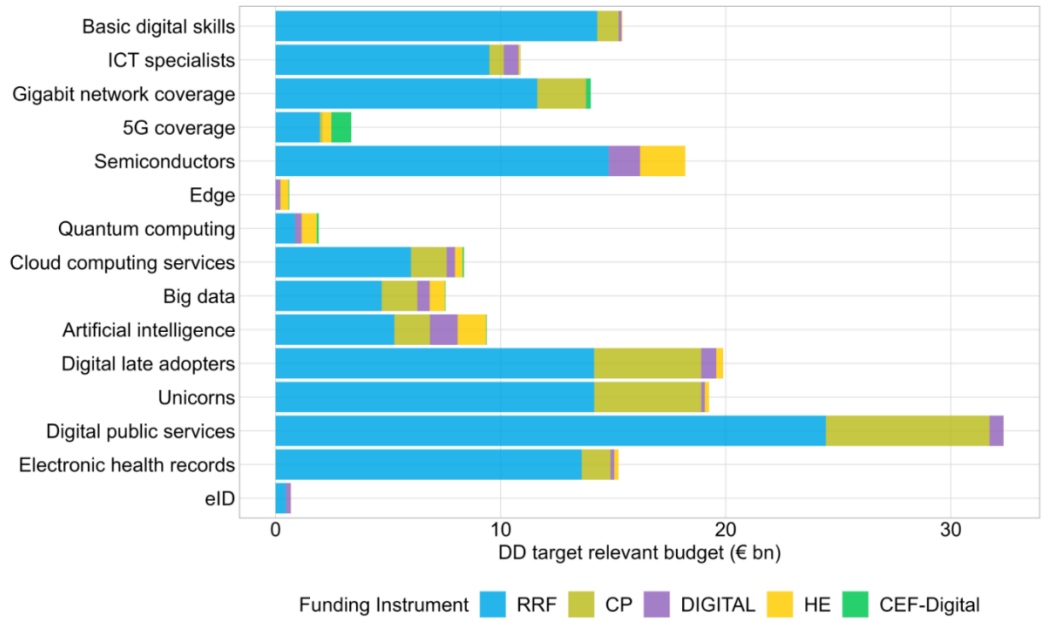
Source: JRC calculations

([519]) The Digital Decade targets indicated in the table with an asterisk (*) benefit from HPC funding. This funding not only supports computing research and infrastructures (e.g., quantum, cloud, AI etc.) but also the training of specialists, the development of hyper-connectivity (5G, edge nodes), and the adoption of HPC by SMEs. In total HPC funding amounts to EUR 3 267 million, mainly channelled through DIGITAL (EUR 1 967.2 million), Horizon Europe (EUR 900 million), CEF (EUR 200 million), and the RRF (EUR 168 million).

([520]) Including measures in the REpowerEU chapters contributing to the digital transition. It should be noted that those measures are considered in the analysis in this report but do not contribute to the achievement of the 20% digital target set by the Regulation establishing the Recovery and Resilience Facility (see also the Guidance on Recovery and Resilience Plans in the context of REPowerEU: https://commission.europa.eu/publications/guidance-recovery-and-resilience-plans-context-repowereu_en). Excluding measures under the REpowerEU chapter, the amount of the RRF that contributes to the digital transition is about EUR 149.7 billion, which represents about 26% of the total RRF funds.

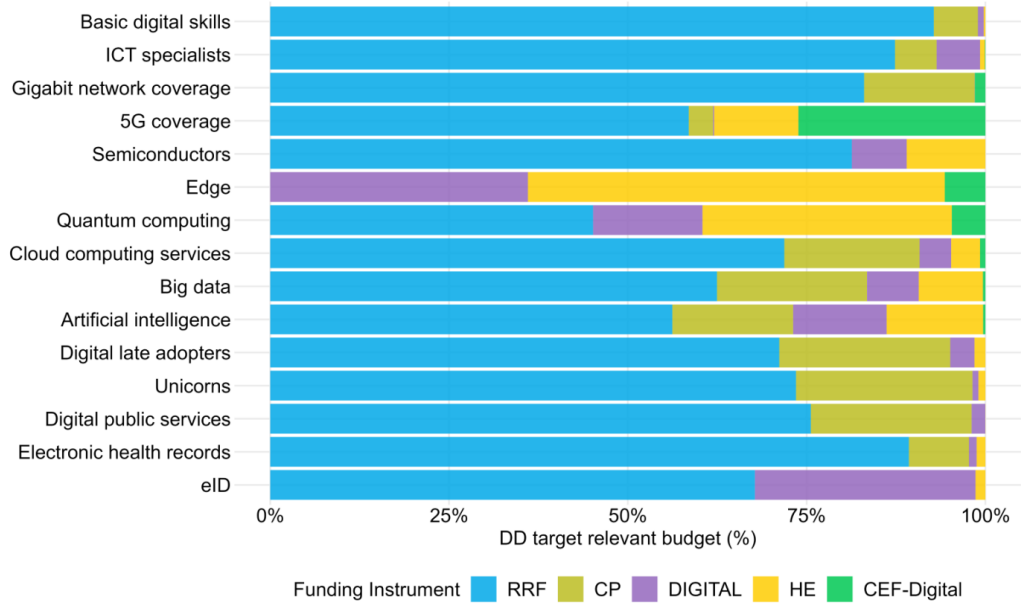
([521]) While the overall Cohesion Policy funds total is EUR 392 billion, only the following funds are included in the mapping. and subsequent estimations: the European Regional Development Fund (ERDF), the Cohesion Fund (CF), and the European Territorial Cooperation Fund (Interreg), Including the digitalization investments from the REPowerEU chapters.

Figure 70. Digital Decade-relevant budget (billion EUR) by DD target



Source: JRC Calculations

Figure 71. Digital Decade-relevant budget (%) by DD target



Source: JRC Calculations

The Recovery and Resilience Facility (RRF) emerges as the primary contributor to most of the Digital Decade targets and plays an especially significant role in supporting basic digital skills (contributing to over 90% of the funding in this area) and ICT specialists (87%), as well in gigabit connectivity, digital public services, semiconductors, and eHealth (more than 75%).

Other programmes besides the RRF have a high relevance for more innovative, cutting-edge targets. For example, by providing a significant proportion (26%) to the 5G target, **CEF-Digital** is making a significant contribution to boosting the performance of Europe's network infrastructure.

Moreover, while the Digital Decade targets on connectivity are currently focused on deploying gigabit access networks and standard 5G networks, **CEF-Digital** focuses on the deployment of strategic cross-border backbone and stand-alone 5G infrastructure supporting enhanced services such as connected and automated mobility (CAM), smart cities, smart health and security. Its impact goes beyond the achievement of the Digital Decade targets and serves the strategic interests of the EU for digital sovereignty.

The **Digital Europe Programme** makes significant contributions to the Digital Decade targets, especially to the edge deployment target, quantum computing and eID. The overall programme, however, contributes to the Digital Decade objectives and, in 2025-27, it will focus on a set of priority areas which have proven to be successful, yielding significant impact. They also play a critical role for the EU's future and its digital transformation and/or are considered essential areas by the Member States.

The proposed funding amounts are still under discussion with the Member States and will also be adapted to the overall budget availability in this period.

Furthermore, **Horizon Europe** makes significant contributions to research and innovation-focused Digital Decade targets, such as quantum (38%) and edge computing (62%). Horizon Europe also contributes significantly to 5G, developing AI (18%) and semiconductors (17%), to achieve Digital Decade targets.

