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Digital Decade Cardinal Points

Accompanying the document

**Communication from the Commission to the European Parliament, the Council, the
European Economic and Social Committee and the Committee of the Regions**

Report on the state of the Digital Decade 2023

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1 Digital Skills

1.1 The EU's digital skills landscape in 2023: Importance and status

We are currently facing a **significant digital skills gap** in Europe. Most **jobs** nowadays require some level of **digital skills**¹, particularly in the context of the digital transition, and following the 'digitalisation push' by companies as a reaction to the coronavirus crisis whereby almost half of adult workers saw new digital technology introduced at their workplaces.² In addition to that, many companies and in particular **small and medium-sized enterprises** are experiencing an increased competition for digitally skilled talent which they face on an already tense job market.

More generally, a large share of all Europeans (46% in 2021³ according to Eurostat) still does not possess **basic digital skills** and are thus not confident when performing activities online and with digital devices, nor can they reap the full benefits of digital technologies. There is also evidence of low levels of digital skills among a significant share of young people, where it has been estimated that around one third of eighth graders are performing below a basic level of digital skills⁴.

To ensure that everyone can embark on the digital transformation journey in a fair way, it is crucial to make sure that **we are not leaving anyone behind, without the right digital skills**. This is in line with Principle 20 of the European Pillar of Social Rights⁵, which identifies digital communications as one of the essential services to which everyone shall have access to and calls for support for access to those in need. It also reflects Principle 1, i.e. that everyone has the right to quality and inclusive education, training, and life-long learning in order to maintain and acquire skills that enable them to participate fully in society and manage successfully transitions in the labour market.⁶ The need to tackle the digital divide is also clearly stated in the **Declaration on Digital Rights and Principles**⁷, recalling that **everyone** has the right to education, training, and lifelong learning, as provided by Article 14 of the Charter of Fundamental Rights of the European Union⁸, and should be able to acquire basic and advanced digital skills.

¹ According to the CEDEFOP's 2nd European Skills and Job Survey, 87% of adult workers use computing devices at work. For further information see: Cedefop (2022). Setting Europe on course for a human digital transition: new evidence from Cedefop's second European skills and jobs survey. Luxembourg: Publications Office. Cedefop reference series; No 123, available at <http://data.europa.eu/doi/10.2801/253954>.

² Cedefop (2022). Setting Europe on course for a human digital transition: new evidence from Cedefop's second European skills and jobs survey. Luxembourg: Publications Office. Cedefop reference series; No 123, available at <http://data.europa.eu/doi/10.2801/253954>.

³ For more information on the digital skills indicators published by Eurostat, see the digital skills indicator table (https://ec.europa.eu/eurostat/databrowser/product/view/ISOC_SK_DSKL_I21) as well as the section in the "Information about data" page (<https://ec.europa.eu/eurostat/web/digital-economy-and-society/information-data#Digital%20skills%20indicator>)

⁴ Fraillon J., Ainley J., Schulz W., Friedman T., Duckworth D. (2019). Preparing for Life in a Digital World: International Computer and Information Literacy Study 2018 International Report. Amsterdam: IEA.

⁵ For more information on the European Pillar of Social Rights, see: <https://ec.europa.eu/social/main.jsp?catId=1606&langId=en>.

⁶ Moreover, the Commission Staff Working Document on access to essential services in the EU (SWD(2023) 213 final/2), 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. More information and link to the report is available at:

<https://ec.europa.eu/social/main.jsp?langId=en&catId=89&furtherNews=yes&newsId=10595>.

⁷ <https://digital-strategy.ec.europa.eu/en/library/european-declaration-digital-rights-and-principles>.

⁸ https://www.europarl.europa.eu/charter/pdf/text_en.pdf.

There is also a particular need to recruit more **ICT specialists** in Europe to fulfil the needs of industrial ecosystems (e.g., the automotive industry, aerospace, electronics.), which are increasingly relying heavily on **cutting-edge technologies**. In fact, in 2019, more than half of EU enterprises that recruited or tried to recruit ICT specialists had difficulties in filling ICT vacancies.⁹ To give one concrete example, between 260 000¹⁰ and 500 000¹¹ cybersecurity experts are currently needed in Europe. The EU needs a bigger pool of such specialists to protect businesses and public services in Europe and to design the cybersecurity solutions of the future.¹² Furthermore, innovations and breakthroughs in different areas such as artificial intelligence (AI), robotics, quantum technology or 6G, are bringing a wave of demand for a **new generation of advanced digital skills**, such as skills in AI and machine learning algorithms, the Internet of Things, big data analytics, cloud computing or cybersecurity. In this respect, higher education institutions play a crucial role in boosting the number of ICT specialists in Europe, given that about two-thirds of ICT specialists in the EU had completed a tertiary level of education in 2022.¹³ In this sense, while the academic offer of both bachelor and master's programmes in the EU in the academic year 2022-23 with respect to the previous academic year in the area of advanced digital technologies has increased, the EU is nevertheless still lagging behind other regions of the world such as the United Kingdom or the United States¹⁴. While there is clearly a need to train ICT specialists with advanced digital skills in one or more technological domains, there is also a need to train ICT specialist to acquire **domain-specific knowledge** with increased understanding of the real needs and specificities of a specific domain, such as an ICT engineer requiring specific additional education in agriculture¹⁵.

In addition to the significant shortage of ICT specialists, Europe also faces a significant digital skills gap in **more traditional non-ICT professions**. Recent research from Germany and the U.S. demonstrated a rising demand for **digital skills in non-tech industries**¹⁶. Moreover, a Danish study showed that in Denmark, the demand for sector specialists with advanced digital skills (i.e., so-called digital integrators) exceeds the demand for digital specialists in fields where digital is at the core of the job.¹⁷ For instance, there is a particularly high need to equip **sector specialists with advanced digital skills**, such as medical doctors who are increasingly relying on advanced digital technologies (e.g., AI and augmented reality) to provide more accurate diagnoses, training future doctors or process the data of their patients in electronic health records, or farmers who are using advanced data analysis to optimise their agricultural production processes. There is also an urgent need for more so-called **digital integrators** to unlock the potential of innovative digital solutions in the green

⁹ Eurostat (2021) : https://ec.europa.eu/eurostat/statistics-explained/index.php?title=ICT_specialists_-_statistics_on_hard-to-fill_vacancies_in_enterprises.

¹⁰ (ISC)² in Assessing Cyber Skills on the basis of the ECSF, ENISA webinar, 16 February 2023

¹¹ According to European Cyber Security Organisation (ECISO), as stated in the Joint Communication to the European Parliament and the Council, EU Policy on Cyber Defence, JOIN(2022) 49 final

¹² A Resilient Cybersecurity Profession Charts the Path Forward : (ISC)² CYBERSECURITY WORKFORCE STUDY, 2021 (<https://www.isc2.org/-/media/ISC2/Research/2021/ISC2-Cybersecurity-Workforce-Study-2021.ashx>), page 25.

¹³ https://ec.europa.eu/eurostat/statistics-explained/index.php?title=ICT_specialists_in_employment.

¹⁴ This represents an increase of 8% in the number of bachelor programmes and an increase of 14% in the number of master programmes in the area of advanced digital skills. The dataset by the Joint Research Centre on the 'Academic offer of advanced digital technologies 2022-2023' is available here:

<https://data.jrc.ec.europa.eu/dataset/7aed1a89-c904-43ed-af0f-b024fc9cb92a>.

¹⁵ For other examples, see also: <https://digital-skills-jobs.europa.eu/en/latest/briefs/digital-jobs-deep-dive>.

¹⁶ https://www.burning-glass.com/wp-content/uploads/2021/02/after_the_storm_recovery_jobs_executive_summary.pdf;
https://www.bertelsmann-stiftung.de/fileadmin/files/user_upload/STUDIE_Burning_Glass_EN_FINAL.pdf;

¹⁷ <https://download.digitaldogme.dk/hubfs/Det%20digitale%20Kompetencebarometer%202020.pdf>

transition, to maintain the EU's competitiveness in a carbon-neutral economy and to support the skills' pillar of EU Net Zero Industrial Act and other EU and national green transition initiatives. Examples include, for instance, experts in the field of digitalisation of energy systems, connected mobility precision farming and hydro informatics, experts mastering the predictive and analytical capacities of AI for future weather forecasting or energy grid management or experts capable of the manipulation of big geospatial data for better resource utilisation.