However, the figure above showing funding dedicated to **more innovative, cutting-edge technologies**, such as 5G, AI, semiconductors, edge, quantum and big data is rather modest in absolute terms, in particular when compared to the other headings, and when put in the perspective of the ambition of the respective 2030 targets. Joint investment in the form of multi-country projects for these targets is therefore critical.

6.2.3. Overview of selected funding programmes

6.2.3.1. Recovery and Resilience Facility (RRF)

The RRF, together with the national recovery and resilience plans (RRPs), is making an essential contribution to the EU's digital transformation. The total RRF budget dedicated to digital reforms and investment had increased by early 2024 **to EUR 150 billion** ([522]).

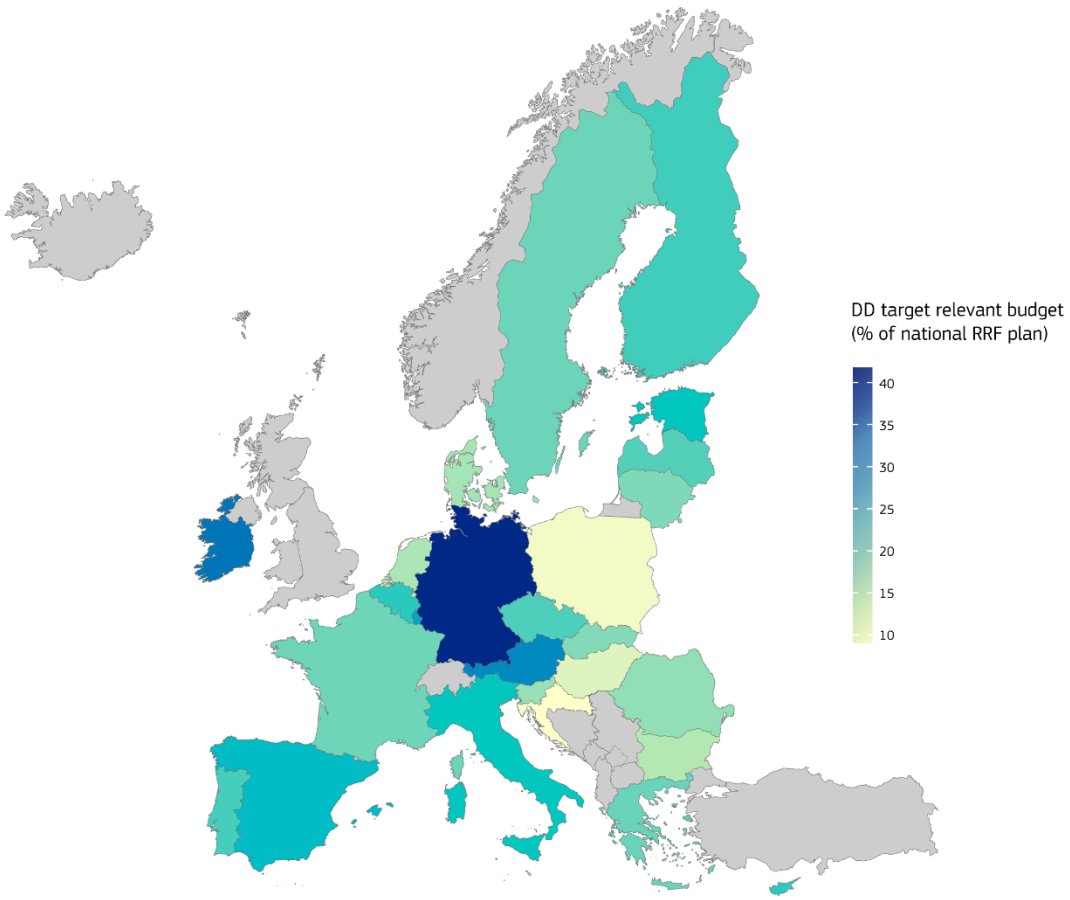
In terms of areas funded, **the EU budget is primarily supporting government and public bodies in digitalising key sectors**, in particular health systems and transport. Significant efforts are also being made to support the **digitalisation of businesses**, to help the **acquisition of digital skills** (advanced and basic) and to support **research and innovation**, along with **key advanced digital infrastructure and technologies** (such as quantum computing, AI and cloud/edge computing). The revision of the Recovery and Resilience Plans to add REPowerEU chapters did not affect the share of digital expenditure, which remains significant and ambitious across Member States.

([522]) Including measures in the REpowerEU chapters contributing to the digital transition. It should be noted that those measures are considered in the analysis in this report but do not contribute to the achievement of the 20% digital target set by the Regulation establishing the Recovery and Resilience Facility (see also the Guidance on Recovery and Resilience Plans in the context of REPowerEU: https://commission.europa.eu/publications/guidance-recovery-and-resilience-plans-context-repowereu_en.). Excluding measures under the REpowerEU chapter, the amount of the RRF that contributes to the digital transition is about EUR 149.7 billion, which represents about 26% of the total RRF funds.

Focusing on the **RRF budget that is directly relevant to the Digital Decade targets** ([523]), the chart below depicts the absolute figures (EUR million) of the **Digital Decade-relevant RRF budget allocation** to each Member State.

It is evident that certain Member States receiving a larger share of the overall RRF funding will also make the highest contributions to digital (e.g., Italy EUR 41.8 billion, Spain EUR 39.4 billion, and Germany EUR 11.9 billion). However, certain Member States chose to dedicate major parts of their RRPs to digital, e.g., Germany, Spain, Austria or Ireland each above 30%.

Figure 72. DD-relevant budget (share of total RRF budget)([524])



Source: JRC Calculations

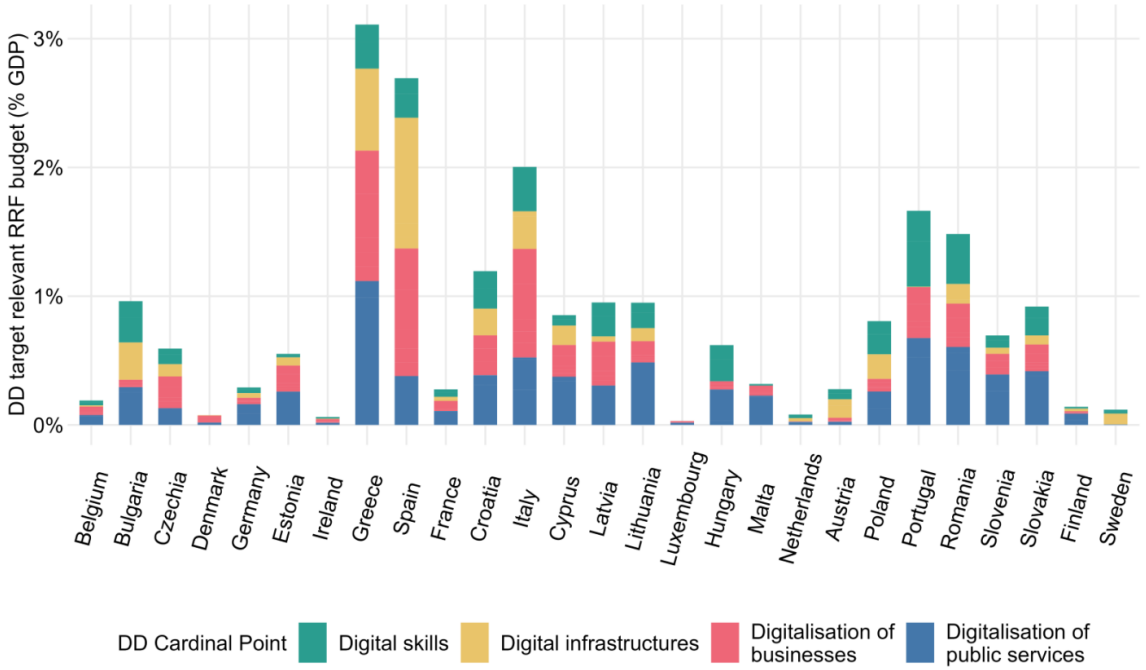
Comparing these shares of funding with the GDP (at 2023 current prices) of each Member State further underlines the importance of the RRF in supporting digital transformation and the

([523]) Joint Research Centre report 'Mapping EU level funding instruments to Digital Decade targets - 2024 update' (Signorelli et al., 2024).

([524]) The designations employed and the presentation of material on the map do not imply the expression of any opinion whatsoever on the part of the European Union concerning the legal status of any country, territory or area or of its authorities, or concerning the delimitation of its frontiers or boundaries. Kosovo* - This designation is without prejudice to positions on status and is in line with UNSCR 1244/1999 and the ICJ Opinion on the Kosovo declaration of independence.

achievement of the Digital Decade targets across the EU. In particular, Greece (3.11%), Italy (2.00%) and Spain (2.91%) will receive a significant proportion of their GDP (at 2023 current prices) towards investment relevant for the Digital Decade targets, indicative of the strong support provided by the RRF to the Digital Decade targets.

Figure 73. Digital Decade-relevant RRF budget (% GDP) by DD target



Source: JRC Calculations

Overall, implementation is picking up in all Member States, although overall progress on digital is slow. Member States have submitted at least their first payment request. At the end of April 2023, under the RRF, the Commission had disbursed around **EUR 232 billion**. The disbursements on digital investment and reforms, however, amounted to some **EUR 17.6 billion,** representing only approximately 7.5% of the total disbursements, due to the complexity of some investment (including multi-country projects) ([525]). Among the **results** achieved so far:

- 14.7 million additional dwellings have been provided with very high-capacity internet access via VHCN;
- 728 475 enterprises (mainly SMEs) have been supported in developing digital products, services and processes;
- 2.1 million people have participated in education or training focused on digital skills ([526]).

Looking at **specific measures**, for example:

- **Romania** implemented a reform aimed at facilitating the nationwide deployment of 5G networks;

([525]) https://ec.europa.eu/economy_finance/recovery-and-resilience-scoreboard/disbursements.html?lang=en.
([526]) https://ec.europa.eu/economy_finance/recovery-and-resilience-scoreboard/disbursements.html?lang=en.

- **Italy** awarded contracts to support the creation or strengthening of at least 30 research infrastructure/institutions of strategic relevance, using advanced digital technologies such as AI;
- **Croatia** set up a voucher system for adult education, training, and upskilling, to enhance the employability and encourage better alignment between labour market demands and workforce skills;
- **several Member States** (Hungary, Czechia, Ireland, Italy, Latvia, Portugal, Slovakia and Spain) are supporting the development of a pan-European network of EDIHs to guide businesses and public bodies in their digital transformation;
- **France** plans to allocate EUR 345 million from its RRP to help industrial SMEs increase their competitiveness by upgrading their production processes with digital solutions ([527]). Furthermore, the 'Industrie du Futur' programme helps companies digitise their manufacturing operations, incorporating technologies such as robotics and AI-based software.

In conclusion, looking at the JRC mapping of EU funding contribution to DD targets and at the roadmaps, it is clear that RRF represents a major part of the funding for digital transformation at national level, and in a few cases has also allowed some **Member States to join multi-country projects (MCPs)**.

In particular, as the **mid-term evaluation** ([528]) highlighted, support for MCPs under the RRF is affected by the complexity of the projects, which require more time in design (against the tight 2026 deadline for implementing RRF measures) and experience more challenges in their implementation due to the multi-partner component. The issue of tight timing for implementing the RRF might have also affected other investment in the digital-related areas.

The mid-term evaluation of the RRF found that the fund has played a pivotal role in supporting the EU's economic recovery, with public investment increasing in particular during the COVID-19 pandemic and subsequent energy crisis. It has led to a rapid return to pre-pandemic levels of economic activity, and it complied with the EU's additionality principle (i.e., supplementing rather than replacing national funds) by supporting reforms and investment in key areas, including green and digital.

Overall, the evaluation estimated that the RRF might increase real EU GDP by up to 1.4% by 2026, with significant potential for employment growth. However, challenges remain, including the need for sufficient flexibility in plan design and adequate administrative capacity. One of the findings of the RRF was that the administrative burden for implementation and reporting was higher than initially expected by Member States.

6.2.3.2. Digital Europe Programme (DEP)

The Digital Europe Programme has already achieved several important results related to the deployment of innovative new digital solutions, infrastructure and related services:

([527]) Country snapshots: https://commission.europa.eu/document/download/1455a856-0cca-4433-bac7-c21144fab9b1_en?filename=Recovery_and_resilience_FS_FR_1.pdf.

([528]) Mid-Term evaluation of the Recovery and Resilience Facility: Strengthening the EU through ambitious reforms and investment, SWD(2024) 70 final. ; related press release: https://ec.europa.eu/commission/presscorner/detail/en/ip_24_943.

- For instance, in October 2023, the **EuroHPC JU** awarded a public contract for **JUPITER** – the first system in Europe to achieve exascale performance, i.e., the ability to execute over one billion calculations per second. The system will make the EU a world leader in supercomputing and will be operational by late 2024. It is expected to have a major impact on European scientific excellence and industrial innovation. Currently three EuroHPC systems are in the top 10 of the world's most powerful computers. They are also among the world's most energy--efficient supercomputers.
- Data spaces in key sectors are currently being set up. For instance, the **Cancer Image Europe platform**, launched in September 2023, links up 39 datasets of images of 9 cancer types, for a total of over 200 000 image series from some 20 000 individuals. The **European Genomic Data** Infrastructure gives all countries the technical capability to access more than 2 500 synthetic genomics and phenotype data (including cancer, rare diseases and population genomics).
- The uptake of digital technologies is also encouraged by capacity building and specialised digital services, for instance, the 151 European Digital Innovation Hubs established across the EU, Iceland and Liechtenstein, offering 'test before invest' services which allow companies to experiment with new cutting-edge technologies, risk free and in a living lab. They also offer technical expertise, financial guidance and training/skills development.
- Testing and experimentation facilities have been established to help technology providers across the EU to test and experiment at scale state-of-the art AI solutions, including both soft and hardware products and services – e.g., robots – in real-world environments.
- The first cycle of specialised education programmes (master's programmes) and short-term training courses started in areas such as health, civil engineering, AI, cybersecurity, the Internet of Things (IoT), blockchain, quantum computing and robotics, to ensure people have the skills to use these innovative technologies.
- DEP has proven crucial in scaling up solutions under the **European Interoperability Framework** and ensuring their systematic implementation when designing cross-border digital public services. A few examples: 19 EU Member States and a total of 28 countries around the world have been actively supported by **SEMIC** (the EU's semantic interoperability platform); the Interoperability Test Bed has been used in more than 118 000 validations to test conformity of public services; the Interoperable Europe Academy curricula includes new courses, covering topics such as AI and interoperability, translated into all official EU languages and followed by more than 7 000 civil servants in 2023.
- While several EU programmes fund digital solutions to some degree, only Digital Europe applies **strategic investment**, thereby creating digital ecosystems, with a strategic vision for digital transformation across Europe, to ensure its digital autonomy and competitiveness on the global stage.
- The solutions Digital Europe promotes are mutually reinforcing or building on each other. HPC systems in Europe, for instance, which are now among the best in the world, are essential building blocks for Destination Earth, which needs intensive use of high-performance computing to run the highly complex simulations of the earth system.