In addition to the structural shortage of both ICT specialists (including those with domain-specific knowledge) and sector specialists that possess advanced digital skills, the sector suffers from a severe **gender imbalance in the EU** with 81% of employed ICT specialists in 2022 being male¹⁸, although women account for 51% of the European population. The way that digital solutions are devised and deployed may be affected by the fact that only a small share of employed **ICT specialists and ICT graduates are women**. This gap does not fully recognise the value of women's contributions and talent which is essential for building a Digital Europe, and there is therefore a high need to increase the pool of talent in this field. Furthermore, the need to close the gender digital divide was both an important topic of discussion during the Structured Dialogue on Digital Education and Skills as well as during the 67th session of the Commission on the Status of Women, which took place at the UN Headquarters in New York in March 2023. The Agreed Conclusions *inter alia* restate commitment to enhance digital skills and literacy for all women and girls.

Moreover, it is important to note that we cannot create ICT specialists or sector specialists with advanced digital skills overnight. This is why boosting the development of digital skills from an **early age** onwards and in a continuous manner is therefore essential for advancing the level of digital skills of the EU population and the number of students of all ages and genders who consider studies and careers in ICT or digital-related fields. In this respect, for instance, evidence shows that pupils who are involved in the learning of coding or computational thinking from an early age are more likely to continue studying ICT or digital-related fields. This has an impact on the number of students choosing this study path or young people embarking on a career in a digital field.¹⁹ Three main educational approaches currently are applied across the EU to boost digital skills already at school level, including the (a) cross-curricular approach (aims at having students develop digital skills in all/multiple subjects), the (b) approach to introduce a separate subject (e.g. informatics, also known as computer science) as well as the (c) approach to include digital skills in an already existing subject (e.g. science). Whereas each approach is valid, making informatics a compulsory subject has the advantage to offer the possibility to all students to develop digital skills, potentially increasing their interest in STEM and digital disciplines, and reducing the above-mentioned gender gap.²⁰

There is a crucial **need to tackle skills mismatches in Europe**, including by boosting the digital skills of young people and encouraging them, and particularly women, to take up ICT studies and subsequently to embark on a job in/related to ICT, provide up- and reskilling opportunities to the working population as well as to achieve gender convergence in the ICT related studies and occupations. For this, many important initiatives and policies to boost digital skills already exist at EU and Member State level. The Recovery and Resilience Facility (RRF), for instance, supports reforms and investments aiming to promote, among others, the development of human capital in digitalisation, including measures supporting basic and advanced digital skills as well as the formation

¹⁸ https://ec.europa.eu/eurostat/statistics-explained/index.php?title=ICT_specialists_in_employment

¹⁹ https://news.microsoft.com/wp-content/uploads/2017/02/Microsoft_girls_in_STEM_final-Whitepaper.pdf

²⁰ For a more detailed discussion of the different existing approaches, see the Commission Staff Working Document (SWD(2023) 205 final) accompanying the 'Proposal for a Council Recommendation on the key enabling factors for successful digital education and training' and the 'Proposal for a Council Recommendation on improving the provision of digital skills in education and training'.

of ICT specialists (see section 1.5.1.2 for more details). The RRF funds are complemented by national funding as well as other European funding programmes (e.g., Erasmus+, European Social Fund Plus, Digital Europe Programme, InvestEU, Horizon Europe, etc.) and key initiatives (e.g., Digital Skills and Jobs Coalition/Platform, the European Skills Agenda, the Digital Education Action Plan, EU Code Week, Large-scale Partnership in the Digital ecosystem under the Pact for Skills, etc.), as described in further detail in this thematic chapter further below.

The EU's ambitious Digital Decade targets of the recently adopted **Path to the Digital Decade Policy Programme** (DDPP) will only be achieved with focused and coordinated efforts, including the aim that at least 80% of the population aged 16-74 will have **basic digital skills by 2030**²¹ and that 20 million **ICT experts** will be employed in the EU, with more graduates and a better **gender balance**. The Digital Decade targets are complemented by a target set in the European Education Area²² of reducing the percentage of eighth graders who underachieve in **computer and information literacy** to less than 15% by 2030.

Given the urgency to boost skills, including digital skills at all levels, President von der Leyen of the European Commission announced during the State of the Union address in 2022 that 2023 would be designated as the **European Year of Skills**²³. This decision was made to emphasize the importance of individuals acquiring the necessary skills through education and upskilling for quality employment, to address labour market mismatches, to aid businesses in addressing the shortage of skilled workers, including by attracting the right skills to our continent, and to unify efforts at EU level to enhance the skills - including digital skills - of EU citizens. The European Year of Skills²⁴ will pursue four main objectives:

- Promoting investment in training and upskilling, enabling people stay in their jobs or find new ones.
- Ensuring skills match the needs of employers, by closely cooperating with social partners and companies.
- Matching people's aspirations and skill sets with opportunities on the job market, especially for the green and digital transition and the economic recovery.
- Attracting people from outside the EU with the skills needed.

1.2 Overall outlook based on DESI digital skills indicators

The Digital Skills Dimension of DESI 2023 includes two groups of indicators, one describing the digital skills of the population, the other describing highly skilled digital workforce, in line with the targets of the Digital Decade²⁵.

²¹ This target is also included in the European pillar of Social Rights Action Plan.

²² Council Resolution on a strategic framework for European cooperation in education and training towards the European Education Area and beyond (2021-2030) 2021/C 66/01.

²³ Available at: https://state-of-the-union.ec.europa.eu/index_en

²⁴ https://year-of-skills.europa.eu/index_en

²⁵ For details on DESI 2023 methodology and indicators, including indicator's codes: "Digital Decade Digital Economy and Society Index (DESI) 2023 Methodological Note" SWD (2023) 574 (<https://digital-strategy.ec.europa.eu/en/news-redirect/798352>).

Table 1 DESI 2023 digital skills indicators grouped into two classes: 1a Basic and advanced skills; 1b Highly skilled digital workforce.

	EU DESI 2023	EU 2030 target
1a1 Internet use	89%	
% individuals	2022	
1a2 At least basic digital skills	54%	80%
% individuals	2021	
1a3 Above basic digital skills	26%	
% individuals	2021	
1a4 At least basic digital content creation skills	66%	
% individuals	2021	
1a5 Enterprises providing ICT training	22%	
% enterprises	2022	
1b1 ICT specialists	4.6%	20 million
% individuals in employment aged 15-74	2022	~10%
1b2 ICT graduates	4.2%	
% graduates	2021	

Source: DESI 2023, European Commission. Indicators' description and details in DESI 2023 methodological note²⁶. Indicators and 2030 targets of the Digital Decade Policy Programme are highlighted. 80% of individuals with at least basic digital skills and 20 million of ICT specialists in employment, corresponding to approximately 10% of total employment, both by 2030.

1.3 Basic and advanced skills

1.3.1 At least basic digital skills

Almost one European out of two does not have the basic digital skills needed to access the opportunities offered online such as obtaining information from public authorities, using online banking, shopping online, or other selected activities related to internet or software use for work, learning and participating in society.

Digital skills are measured via a Eurostat indicator that refers to the five digital competences of the EU Digital Competence Framework (DigComp): information and data literacy skills, communication and collaboration skills, digital content creation skills, safety skills and problem-solving skills. All competences are assessed from a digital point of view²⁷To reach at least basic digital skills, people must know how to do at least one activity related to each digital competence. No recent data is available in this area and many measures already undertaken by Member States are therefore not reflected in available data. As reported in the 2022 DESI exercise, which contains the latest available data, in 2021, only 54% of the adult population of the European Union had at least basic skills, still far from the DDPP 2030 target of 80%. Differences among countries are stark: the Netherlands and Finland were close to reaching the target with 79% of adults with at least basic digital skills in 2021. However, in eight Member States the share of individuals with at least basic digital skills was lower than 50%, with Romania, Bulgaria, Poland, and Italy ranking the lowest.