HPC is also an essential building block for implementing the European Data Strategy, a key aspect of which is the shared, interoperable data spaces pooling European data in key sectors, which, in turn, are an essential resource for the AI community to train their models.

HPC is also key to boosting the development of human-centric AI. To ensure these new technologies are being used efficiently by companies, in particular SMEs, EDIH established all over Europe are providing key expertise, training and testing facilities.

6.2.3.3. Horizon Europe

The Horizon Europe programme aims to deliver impactful research and innovation across various dimensions, including scientific, technological/economic and social impact. When it comes do digital, Horizon Europe has been instrumental in promoting EU leadership in several technologies underpinning the Digital Decade vision and targets.

Overall, it is expected that around 35% of Horizon Europe will support work for the digital transition. Horizon Europe includes a dedicated cluster for 'Digital, industry and space', to develop research and high-end innovation in enabling technologies, such as AI and robotics, next generation internet, microelectronics, IoT and cloud computing, high performance computing and big data, 6G, extended reality, quantum and emerging technologies like photonics or graphene.

Recently, close to half a billion euro were invested in cutting-edge technologies and research following the latest selection of proposals from a series of calls under the latest work programmes for the 'Digital, Industry and Space' cluster. With a balanced mix of project participants from academia and research organisations, together with industry players, including strong representation from SMEs, these projects will see Europe shaping advanced digital technologies for a European industry with global leadership in these key areas of research and technological investment.

On **AI** for example, the projects tackle key research and innovation challenges for new technologies, reducing the energy consumption of powerful AI systems, optimising resource management for data-intensive applications and developing tools for easier data sharing.

On **semiconductors**, the full value chain is covered by Horizon projects, starting from material research (e.g., ferroelectrics, graphene), then addressing manufacturing processes (e.g., atomic layer deposition), architectures (e.g., neural networks and AI) and semiconductor devices (both analogue and digital). These projects will further boost and strengthen Europe's lead in semiconductor research and innovation. Their outcome will be complementary to the technological capacity building and innovation supported by the **European Chips Act**.

In the area of **quantum** technologies, projects will work in areas such as quantum photonic integrated circuit technologies and quantum computers. These projects underpin the EU's efforts to strengthen European technological sovereignty in this strategic field and achieve first-mover industry leadership, thus capitalising on Europe's established excellence in quantum science and technology.

All these activities will also aid research into combining digital with other technologies and sectoral areas like cybersecurity, health, energy or mobility for example. The work of Horizon Europe will be complementary to that of the Digital Europe Programme or the CEF.

Moreover, Horizon Europe supports several European partnerships in the digital domain (with Joint Undertakings for Chips, EuroHPC, Smart network and Services and other partnerships in AI, data and robotics, photonics, 'Made in Europe' and the Virtual Words and Advanced Materials partnerships). All these collaborations are essential for consolidating European industrial and R&I ecosystems. They are also extremely useful to operationalise the link between R&I under Horizon Europe and the pursuit of policy objectives, by bridging to other programmes like the DEP and CEF.

6.2.3.4. Connecting Europe Facility (CEF)

CEF Digital supports Europe's digital transformation by catalysing public and private investment in safe, secure and sustainable high-performance backbone and 5G infrastructure across the EU, as well as between Member States and with countries outside the bloc.

Backbone connectivity, including terrestrial, submarine cables and satellite-based connectivity, is a prerequisite for high capacity and high performance (in terms of resilience, security, redundancy and latency) by digital networks throughout the EU, in particular for the outermost regions, islands and Member States with coastlines, as well as overseas countries and territories (OCTs).

Backbone infrastructure is also crucial in providing efficient international connectivity of strategic importance, such as linking the EU with its trading and research partners around the globe. Submarine cables have, in particular, been in the spotlight, as over 99% of intercontinental data traffic relies on them, including the three island Member States, Cyprus, Ireland and Malta, as well as a number of islands that belong to other Member States the EU's outlying territories ('outermost regions'). There have been repeated calls to strengthen the security and resilience of submarine cable infrastructure, including increasing public funding to support private investment in a challenging environment.

Despite being a new programme (the 1st CEF had a different scope closer to what DEP is in this budget period), CEF Digital has already produced impressive results in its first 2 years of application.

- As of January 2024, the current portfolio comprises 71 actions (projects) resulting from calls 1 and 2, involving 26 countries (including OCTs) and related mainly to backbone networks (in particular submarine cables), 5G for Smart Communities and 5G corridors. The third call for proposals which closed early in 2024 was oversubscribed in 2 out of the 3 topics called for.
- EU direct intervention through CEF Digital is meant, firstly, to stimulate state-of-the-art deployments (such as 5G corridors along transport corridors, or 5G for smart communities), which the market alone would otherwise not have done. Secondly, it aims to focus resources on supporting resilient, high capacity and sovereign connectivity within the EU and internationally, through subsea cables, in line with the Nevers Call of 9 March 2022, or through its contribution to the European quantum communication infrastructure (EuroQCI), in the context of the EU's Secure Connectivity programme.
- CEF Digital provides a grant worth EUR 22.3 million for the CAM Ring submarine cable (Continent-Azores-Madeira), as the current one is becoming obsolescent and its replacement is an essential priority for the EU. For this purpose, a new project will deploy

a long-term solution to satisfy the increasing demand for connectivity in the next 30 years. The new CAM Ring will provide greater backbone interconnection in the Atlantic as a possible bridge to the Americas. Its benefits go beyond connectivity, as it will be one of the first cables integrating smart components to detect seismic and underwater nautical activity and carry out environmental monitoring and data gathering for scientific purposes.

- The Pisces project (EUR 29 million grant) aims to bridge the digital connectivity gap between Ireland and the rest of the EU with direct, high capacity, open access, scalable dark fibre connectivity to France, with plans for future additional subsea branches to Spain and Portugal (approximately 2 100 km). The system will provide a strategic link to meet the objectives of the EU's Digital Global Gateway Strategy, strengthening connectivity between Ireland and the rest of the EU. The system will also link transatlantic and other international cable systems that land in Ireland and France and will allow capacity interconnection on these systems.
- The ViaTunisia project (EUR 9.5 million grant), aims to build a submarine cable between Marseilles (France) and Bizerte (Tunisia), in full compliance with EU security and data protection requirements. The existing routes between Tunisia and France are either obsolete or involve indirect paths via Italy. These routes do not effectively meet current demands and are insufficient to accommodate the projected exponential traffic increase (+44%/year). ViaTunisia has been designed as a global project for an open access cable aiming to provide wholesale offer and use the latest transmission technologies at competitive prices. This project will improve connectivity between Europe and Africa, ultimately contributing to EU's digital sovereignty.
- The CEF Digital programme is also supporting several projects (Tussas Connect 1&2, Far North Fiber 1, North Pole Fiber 1 and the Northern Gateways study, with around EUR 37.6 million grants), as well Arctic connectivity, including the strategic geopolitical interest of an alternative route to Asia (Japan) through the Arctic. This route is becoming increasingly important following the rise of tension in the Middle East and a number of incidents in the Suez Canal/Red Sea passage. At the same time, connectivity in the Arctic is serving the EU's overseas Country and Territory Greenland and areas that have remote and isolated populations. With the use of "'smart cables'" (i.e., cables that have sensors or are used as sensors), the cables could serve multiple EU policy areas (environmental and climate change, earthquake/tsunami detection, submarine fauna monitoring, etc.).
- The Subsea French Guiana project (EUR 30 million grant)[529] is extending the reach of the existing infrastructure for EllaLink, which currently links Portugal to Brazil. EllaLink is planning to build a branch of 2 145 km length on the main system to connect to the city of Cayenne in French Guiana. While French Guiana currently only relies on connections through North America, this new cable will connect this outermost EU region directly to continental Europe with no dependency on any 3rd party, and therefore reinforce the sovereignty of the digital development in the entire Caribbean region. It will as well improve the security and resilience of the highly strategic European spaceport at Kourou.
- CEF is catalysing increasing support for 5G deployment. While the '5G for Smart Communities' project started with a modest number of proposals (7) in call 1, this has since

[529] Co-funded by the ERDF with EUR 10 million.

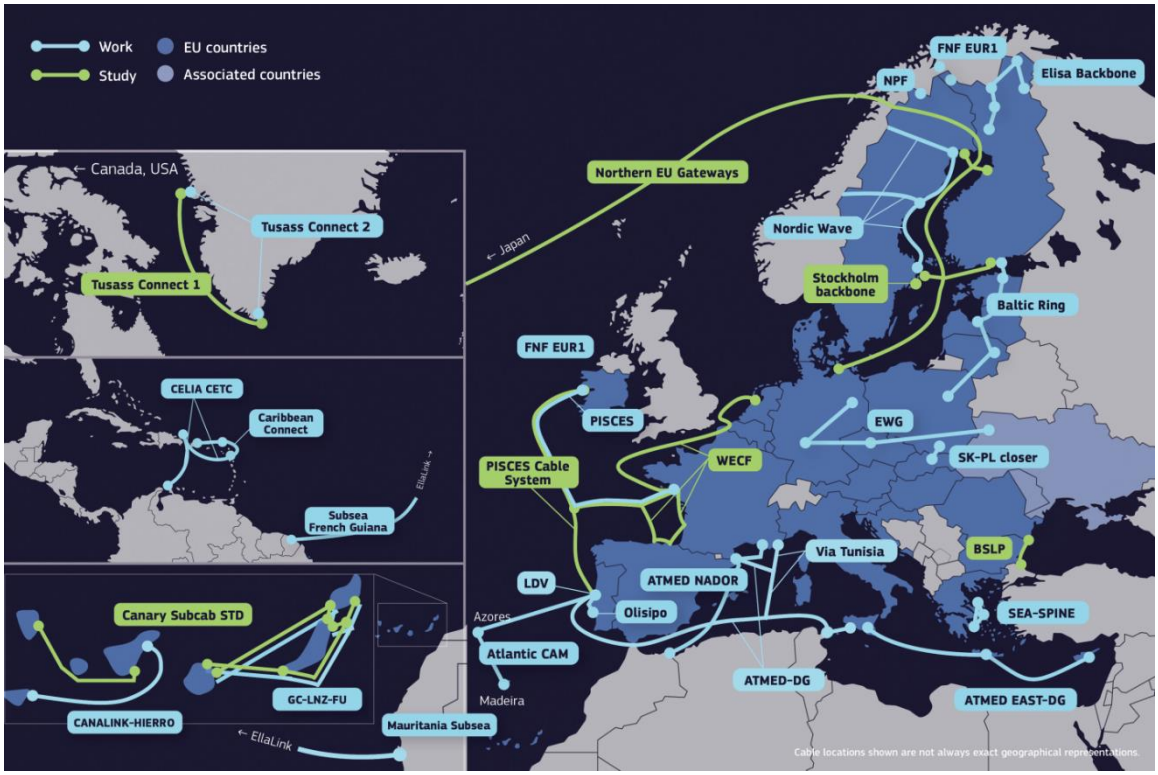
increased to 18 in call 2. Currently, there are a total of 32 proposals under evaluation in call 3.

The total number of projects under implementation is 17 and most of them are cross-sectoral in nature. The use-cases correspond to specific local needs, bringing impact on the ground, but at the same time providing replicable solutions to be multiplied throughout Europe. So far, the programme has made it possible for public and private 5G networks to be deployed in small cities or larger regional areas, as well as in urban and rural areas. A variety of 5G-based applications such as e-health, smart city, port logistics and smart agriculture have so far received funding, in multiple sectors (health, education, energy, transport). There are a lot of partnerships: between the 25 mobile network operators and companies (tech, software) on the supply side and the 37 public authorities/SGI (service gateway interface) providers on the demand side. The average project costs funded in call 1 & 2 is EUR 3 million.

- CONNECTOW is a smart city project in the city of Wavre, Belgium, which enables four different use cases for 5G technology. The first one is in public safety, with the use of drones for delivering real-time data to emergency responders at the scene. The second is in smart metering for energy management systems and energy awareness on the part of building occupants. There is also a use case deploying 5G-based wireless sensor network for air quality monitoring in residential areas, to improve quality of life for residents and visitors.
- Since 2023, a first wave of 18 projects for 5G corridor deployment funded under CEF Digital has been launched, with a combined grant aid of EUR 42 million (EUR 106 million total investment). These projects are contributing to the uninterrupted deployment of 5G connectivity infrastructure along motorways, rail and waterways, enabling service continuity for advanced connected and automated mobility (CAM) services and automated rail operations (FRMCS) as well as gigabit connectivity provision to road users and train passengers.
- This deployment, that follows the paths of the 9 TEN-Transport corridors, is focusing on cross-border sections of these corridors and is expected to play a crucial role in the green and digital transition of Europe, in particular for the mobility and transport sectors. Examples of projects include 5G-NETC, driven by Telia in the Nordic countries (road and rail), with connections to Finland, Denmark, Norway and the Baltic States, and 5G On Track, which focuses on service continuity for connected vehicles crossing the border between Germany and Luxembourg, under the leadership of Deutsche Telecom, PostLux and BMW.

In conclusion, already after the first 2 years of implementation, the digital strand of CEF was able to demonstrate that it can have a significant contribution to evolving policy priorities such as strengthening the reliability, security, resilience and sovereignty of EU's internal and international digital connectivity.

Figure 74. CEF-funded projects in the area of global gateways



Source: European Commission

Based on the performance to date, it is clear that CEF has been instrumental in funding major digital infrastructure deployment projects of key European strategic value, in particular, cross-border projects, which are not prioritised under other funding programmes. Its role will become even more important in future.

In its White Paper on '**How to master Europe's digital infrastructure needs',** the Commission presents a number of scenarios for the future transformation of the digital infrastructure sector and outlined the need to leverage private financing and improve synergies between existing EU funding instruments and programmes. More specifically, EU financing should serve the goal of promoting a vibrant community of European innovators, creating the 'Connected Collaborative Computing' Network ('3C Network'), an ecosystem that spans semiconductors, computational capacity in all kinds of edge and cloud environments, radio technologies, connectivity infrastructure, data management and application.

Moreover, the White Paper stresses the importance of ensuring appropriate funding for cable projects of European interest (CPEIs) by potentially pooling together EU and national funding instruments, with particular focus on leveraging private investment, including through financial instruments, to support CPEIs. The 2nd CEF work programme will be one of the key instruments for delivering on these objectives.

6.2.4. Building synergies in funding

The **significant scale-up of EU investment in digital technologies** delivered through programmes and instruments in the 2021-27 multiannual financial framework (MFF) creates opportunities to improve efficiencies, including the cross-fertilisation of industries. It also opens a window to reinforcing European innovation by exploring and exploiting technologies

at the interface between the civil, defence and space industries – such as AI, cloud and quantum computing, as set out in the 2021 **Action Plan on Synergies between the European civil, defence and space industry**.