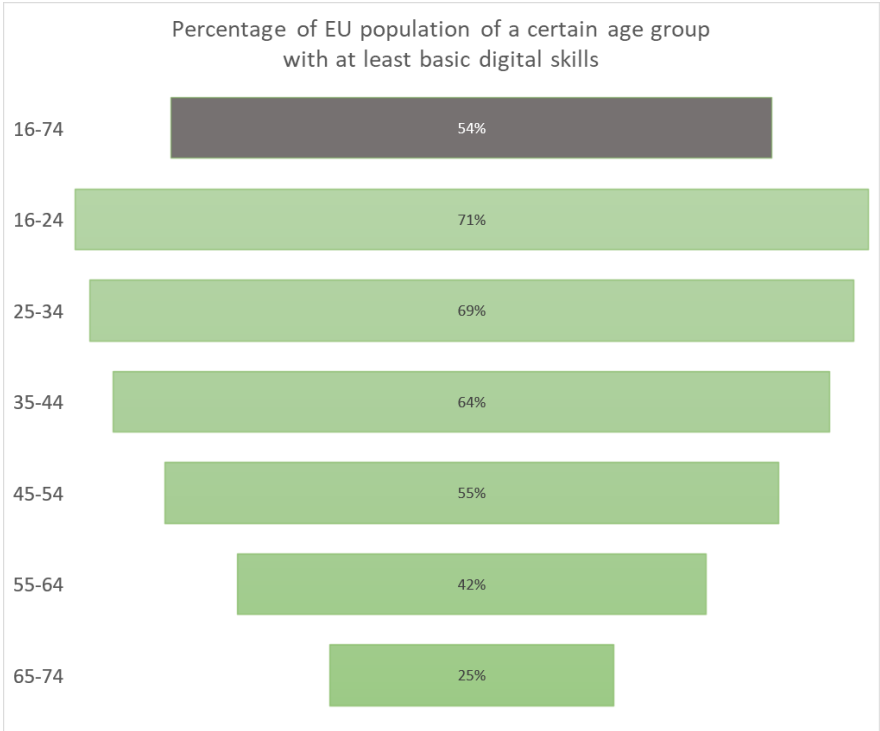
²⁶ "DESI 2023 methodological note", SWD(2023) 574: <https://digital-strategy.ec.europa.eu/en/news-redirect/798352>

²⁷ The list of questions can be consulted here under Section 4.1 "Data description": https://ec.europa.eu/eurostat/cache/metadata/en/isoc_sk_dskl_i21_esmsip2.htm

Socio-demographic factors influence the levels of digital skills. For example, 71% of young adults (aged 16-24), 79% of individuals with high formal education, and 77% of higher education students had at least basic digital skills. By contrast, only 35% of those aged 55-74 and 29% of retired and inactive citizens had at least basic digital skills. The gap between the digital skills of the rural population and those of urban areas was still substantial: only 46% of individuals living in rural areas had at least basic digital skills compared to people living in the predominantly urban areas (61%).

The analysis by age groups at the EU level shows that the digital skills gap is particularly important for older age groups (Figure 1). Slightly more than half of the EU population (54%) had at least basic digital skills in 2021, but the percentage decreases in older age-cohorts. Amongst the elderly aged 65-74, only one in four (25%) were classified as having at least basic digital skills²⁸. Significant differences remained between Member States. Digital reskilling efforts are needed and may prove to be particularly challenging for the oldest age groups. This makes the 2030 target in basic digital skills even more distant if specifically designed initiatives targeting the older age groups are not put in place.

Figure 1: Percentage of the EU population with at least basic digital skills by age groups (reference year 2021)

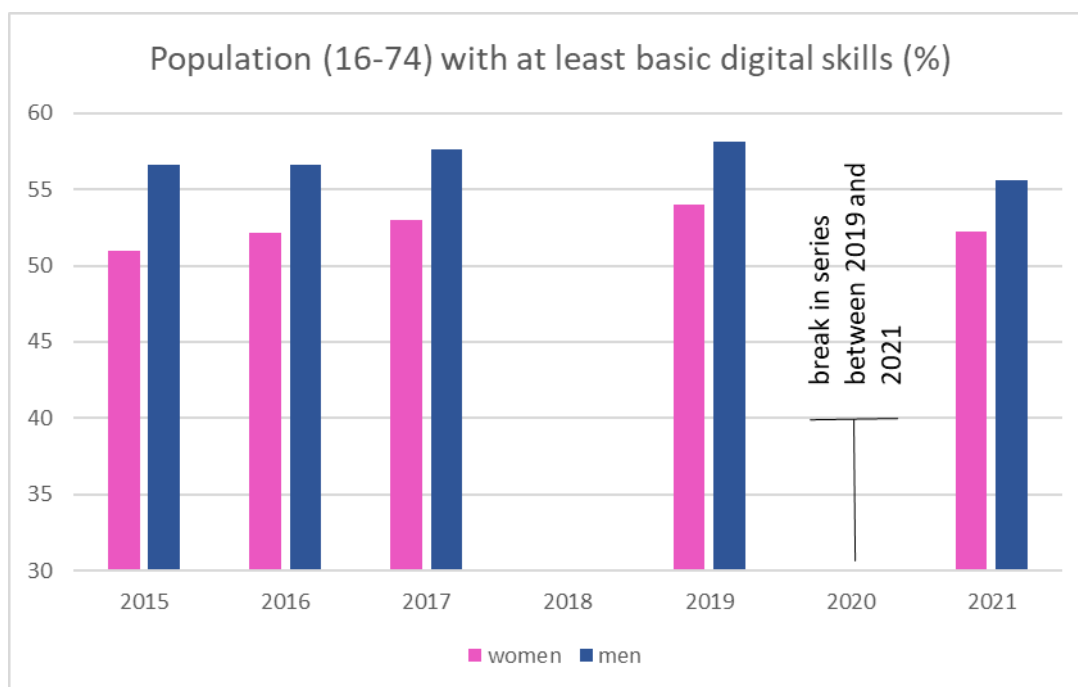


The gap between men and women's digital skills has continued to decrease in recent years, with the difference in percentage of men and women with basic skills dropping from 5.6 percentage points in 2015 to 3.4 percentage points in 2021 (Figure 2)²⁹.

²⁸ For a more sophisticated analysis of the groups affected by the digital divide please see [Centeno et al, 2022](#).

²⁹ The methodology to collect digital skills indicators has been changed substantially between 2019 and 2020 to better capture the rapid technological changes of the ICT landscape. A new Digital Skills Indicator (DSI) was introduced in 2022 based on the European Commission’s Digital Competence Framework 2.0. The methodology was updated by the Joint Research Centre of the European Commission and the Information Society Statistics Working Group with Member State representatives. The changes include variation in the mode of data collection due to the Covid pandemic from face-to-face to telephone or online interviews; changes in the sampling of some countries; and the inclusion of a fifth dimension of digital skills on safety (the DSI now

Figure 2: Percentage of individuals aged 16-74 with at least basic skills in the EU by sex (from 2015 to 2021). Left-hand side: percentage of women; right-hand side: percentage of men. Source: Eurostat, EU survey on the use of ICT in households and by individuals.



1.3.2 More advanced skills, internet use and in-job training

In 2021, 26% of EU individuals had above basic digital skills³⁰. This means that they scored above basic in all five digital competences. Having above basic digital skills is important both to increase competitiveness in the labour market and to enable the take-up of digital solutions in business.

As reported in the 2022 DESI exercise, different levels of individuals' skills in digital content creation were observed in 2021 across Europe. The competence of digital content creation is considered here as the most relevant one in terms of labour market needs, as it includes among other skills using advanced features for data analysis and writing code in a programming language³¹. The Netherlands

measures: Information and data literacy; Communication and collaboration; Digital content creation; Safety and Problem solving). More info in: [Vuorikari et al, 2022\(a\)](#) and [Vuorikari et al. 2022\(b\)](#).

³⁰ The digital skills sub-dimension of DESI includes other basic indicators in addition to the at least basic digital skills one, that is one of the DD KPIs. DESI is in fact a composite index providing a metric for the multiple facets of the level of digitisation of the EU and its Member States. To this aim, its dimensions and sub-dimensions are populated by different observable indicators, each describing a slightly various aspects of the very same latent concept. In a well-constructed composite index, the ensemble of the indicators included helps providing a more complete picture of the concept to measure. The skills sub-dimension includes, in addition to the headline indicator "at least basic digital skills", indicators describing more advanced skills – percentage of people having "above basic digital skills" and "at least basic digital content creation skills", the "frequency of internet use" and the share of "enterprises providing ICT training".