Therefore, the development of adequate tracking for digital expenditure across **EU funding programmes and instruments, directly or indirectly contributing to the digital transition**, is also key to identifying and strengthening potential **synergies.** Synergies encompass compatibility, complementarity and consistency between different forms of EU funding. This requires good interaction between two or more programmes aiming to increase the effects that could be achieved by individual interventions.

The creation of synergies requires adequate planning, designing and programming of EU funding programmes, aligning strategic priorities and rules. Synergies may unfold:

- when funds from different programmes or different levels in the same projects are brought together (**complementary funding**);
- when successive projects build on each other, upstream or downstream (**sequential funding**);
- when one programme or instrument takes up high-quality project proposals from other programmes e.g., Seal of Excellence and Sovereignty Seal (**alternative funding**);
- when two or more complementary projects run in parallel.

European Digital Innovation Hubs (EDIH), funded under the Digital Europe Programme, received additional funding in conjunction with the European Regional Development Fund. The EDIHs have a strong regional focus, aiming to create a pan-European network with one EDIH per NUTS II region. Member States naturally allocate funding to the EDIHs through European Regional Development Fund (ERDF) co-funded programmes, aligning with the regional emphasis of the EDIHs and the objectives of the ERDF programmes, such as competitiveness, uptake of digital technologies and smart growth, in several Member States. This approach ensured that only high-quality operations are selected.

The most important example of sequential funding for digital projects can be found among Horizon Europe, the Digital Europe programme (DEP) and the Connecting Europe Facility – Digital (CEF2 – Digital). These are contributing to the Digital Decade targets for 2030 at different levels (prepare, deploy, connect). Horizon Europe supports research, technological development, demonstration, piloting, proof-of-concept, testing and innovation – including pre-commercial deployment – for innovative digital technologies.

The DEP focuses on large-scale digital capacity and infrastructure building, to support the uptake and deployment of existing or tested critical innovative digital solutions across the EU. CEF2 – Digital supports the deployment of very high-capacity backbone networks and 5G networks, both in corridors and smart communities, necessary for deploying digital services and technologies across the EU.

Synergies among these three programmes are already anchored into the design of the work programmes, for instance, in the areas of common European data infrastructure and services as well as supercomputing/quantum computing. The Digital Europe programme--funded sectoral data spaces benefit from Horizon-funded projects, which, for

instance, support digital technologies, methods, architectures and processes for user-friendly, safe, trustworthy, transparent and environmentally sustainable collection, storage, and processing of data.

One concrete example is the Horizon2020-funded *Beyond One Million Genomes* project, which prepared the groundwork for the DEP-funded Genomic Data Infrastructure project, by defining the legal, technological and data-related requirements and guiding Member States' agreement on the respective recommendations. In supercomputing, the European High Performance Computing Joint Undertaking (EuroHPC JU) draws funds from the Digital Europe programme, Horizon Europe and CEF Digital. Synergies between these three programmes are being exploited, so the initiatives are complementary and mutually reinforcing.

Another example of sequential funding is the action being put into place to assist the migration of innovation from the civil to the defence sector, and vice versa, in the context of spin-in calls. These are subject-specific research or development projects published under the annual **European Defence Fund (EDF) calls for proposals**.

For spin-in calls, the objective is to transfer results generated in other civil EU-funded programmes to the defence sector. Furthermore, it encourages proposals to drive forward and integrate results from other sectors, combining them with defence-specific solutions. This will increase the EU's overall R&D efficiency, avoid unnecessary duplication of R&D efforts, improve defence industrial innovation capacity and equip the EU's armed forces with the most effective solutions.

The proposals need to build on or integrate results that have been achieved within one or more projects funded under an EU programme call that focuses on civil applications. Such previous projects may be completed or may still be active. The submitting consortium does not necessarily need to include the participants or result owners of the previous project(s). However, applicants must provide a confirmation that they have or will have the necessary rights to use and commercialise the results of the previous project(s).

Cyber defence applications rely in most cases on cybersecurity technologies. There are many initiatives in the civil domain focused on the automation of penetration testing. However, due to the particular conditions of defence-related use-cases, to make them suitable for defence applications civil technologies need to be adapted, further improved or combined with defence-specific technologies through additional R&D efforts. For this reason, a call for proposal was issued in 2023 on the **automation of security penetration tests** ([530]).

The Seal of Excellence is a quality label first introduced in Horizon 2020, and since then it has gradually become a key instrument for creating synergies. The Seal is awarded to project proposals submitted under a Horizon Europe call for proposals and ranked above a predefined quality level, but which were not funded by Horizon Europe due to budgetary constraints.

With this label the Commission recognises the value of project proposals and encourages other funding organisations to take advantage of the high-quality Horizon Europe evaluation process. Under **Horizon Europe**, improvements regarding quality and support for implementing the Seal of Excellence have been introduced. The **European Innovation Council (EIC)**

([530]) https://ec.europa.eu/info/funding-tenders/opportunities/portal/screen/home.

Accelerator Seal of Excellence offers a wide variety of funding opportunities by using synergies with other EU and national programmes such as NextGenerationEU or Cohesion funds.

One concrete example is the Spanish recovery and resilience plan, which has allocated EUR 50 million to 30 innovative companies awarded the Seal of Excellence under the 2021 and 2022 calls by the Spanish innovation agency – the Centre for Technological Development and Innovation (CDTI). One of these projects focuses on digital identity sovereignty, based on blockchain ([531]).

Similar to Horizon Europe, **the Digital Europe programme awards the Seal of Excellence**. In 2024, the European Digital Innovation Hubs (EDIHs) network comprises 227 hubs. 151 EDIHs are funded by the DEP and over 70 Seals of Excellence EDIHs have been funded through operational programmes supported by the European Structural and Investment Funds (ESIF) or the RRF. In 2023 **CEF Digital** also awarded Seals of Excellence to a number of projects submitted in call 2 for Global Gateways which could not be funded due to a lack of budget.

Building on the success of the Seal of Excellence, the Strategic Technologies for Europe Platform (STEP) Regulation ([532]) **has proposed to introduce a new 'Sovereignty Seal'**. This would be awarded to projects meeting the minimum quality requirements (including eligibility, exclusion and award criteria) in the selection process of a competitive procedure of calls for proposal under the Digital Europe programme, the European Defence Fund, the EU4Health programme, Horizon Europe or the Innovation Fund.

For projects to be awarded the Sovereignty Seal, they must contribute to the STEP objectives, namely (1) supporting the development or manufacturing of critical technologies throughout the EU, or safeguarding and strengthening their respective value in the following sectors: **digital technologies and deep tech innovation**, clean and resource-efficient technologies, including net-zero technologies and biotechnologies; (2) addressing shortages of labour and skills critical to all kinds of quality jobs in those sectors ([533]).

Synergies can also take place between grants and repayable forms of support such as loans, guarantees and equity investment, and this can be very relevant in some situations to address particular market failures or investment gaps. The InvestEU Fund can be combined with grants or financial instruments (or both), funded by the centrally managed EU budget or by the EU Innovation Fund.

To maximise the impact and added value of EU financing support, it is appropriate to promote streamlined investment process that ensures the visibility of the project pipeline and maximises synergies across relevant EU programmes in areas such as digitisation. A project using EU grants and InvestEU will be carried out under the InvestEU rules, which will

([531]) Directorate-General for Research and Innovation, Seal of Excellence – a concrete example of synergies, 6 March 2024: https://research-and-innovation.ec.europa.eu/news/all-research-and-innovation-news/seal-excellence-concrete-example-synergies-2024-03-06_en.

([532]) Proposal for a Regulation of the European Parliament and of the Council establishing the Strategic Technologies for Europe Platform ('STEP') and amending Directive 2003/87/EC, Regulations (EU) 2021/1058, (EU) 2021/1056, (EU) 2021/1057, (EU) No 1303/2013, (EU) No 223/2014, (EU) 2021/1060, (EU) 2021/523, (EU) 2021/695, (EU) 2021/697 and (EU) 2021/241, COM/2023/335 final, https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52023PC0335.

([533]) European Commission, Sovereignty seal: https://commission.europa.eu/strategy-and-policy/eu-budget/strategic-technologies-europe-platform/sovereignty-seal_en.

be applied for the entire project. This means a single rulebook and a major simplification compared to the previous MFF. A good example of this are the existing **blending operations between the Digital Europe Programme and InvestEU**, where the InvestEU guarantee is increased to provide targeted equity support in the field of strategic digital technologies or chips.

In its White Paper 'How to master Europe's digital infrastructure needs', the Commission shared its vision as regards the transformation of the electronic communications sector and the need to build an ecosystem between actors in different sectors in the value chain, including chips manufacturers, electronic communications network equipment providers, edge and cloud service providers. People and devices communicating with each other depend on the availability of high-performing digital infrastructure. Edge technology is expected to facilitate the presence of significant computational capacity, in a wide range of devices, robots, drones, medical devices, wearables and self-driving cars. Connectivity and computing are converging and the companies in these different segments of the value chain also need to work together, in close collaboration, in order to succeed.

In order for the EU to build industrial capacity in this transition towards cloud-based networks and the integration of telco-edge infrastructures and services, today's connectivity providers must become tomorrow's providers of collaborative connectivity and computing (3Cs). This transformation could be supported by the development of an ecosystem between actors in the different sectors and facilitated by exploiting synergies between existing EU funding programmes.

Under the 1st CEF work programme, the first steps have been taken to build 5G infrastructure through the co-financing of use cases in smart communities and corridors. In its second work programme, the Commission intends to step up a gear and, together with other programmes, channel financing to a number of deployment pilots that set up end-to-end infrastructure and platforms and bring together players from different segments of the connectivity value chain and beyond.

6.3. The international dimension of the Digital Decade

International aspects of digital policies are intrinsically linked to internal ones. International cooperation efforts in the area of digital policies focus on (i) promoting the EU's human-centric model and regulatory framework, (ii) protecting EU strategic interests, including EU economic security and (iii) reinforcing the global role of the EU in the digital world.

To safeguard economic interests, the EU has implemented measures such as the EU Economic Security Strategy, promoting cooperation with key partners in emerging technologies. These measures aim to balance economic openness with strategic interests and increase the EU's resilience in critical sectors.

Instruments like the European Declaration on Digital Rights and Principles have influenced international agreements such as the OECD's Declaration on a Trusted, Sustainable and Inclusive Digital Future and discussions for a UN Global Digital Compact. The EU has laid the foundations for digital diplomacy through Council Conclusions ([534]), and aims for a

([534]) Council Conclusions on EU digital diplomacy of 18 July 2022 and 26 June 2023, and Council Conclusions of 18 April 2024 which further emphasised the importance if the international dimension of EU digital policies.

stronger, more strategic and coordinated approach to digital coalition-building and diplomatic outreach, to allow for EU leadership in the global digital governance.

The EU has developed **international digital partnerships**, building on our strong ties with like-minded partners. It is structured across **three levels:**

1. **Trade and Technology Councils and digital partnerships**
2. **Digital Dialogues**
3. Partners we cooperate with through the **Neighbourhood Policy, Global Gateway and regional alliances**

The EU's international digital partnerships match the four pillars of the Digital Compass – skills, infrastructure, transformation of business and transformation of public services – and build on a 'cooperation toolbox' including regulatory cooperation, R&I and industrial cooperation, investment in secure digital infrastructure, capacity building and skills and cooperation in international forums.

6.3.1. Trade and Technology Councils and digital partnerships

The Commission has continued to develop its network of international digital partnerships with like-minded partners like the USA, India, Japan, South Korea, Singapore and Canada, developing cooperation in research and innovation, investment and technical support, policy and legislation approximation as well as standardisation.

Through the **EU-United States Trade and Technology Council (EU-US TTC),** the EU has advanced cooperation in key areas such as emerging technologies, secure and resilient connectivity, protection of human rights and values online and facilitation of trade. The sixth EU-US TTC ministerial meeting ([535]) took place on 4-5 April 2024 in Leuven Belgium, after a fifth meeting ([536]) which had taken place on 30 January 2024 in Washington DC.

The sixth TTC Ministerial meeting established a positive, long-term cooperation agenda on AI, quantum, 6G, semiconductors and standardisation. It identified a common commitment to a risk-based approach to AI and support for safe and trustworthy AI technologies. It also announced a dialogue between the EU AI office and the US Safety Institute on developing tools, methodologies and benchmarks for measuring and evaluating AI models.

A common 6G vision ([537]), setting out a path for leadership on this technology, was released and an administrative arrangement for research collaboration signed. In the **semiconductors** area, it was agreed to continue cooperating to identify in advance supply chain disruptions and ensure the transparency of subsidies. Finally, a Digital Identity Mapping Report ([538]) was released with the aim of identifying use cases for transatlantic interoperability and the cross-border use of digital identities.

The EU-US TTC also focused on online platforms, with the release of a set of joint principles on gender-based violence ([539]) on online platforms, which complement the list of high-level

([535]) Sixth EU-US TTC Ministerial meeting: https://ec.europa.eu/commission/presscorner/detail/en/IP_24_1827.
([536]) Fifth EU-US TTC Ministerial meeting: https://ec.europa.eu/commission/presscorner/detail/en/IP_24_575.
([537]) https://digital-strategy.ec.europa.eu/en/library/advancing-6g-vision-transatlantic-collaboration.
([538]) https://futurium.ec.europa.eu/en/EU-US-TTC/news/eu-us-ttc-digital-identity-mapping-exercise-report.
([539]) https://digital-strategy.ec.europa.eu/en/library/us-eu-trade-and-technology-council-ttc-joint-principles-combatting-gender-based-violence-digital.

principles ([540]) on the protection and empowerment of minors and data access for researchers, which themselves are in line with the EU's Digital Services act. A dedicated workstream involving researchers also published a report on data access mechanisms ([541]) for researcher access to platforms' data.

The **ninth EU-US Cyber Dialogue** took place on 6-7 December 2023 in Brussels. The EU and US committed to work together on achieving mutual recognition for the government-backed cybersecurity labelling programmes and regulations for Internet-of-things devices.

The first **EU-India Trade and Technology Council** on 16 May 2023 launched cooperation on microelectronics, digital public infrastructure (DPI), digital skills and talents, high performance computing (HPC) and quantum, AI, and ICT standardisation. This will enable EU companies to gain access to new markets and leverage India's technological expertise.

Over the course of 2022, **three digital partnerships** with key East Asian countries – **Japan, South Korea and Singapore –** were launched. These partnerships showcase the EU's strategic engagement in the digital field with a pivotal region of the world. They aim to provide an overall framework for bilateral cooperation on (i) digital policy and regulatory matters (such as data free flow with trust, platforms and AI), (ii) our positions on digital matters in international fora and (iii) research and investment opportunities in cutting-edge technologies such as HPC, semiconductors and 5G/6G.