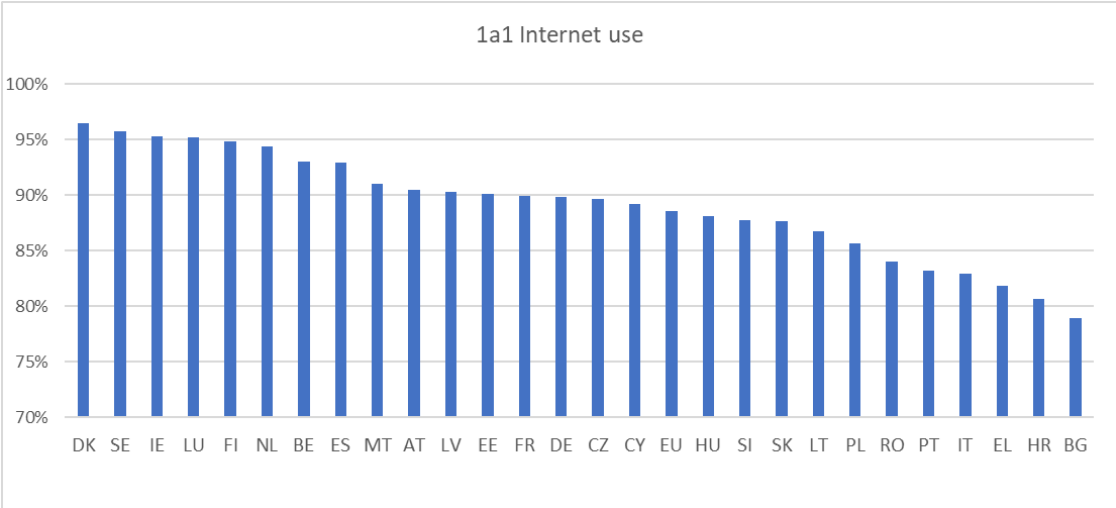
³¹ The list of activities in the digital content creation area is: Using word processing software; Using spreadsheet software.

Editing photos, video or audio files; Copying or moving files (such as documents, data, images, video) between folders, devices (via e-mail, instant messaging, USB, cable) or on the cloud; Creating files (such as documents, image, videos) incorporating several elements such as text, picture, table, chart, animation or sound; Using advanced features of spreadsheet software (functions, formulas, macros and other developer functions) to organize, analyse, structure or modify data and Writing code in a programming language.

and Finland lead in at least basic digital content creation skills, closely followed by Croatia and Luxembourg with scores above 80%. Romania and Bulgaria have the lowest percentage of individuals reporting at least basic digital content creation skills in 2021.

In 2021, over one in four (26%) EU citizens indicated being worried about the difficulty of learning new digital skills to take an active part in society, like working or studying online and online voting. At the same time, more than eight in ten Europeans (81%) indicated thinking that digital tools and the internet will be important in their lives by 2030³², illustrating the growing importance of the internet in our societies. In 2022, regular internet users stood at 89%, meaning those who used internet at least once a week, including those using it every day (Figure 3), with an increase of 10 percentage points in six years (79% in 2017). The highest share of internet users was recorded in Denmark and Sweden with 96% of individuals, closely followed by Ireland, Luxembourg, and Finland with 95%. In 2022, Bulgaria (79%) Croatia (81%) and Greece (82%) reported the lowest rates of regular internet users in the EU.

Figure 3: Internet Use: Once a week, including every day (% of all individuals), 2022. Source: Eurostat, EU survey on the use of ICT in households and by individuals

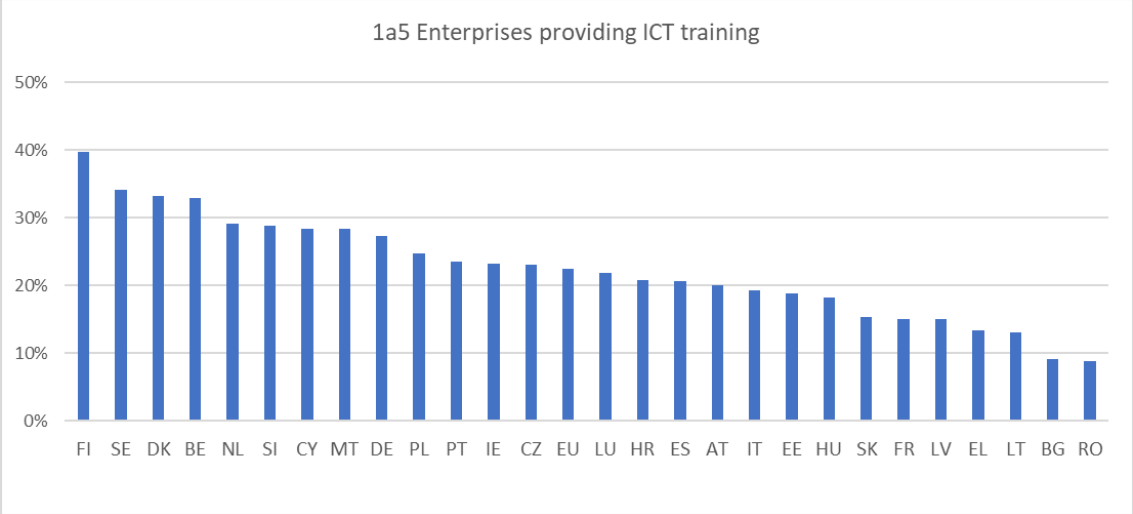


Training is also crucial to equip or enhance employees with ICT skills. In 2022, 1 out of 5 enterprises provided ICT training to their personnel (22%), a value that has remained stable since 2017 (21%). The value reached among large enterprises - 70% - was in 2022 more than three times higher than that of Small and Medium Enterprises (SMEs), 21%, which represent the largest share of the non-financial business sector in the EU. However, in the information and communication sector more than 65% of enterprises provided ICT training to their employees in 2022, an increase from 63% in 2017.

Given the transversal role of digital competences in the economy, the ICT training of the workforce plays a key role in all the different sectors of the EU economy.

³² Source: Special Eurobarometer Report on Digital Rights and Principles, n. 518, 2021

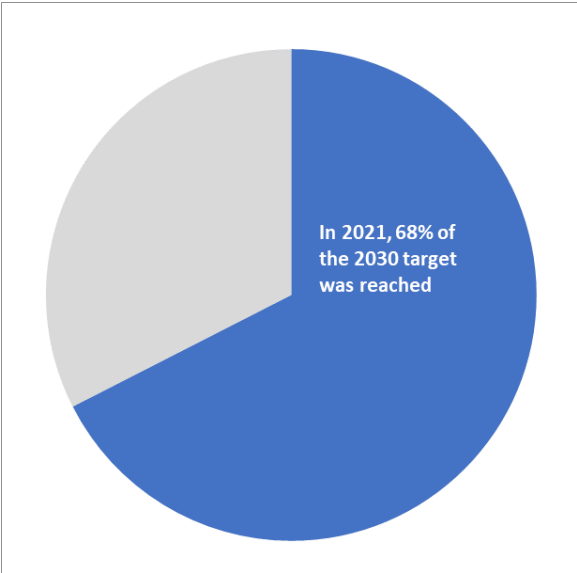
Figure 4: Percentage of enterprises providing ICT training, year 2022 (all activities except the financial sector). Source: Eurostat, EU survey on the usage of ICT in enterprises



1.3.3 At least basic digital skills: trends towards 2030

By 2021, the EU reached only 68% of the objective of the Digital Decade in digital skills – that is having 80% of people equipped with at least basic digital skills – demonstrating an insufficient pace of progress to reach the 2030 target. In four years, between 2015 and 2019, the percentage of the population with at least basic digital skills in the EU increased only by 2.4 percentage points, which makes reaching the 80% target in approximately seven years unrealistic without massive investments and policy interventions (see also Figure 6)³³.

Figure 5: Percentage of people in the EU with at least basic digital skills (year 2021). The whole circle represents the 2030 target of which the blue part is the level already achieved by the EU, according to the latest available data point, while the grey part represents the gap.



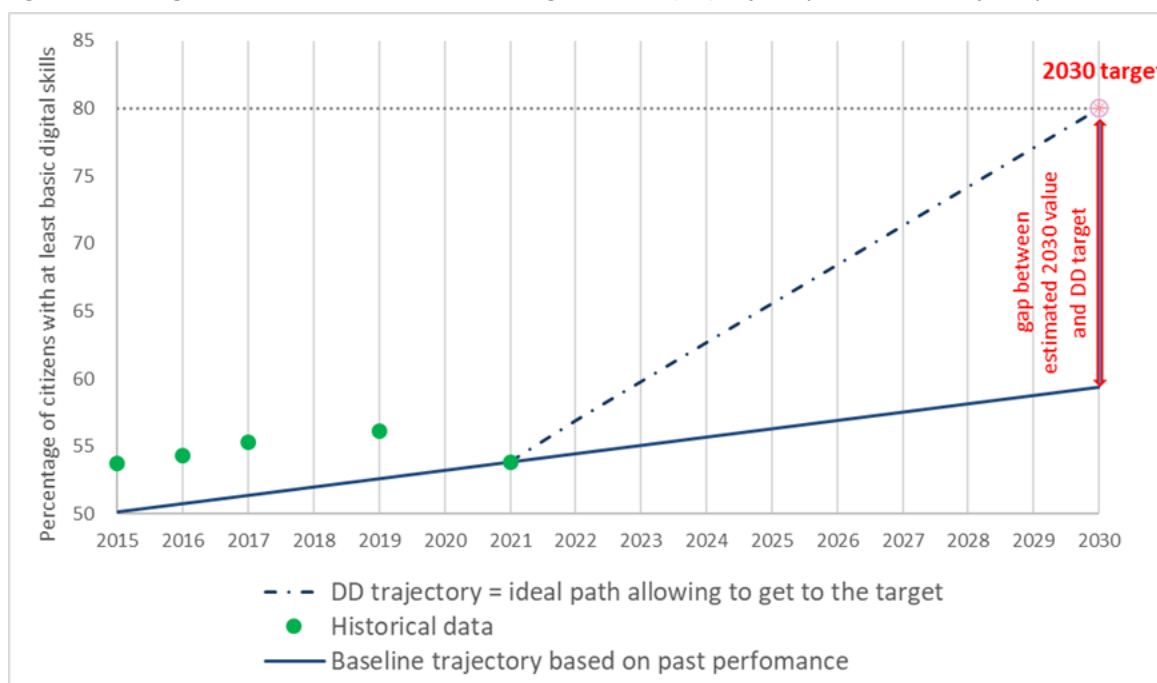
According to the baseline trajectory, in 2030 approximately 60% of the population would have at least basic digital skills, corresponding to a projected business-as-usual growth of 11% from 2021 to 2030.

³³ Full comparison with previous year is not possible due to the methodological revision that took place between 2019 and 2020.

The Digital Decade and baseline trajectories for the skills KPI are based on the linear functional form. The assumption is that the basic digital skills 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 on the historical time series until 2019 (included) and then adjusted to correct for the break in series. Figure 6 shows the available historical data, the Digital Decade and baseline trajectories of the KPI. According to the baseline trajectory, in 2030 approximately 60% of the population is estimated to have at least basic digital skills, corresponding to a growth of only 11% in the next seven years. The 2030 estimate stands at 20 percentage points below the target³⁴.

To progress from 54% to 80% of digitally skilled citizens in the population, the basic skills KPI should overall grow by 48% from now to the end of the decade, a much higher rate than the one estimated under a business-as-usual scenario (11%) This means accelerating the growth of the business-as-usual scenario by more than four times. The target is not expected to be met without significant reinforced investments and policy interventions.

Figure 6: Basic digital skills in the EU. Historical data, Digital Decade (DD) trajectory and baseline trajectory towards 2030



³⁴ Digital Decade and baseline trajectories are presented in the “Communication from the Commission establishing Union-level projected trajectories for the digital targets” [C\(2023\) 7500](#)

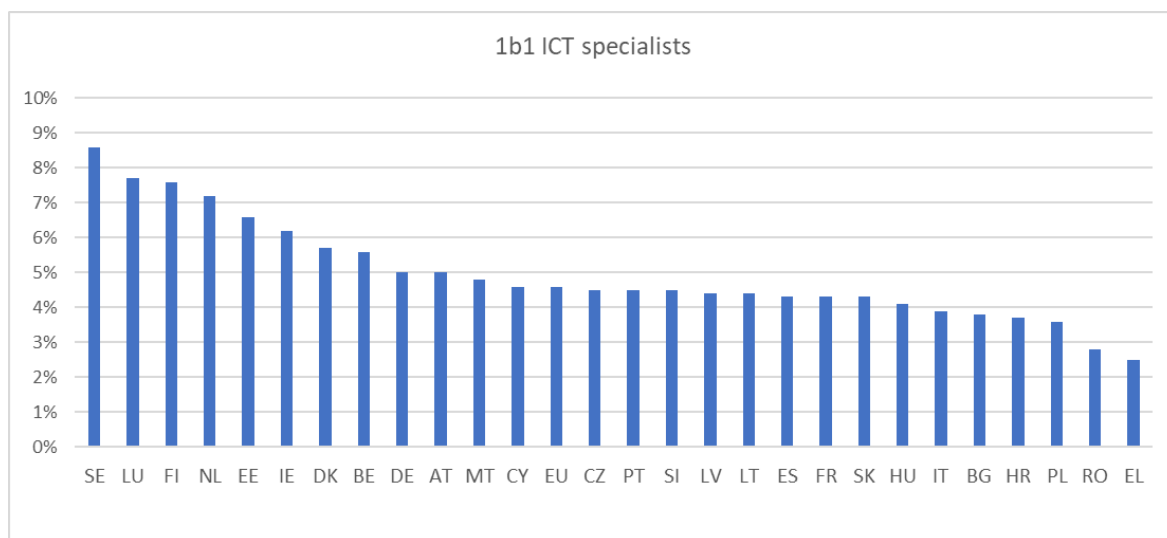
1.4 Highly skilled digital workforce

1.4.1 ICT specialists in employment

The introduction of new technologies and digitalisation continues to impact our society through changes in the way that people live, work, and interact with one another. Digital technologies and services have already been the cause of significant changes in methods of production and patterns of employment within the EU. Tracking developments and setting milestones for ICT specialists is therefore crucial as these influence a country's comparative advantage in the development, installation and servicing of digital technologies and services, all necessary conditions to foster competitiveness and productivity.

Despite the sustained growth over the last 10 years, the total number of ICT specialists in employment was 9.37 million across the entire EU in 2022, falling short by more than 10 million of the 2030 target at the EU level (20 million). To allow comparisons amongst countries, it is important to note that the 20 million target corresponds to approximately 10% of the workforce by 2030 while the 2022 value in the EU corresponds to 4.6% of total employment. The phenomenon is heterogeneous across the EU countries, with Sweden, Luxembourg, Finland and the Netherlands all having a percentage of ICT specialists in employment in between 7.2% and 8.6%; whilst in Italy, Bulgaria, Croatia, Poland, Romania and Greece the percentage was below 4% in 2022 (Figure 7).