The partnerships include agreed digital trade principles as key deliverables. The EU has launched new joint projects with its partners to reinforce mutual economic resilience, increase the EU's excellence in R&I and boost competitiveness. A key project is to deploy a secure and direct submarine cable between the EU and Japan and the rest of the region, through the Arctic.

Following the successful start of the partnerships in East Asia, the EU launched a digital partnership with **Canada** on 24 November 2023 on the occasion of the EU-Canada summit. New digital partnerships with Australia, New Zealand and Brazil are being explored.

6.3.2. Digital dialogues

The EU's international digital partnerships are underpinned by a growing programme of bilateral digital dialogues with key partners around the world.

In the **Latin America and Caribbean** region, bilateral digital policy dialogues have been set up with **Brazil** (which took place 18-22 March 2024), **Argentina** (which took place on 21-22 June 2023) **and Mexico**. These will be complemented with a bi-regional dialogue established under the EU-LAC Digital Alliance. The first bi-regional digital policy dialogue under the Alliance took place on 27-29 November 2023 in Cartagena de Indias, Colombia.

The dialogues aim to promote the EU's human-centric approach to digital transformation in these countries, covering themes like regulatory convergence with the EU (especially on key areas such as digital markets and services) as well as AI, alignment with EU technical norms and cybersecurity standards, deployment of secure and resilient digital infrastructure (including 5G), stimulation of EU-led value chains for the digital transformation of the economy, the

([540]) https://digital-strategy.ec.europa.eu/en/library/transparent-and-accountable-online-platforms.
([541]) https://digital-strategy.ec.europa.eu/en/library/status-report-mechanisms-researcher-access-online-platform-data.

development of digital government, addressing social inclusion through digital, and promoting secure global connectivity.

In **Asia**, the EU held a second High Level Dialogue on Digital with **China** on 18 September 2023. The dialogue addressed problems EU companies encounter in China, such as access to ICT standardisation bodies, cross-border data flows, as well as malicious disinformation and cyber activities. The China-EU ICT Dialogue was agreed to be resumed and took place on 29 February 2024.

In line with the 'One China' policy, the EU maintains a Digital Economy Dialogue with **Taiwan** which promotes research cooperation in areas such as semiconductors and 5G/6G, regulatory cooperation in the fields of data, online platforms and AI, and coordination related to internet governance.

6.3.3. Global Gateway and regional alliances

The programme of policy dialogues is accompanied by a growing number of digital cooperation initiatives, supported by instruments such as NDICI-Global Europe, the Connecting Europe Facility and Horizon Europe, in addition to Team Europe initiatives which bring together the contributions of Member States.

The Global Gateway initiative focuses on digital infrastructure investment to bridge the global digital divide and increase the security of digital connections between Europe and its partners. The Commission is in particular supporting the deployment of secure 5G networks provided by trusted vendors in non-EU countries, notably in LAC and the EU neighbourhood. It is also working on supporting the security and resilience of submarine cables, supporting the EU's digital resilience and reducing dependencies.

To promote a 'team Europe' approach, the Commission and Member States joined forces to establish a coordination platform aimed at strengthening the EU's global role in support of a human-centric model of digital transformation: the D4D Hub ([542]). The results of these efforts are already visible in several flagship initiatives implemented on the ground, including:

An EU-Africa Global Gateway investment package, with digital flagships for the digital transition ([543]).

- An EU-Latin America and Caribbean Digital Alliance ([544]), launched in March 2023 and providing a forum for regular high-level bi-regional dialogue and cooperation on priority topics, supported by a number of Global Gateway flagship initiatives.
- Digital economy packages have been launched with Nigeria, the Democratic Republic of the Congo and Kenya. Packages are being planned with Tanzania, Mozambique and Senegal.

6.3.4. Association countries

Priority is given to countries in the EU's neighbourhood, with a focus on candidate and pre-candidate countries, to increase their alignment with the EU's policy and regulatory agenda.

([542]) https://d4dhub.eu/.
([543]) https://ec.europa.eu/commission/presscorner/detail/en/fs_22_1117.
([544]) https://ec.europa.eu/commission/presscorner/detail/en/ip_23_1598.

The Commission has supported digital transformation efforts in enlargement countries and the EU neighbourhood, including by granting them association status with EU programmes like Digital Europe and the Connecting Europe Facility. Association agreements to the Digital Europe programme were signed with Ukraine, Moldova, Montenegro, North Macedonia, Serbia, Albania and Türkiye. Both Ukraine and Moldova signed association agreements to all three strands of the Connecting Europe Facility**.**

The Commission held its second edition of the Regulatory Dialogue on digital policies on 30 June 2023 in Brussels with **Western Balkans countries**. The topics included data governance and the free flow of data, digital identity and trust services (Balkan Digital Identity Wallet), e-services and interoperability, and cybersecurity. The Western Balkans New Growth Plan of 8 November 2023 contains digital single market as one of the priority actions.

Since the start of Russia's invasion of **Ukraine**, the EU has substantially stepped-up support for the country's digital transformation, focusing both on emergency and long-term measures. On 9 July 2023, the Commission welcomed the fourth extension (for a further 12 months) of the voluntary roaming agreement between EU and Ukrainian operators. In parallel, the EU has been working towards a long-term roaming arrangement with Ukraine, through the EU-Ukraine Association Agreement.

A similar approach for roaming is being followed with Moldova, where efforts towards a long--term arrangement through the EU-Moldova Association Agreement are to be complemented by short--to- -medium term voluntary agreements between operators on both sides.

The third EU-Ukraine Cyber Dialogue took place in November 2023. A working arrangement between ENISA and the Ukrainian cyber agencies was signed by both sides on 13 November.

6.3.5. Multilateral cooperation

The EU has recorded significant success in multilateral forums.

As a part of the Hiroshima process, G7 Leaders endorsed the International Guiding Principles on AI and a voluntary code of conduct for AI developers. Both documents reflect the core concepts of the EU AI act and represent the most advanced international governance tools for trustworthy AI to date.

The Commission continues to play a pivotal leadership role on the multilateral front, actively promoting the 'Data Free Flow with Trust' initiative that reflects the idea (at the heart of the EU data regulations) that data protection is not a 'restriction' but an enabler to data flows, which increases trust in the digital economy. This is shaping the G7/20 discussions and supports the work of the OECD.

In the **OECD,** DG CONNECT is proactively promoting the EU model for the digital transformation. The EU brought to conclusion the discussions on the first-ever international instrument setting out principles in the area of surveillance, the Declaration on Government Access to Personal Data held by Private Sector Entities.

The OECD also adopted the OECD AI principles and 28 countries joined its Global Partnership on AI (GPAI). In the area of data free flow with trust the EU successfully supported the

Japanese proposal to set up a forum at the OECD called Institutional Arrangement for Partnerships, dedicated to exchange, among like-minded countries.

In the **UN** context, the EU submitted a contribution to the **Global Digital Compact** in a single EU adopted document, in line with the European Declaration on Digital Rights and Principles and the human rights conventions covenants, and treaties.

On **internet governance**, the EU is committed to promoting its human-centric vision and interests in global multi-stakeholder institutions, including standardisation bodies. This encompasses concrete policies related to internet openness and security, as well as setting the global internet policy agenda.

Moreover, the EU promoted the open internet and its multi-stakeholder model through different initiatives, including by putting forward, together with like-minded partners, the Declaration for the Future of the Internet ([545]).

([545]) Declaration for the Future of the Internet: https://digital-strategy.ec.europa.eu/en/library/declaration-future-internet.