Figure 7: ICT specialists in employment as percentage of total employment. Reference year 2022. Source: Eurostat, Labour Force Survey

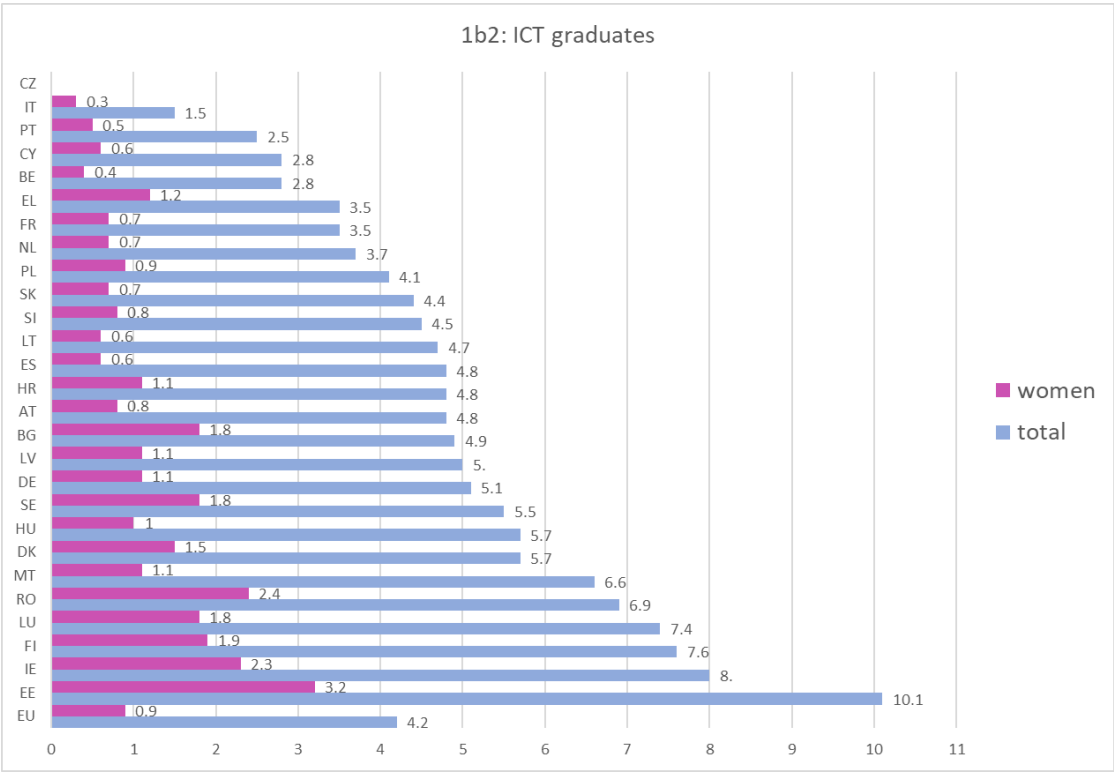


1.4.2 ICT graduates

ICT graduates are essential in meeting the growing labour market demand for ICT specialists, as the number of ICT specialists in employment in the EU grew by 58% from 2012 to 2022 in the EU, almost six times as high as the increase (9%) of total employment.. ICT graduates play a critical role in digital transformation, especially in the most advanced technologies like Big Data, AI and cybersecurity. **In 2021 only 4.2% of all the graduates focused on ICT subjects (Tertiary education levels ISCED: 5-8), an increase of only 0.8 percentage points in five years (it was 3.4% in 2016).** The highest shares were recorded in 2021 in Estonia, Ireland, Finland, and Luxembourg, all with percentages equal or above 7.4%; while Italy, Portugal, Cyprus, and Belgium all had values lower than 2.8% (Figure 8). The percentage of women graduates in ICT is much lower than that of men across all EU countries. In 2021, only one in five ICT graduates were women (0.9% out of 4.2% of all the graduates in the EU in 2021). Even the best performers struggle to have more female graduates in ICT, highlighting the

significant gender disparity. Furthermore, critical sectors like cybersecurity continue to fail to attract women, with only 20% of cybersecurity graduates being women.³⁵

Figure 8: Graduates in ICT subjects as % of total graduates (source: Eurostat, year 2021, Tertiary education levels ISCED: 5-8). No values for Czechia in 2021.

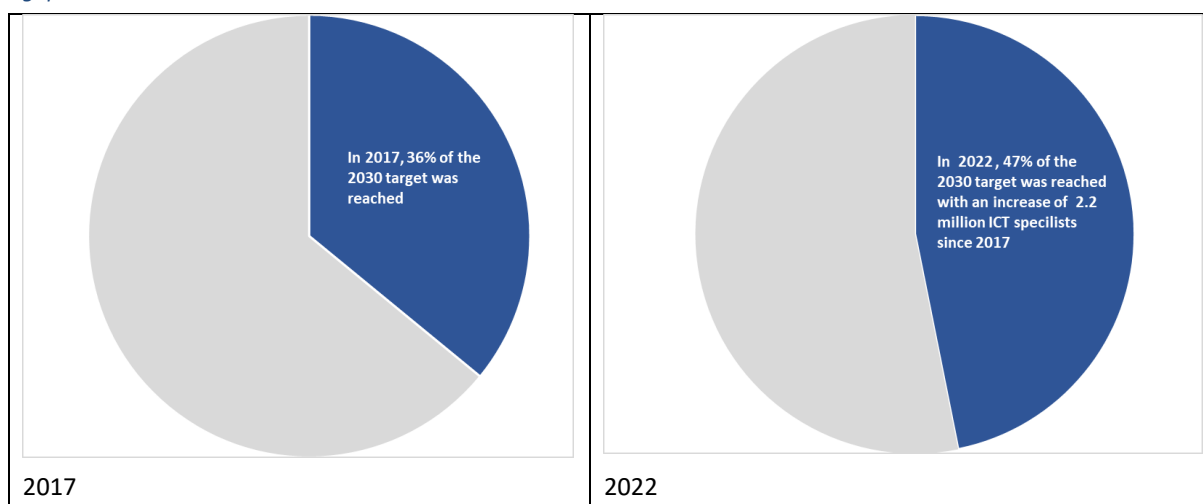


1.4.3 ICT specialists in employment: trends towards 2030 targets

The number of ICT specialists in the EU reached 9.4 million in 2022 corresponding to 4.6% of total employment. However, in the past six years, the number of employed ICT specialists grew by a mere 2.2 million people, from 7.2 million in 2017 to 9.4 million in 2022 that is less than the half of the 20 million target for the EU in 2030 (Figure 9). At the current growth rate, the EU will fall substantially short of the target set for 2030.

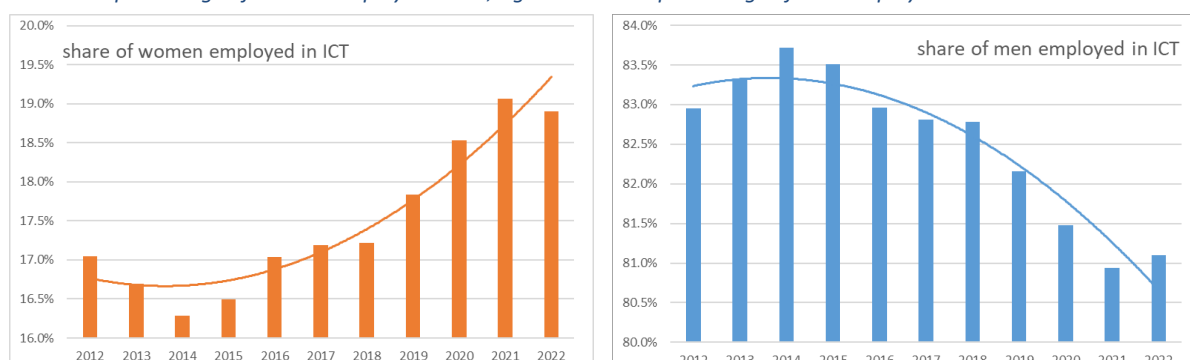
³⁵ Cybersecurity Higher Education Database (CyberHEAD)

Figure 9: Total number of ICT specialists (in million) in employment in the EU since 2017. The circle represents the 2030 target of which the blue part is the level achieved by the EU in 2017 (left) and 2022 (right), while the grey part represents the gap.



In 2022, the gender gap in ICT specialists was still substantial with only 19% of the total ICT workforce being made up of women. In the past decade, there have been consistently more men than women (about five men for each woman), with the women’s percentage being between 16% and 19% and the men’s one between 81% and 84% (Figure 10, please note that the charts for women and men have different scales). Despite a small dip between 2013 and 2015, the percentage of women in ICT employment has risen at a slow pace since 2012 (Figure 10, left). In the same period, the percentage of men employed in ICT has decreased since its peak in 2014-2015 but remains significantly higher than the percentage of women in the sector, on average almost 5 times higher (Figure 10, right). To increase the number of women in the ICT field, all EU Member States would need to take action to promote their access to this field.

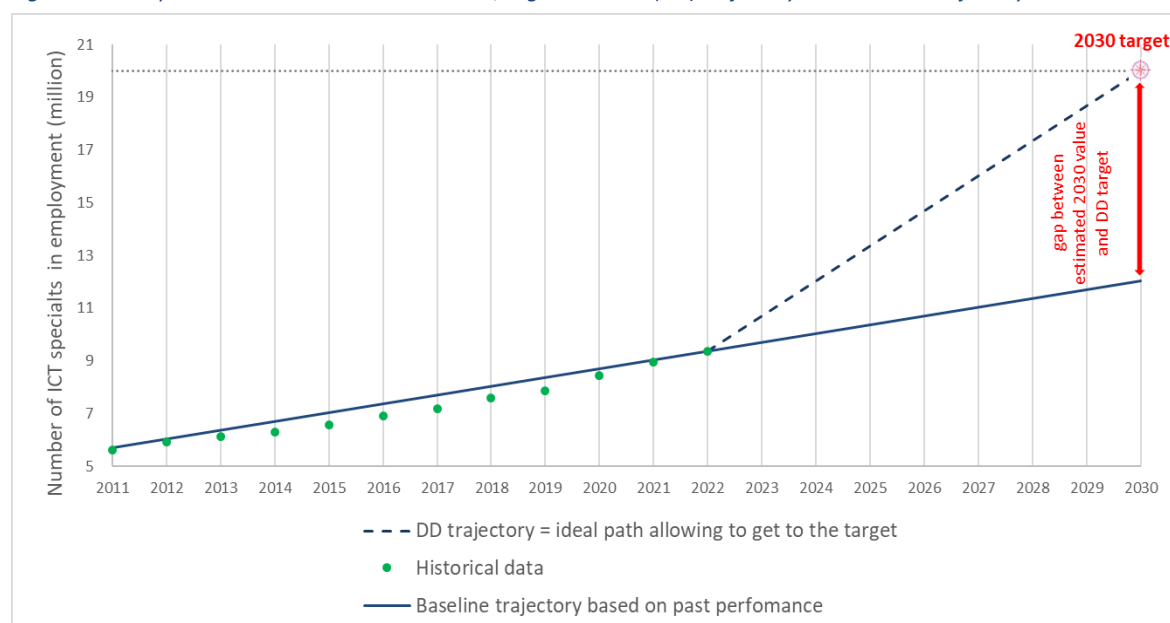
Figure 10: Percentage of individuals employed in ICT in the EU by sex. The solid lines show the time trend since 2012. Left-hand side: percentage of women employed in ICT; right-hand side: percentage of men employed in ICT.



In the case of the ICT specialists' KPI, the DD trajectory is assumed to be a straight line connecting the 2021 value, the most recent available data point, with the 2030 target. The baseline trajectory is based on the linear functional form based on the historical data (all available years included). The assumption is that the KPI follows an increasing trend with a constant rate over the whole period³⁶.

The DD trajectory is shown in Figure 11 together with the historical data and the baseline trajectory. The time series shows a moderate acceleration in the trend of the number of ICT specialists in the past three years, with a slightly higher average growth than in the previous decade (6.0% between 2020 and 2022 compared to 4.2% between 2011 and 2019). **However, according to the current trend, the number of ICT specialists in the EU will be around 12.0 million, with an estimated growth of 29% until 2030.** Given that the number of ICT specialists was 9.4 million in 2022, **the EU would need to more than double the number of ICT specialists to close the gap with the DD target.** Without further interventions in the sector, the EU is not expected to meet the 2030 target.

Figure 11: ICT specialists in the EU. Historical data, Digital Decade (DD) trajectory and baseline trajectory towards 2030



³⁶ Digital Decade and baseline trajectories are presented in the “Communication from the Commission establishing Union-level projected trajectories for the digital targets” [C\(2023\) 7500](#)

1.5 Actions and initiatives

1.5.1 Action at country level

1.5.1.1 *Structured Dialogue on Digital Education and Skills: cross-country synthesis of the main current and emerging themes and trends occurring at Member State level*

In the **2021 State of the Union address**, Commission President von der Leyen stressed that digital education and skills “*need leaders’ attention*” and launched the **Structured Dialogue on digital education and skills** to support Member States with an integrated, coherent, and more ambitious approach³⁷. The Structured Dialogue was carried out in 2022 as a process of exchange regarding digital education and skills between the European Commission and Member States and further confirmed the high political importance accorded by Member States to the need for taking **action**.

Many important initiatives and policies exist in the Member States contributing to achieving the common goals of the Digital Decade. In terms of digital skills investments at national level, Cosgrove et al. (2023)³⁸ recently conducted a thematic analysis on the **Structured Dialogue** with Member States on Digital Education and Skills, which confirms that all Member States had been engaging in digital skills training initiatives **outside of formal education settings** over the past number of years. This includes initiatives related to the provision of general digital skills (e.g., via public employment services and national Digital Skills and Jobs Coalitions), targeted upskilling and reskilling initiatives (e.g., targeted towards staff in SMEs and the unemployed, civil servants, the elderly, migrants and refugee groups, etc.) as well as the provision of **advanced digital skills training** (e.g., advanced trainings in cybersecurity for public administration staff). In terms of formal education, the report also showed that several Member States are currently designing their **curricular reforms** to make sure that digital skills become part of the curriculum at primary and secondary school level as well. In addition, some Member States have made efforts to match **vocational education and training (VET)** curricula to labour market needs (with digital skills being central to these reforms) and supporting teachers to build digital skills (e.g., via online learning, digital education platforms, massive open online courses). Several Member States are also implementing programmes at **higher education level** to teach students either general digital skills, or to increase the provision of advanced or specialist digital skills. Some countries also introduced more general digital skills courses into non-ICT disciplines at higher education level. However, as identified by the Structured Dialogue, the issue of increasing ICT graduates from higher education is not solely a matter of increasing course places, but also entails identifying barriers and solutions to course intake numbers and graduation rates, including the labour market ‘pull’ of ICT students to work in the private ICT sector before course completion. Moreover, to further address the **shortage of ICT specialists**, initiatives at Member State level also include the creation of shorter/more flexible courses to adapt to the varying needs of learners as well as subsidised courses (some via public-private partnerships). Moreover, many initiatives at Member State level aim to achieve **gender equality**, ranging from multi-year programmes targeted towards girls and women in disadvantaged communities and industry-led mentoring programmes, to information days and awareness raising. Furthermore, in several countries **digital skills certification** has been implemented or is currently under development.

³⁷ Available at: <https://education.ec.europa.eu/focus-topics/digital-education/action-plan/action-1>

³⁸ Cosgrove, J., Tsotsou, I., Cachia, R., Centeno, C., Sala, A., Punie, Y., Thematic analysis in support of the Staff Working Document for Council Recommendations: Improving the provision of digital skills in education and training, and Digital education – enabling factors for success, JRC Science for Policy Report, 2023, available as Annex 3 to the Commission Staff Working Document SWD(2023) 205 final, available here: [deap-swd-digital-skills-180423_en.pdf \(europa.eu\)](https://ec.europa.eu/eip/eip-skills-180423_en.pdf).

Several Member States are also developing or implementing **microcredentials** and individual learning accounts in Higher and Vocational Education contexts, and many Member States use multiple data sources to produce **labour market forecasting**.

1.5.1.2 Recovery and Resilience Facility (RRF) expenditure dedicated to digital skills

Several of the above-described initiatives at national level are included in the digital components in Member States' national Recovery and Resilience Plans under the **RRF**. In fact, **around 18% of the RRF expenditure contributing to digital objectives (EUR 23 billion) is dedicated to digital education and digital skills development**. Furthermore, out of the EUR 117 billion expected to contribute to the Digital Decade targets, EUR 13.9 billion is considered relevant for at least basic digital skills and EUR 9.2 billion for ICT specialists²³. More concretely, the study by Cosgrove et al. (2023)³⁹, which also analysed the key themes emerging from RRF national plans⁴⁰, showed that digital skills **provision outside formal education** was the topic with the highest frequency of RRF investments and was complemented by a large number of reforms, which were mostly targeted at the labour market in general; businesses and in particular SMEs; government; or citizens more generally. Reforms related to digital skills provision in **formal education** included **curricular reforms** at primary and secondary level and reforms in the Higher Education Sector (e.g., increasing course places adapting both course content and structure, etc.). Slovakia, for instance, plans to update school curricula and learning materials to include digital skills and teach computational thinking. Italy will review its active labour market policies to also encourage job seekers to acquire green and digital skills, among others. Moreover, **investments** in the provision of digital skills in formal education were also included in a several national recovery and resilience plans. Concrete RRF investments⁴¹, for example:

- A measure in the **Latvian** plan aimed at significantly increasing the number of specialists with advanced digital skills, consisting of developing approximately 20 training modules in advanced digital skills for technologies such as quantum, high performance computing, and language technologies. This training module will be included in higher education programmes as well as educational programmes for professionals in enterprises, reaching approximately 3000 participants in total.
- A measure in the **Spanish** plan aimed at increasing the digital skills for employment structured along three pillars. The first pillar entails digital skills for the employed and unemployed, in particular youth. The second pillar includes a digital training programme for public administrators whereas the third pillar includes training programmes for managers and experts in SMEs, with a focus on increasing the number of female managers and workers in ICT sectors. The investment is expected to reach at least 450.000 people.
- A measure in the **Finnish** plan has the aim of increasing basic cybersecurity skills of the general population, by funding a research project to collect and summarise information on all EU Member States on how each country trains its citizens in basic cybersecurity. The research

³⁹ Cosgrove, J., Tsotsou, I., Cachia, R., Centeno, C., Sala, A., Punie, Y., Thematic analysis in support of the Staff Working Document for Council Recommendations: Improving the provision of digital skills in education and training, and Digital education – enabling factors for success, JRC Science for Policy Report, 2023, available as Annex 3 to the Commission Staff Working Document SWD(2023) 205 final, available here: [deap-swd-digital-skills-180423_en.pdf \(europa.eu\)](https://ec.europa.eu/economy_finance/deap-swd-digital-skills-180423_en.pdf).

⁴⁰ Please note that this analysis did not take into account the magnitude of investments.

⁴¹ Several of the following RRF measures were included in the thematic analysis on digital skills and education in the Recovery and Resilience Scoreboard (2022), available here: https://ec.europa.eu/economy_finance/recovery-and-resilience-scoreboard/assets/thematic_analysis/scoreboard_thematic_analysis_digital_skills.pdf.

project then uses this information to create a common digital platform for teaching and developing cybersecurity skills.

- A measure in the **Romanian** plan to enhance the basic digital skills of citizens living in disadvantaged communities (targeting 100.000 citizens) consists of the reconversion of 105 libraries in communities with marginalised groups into hubs for the development of digital skills is underpinned by additional funds for 1030 libraries to change/upgrade their IT equipment.
- A measure in the **Portuguese** plan, where the National Cybersecurity Centre (Centro Nacional de Cibersegurança) is using RRF to develop an advanced training programme in cybersecurity for public administration and the private sector. The initiative, “C-Academy”⁴², is part of a broader investment to strengthen the overall cybersecurity framework in the country. The C-Academy will offer approximately 44 training courses, with the participation of almost all universities and polytechnics. In addition, the programme will provide certification, including through micro-credentials.

1.5.1.3 Selection of good practices in digital skills shared on the Digital Skills and Jobs Platform

The Digital Skills and Jobs Platform is home to the Digital Skills and Jobs Coalition and the entire digital skills community. It brings together relevant information and resources to support stakeholders in their work on closing the digital skills gap in Europe.

Table 2 includes a selection of good practices in digital skills taking place at regional or Member State level during the year of 2022. Those good practices were shared on the [Digital Skills and Jobs Platform](#)⁴³, tackling several digital skills levels, and have the potential to be replicated in other countries and different contexts. It is important to note that the scale of initiatives (e.g. number of participants, geographic scope) varies across these examples.

Table 2: Selection of good practices by Member State

Country	Short description of good practice	Digital skills level/ target
Belgium	Be Digital Together: an initiative to tackle the gender gap and promote the recruitment of women in ICT, or other sectors calling for workers with sound digital skills, and female entrepreneurship. It also offers an online platform with training and upskilling programmes. ⁴⁴	Basic, intermediate, advanced, digital expert, gender convergence
Bulgaria	Digital National Alliance: the project promotes digital skills and technology in schools and issues a Digital School of the Year Award. ⁴⁵	Basic
Czech Republic	Computer at School: a yearly conference that brings together mainly teachers from primary and secondary schools to promote the effective use of digital technologies in education. ⁴⁶	Basic, intermediate
Denmark	Digital Hub Denmark: a portal for the technology industry also including an introduction to a series of topics, useful to anyone interested in studying, working, and living in Denmark with a special	Advanced, digital expert

⁴² CNCS - C-Academy

⁴³ <https://digital-skills-jobs.europa.eu/en>

⁴⁴ <https://digital-skills-jobs.europa.eu/en/inspiration/good-practices/be-digital-together-belgium>.

⁴⁵ <https://digital-skills-jobs.europa.eu/en/inspiration/good-practices/digital-national-alliance-bulgaria>.

⁴⁶ <https://digital-skills-jobs.europa.eu/en/inspiration/good-practices/conference-computer-school>.

	focus on technology. ⁴⁷	
Germany	AI Campus: a free digital platform with a selection of courses on AI with the objective to build networks between learners, training providers of AI courses, and educational experts. It has successfully built a nation-wide (and global) ecosystem of relevant players in the digital field. ⁴⁸	Basic, intermediate, advanced, digital expert
Estonia	Digital Competence Initiative: a clear and simple competence model for school students including assessment criteria, self-assessment surveys, a digital technology glossary and digital learning scenarios. ⁴⁹	Basic, intermediate, advanced
Ireland	Skills to Advance: an initiative offering upskilling and reskilling opportunities to those with little or no digital skills, who now find themselves in need of new skills to progress and perform their job to the best of their ability. ⁵⁰	Basic, intermediate, advanced
Greece	Counselling, training, and certification in ICT for 1.600 unemployed ICT graduates between the ages of 25 and 29. ⁵¹	Intermediate, advanced, digital expert
Spain	Junta Andalucía: a training programme with an integrated curriculum for cloud computing, available in 105 vocational training centres to train around 6000 students in Andalusia. ⁵²	Intermediate, advanced
France	PIX: an online platform which provides an accessible self-assessment tool allowing learners to assess their digital understanding and proficiency and offers online tutorials for further upskilling as well as subsequent digital skills certification. ⁵³	basic, intermediate, advanced, digital expert
Italy	Girls Code it Better: an initiative focusing on girls in secondary education and on boosting their interest towards digital and innovation-related topics through a course delivered during extracurricular afternoon classes. ⁵⁴	Basic, intermediate, gender convergence
Cyprus	Institute for the future (IFF): a research centre at the University of Nicosia which focusses on blockchain and AI. It is the leading formal education institution on blockchain and accepts bitcoin as payment for tuition fees. ⁵⁵	Basic, intermediate

⁴⁷ <https://digital-skills-jobs.europa.eu/en/inspiration/good-practices/digital-hub-denmark>.

⁴⁸ <https://digital-skills-jobs.europa.eu/en/inspiration/good-practices/ki-campus-germany>.

⁴⁹ <https://digital-skills-jobs.europa.eu/en/inspiration/good-practices/digital-competence-initiative-estonia>.

⁵⁰ <https://digital-skills-jobs.europa.eu/en/inspiration/good-practices/skills-advance-ireland>.

⁵¹ <https://digital-skills-jobs.europa.eu/en/inspiration/good-practices/counselling-training-certification-ict-unemployed-young-people-greece>.

⁵² <https://digital-skills-jobs.europa.eu/en/inspiration/good-practices/junta-andalucia-integrated-curriculum-cloud-computing>.

⁵³ <https://digital-skills-jobs.europa.eu/en/inspiration/good-practices/pix-france>.

⁵⁴ <https://digital-skills-jobs.europa.eu/en/inspiration/good-practices/girls-code-it-better-italy>.

⁵⁵ <https://digital-skills-jobs.europa.eu/en/inspiration/good-practices/institute-future-iff>.

Latvia	Smart Latvia: An initiative to support SMEs in their digital transformation by promoting digital skills and understanding of digital technologies, including an in-depth assessment of a company's digital maturity level. ⁵⁶	Basic, intermediate
Luxembourg	Digital Learning Hub: the initiative is open to everyone of adult age and hosts training courses in the field of IT, including coding, cybersecurity, blockchain and design thinking. ⁵⁷	Basic, intermediate, advanced
Hungary	Code your future!: the project offers an internship programme for IT students with a mentoring scheme to increase the number of graduating students graduates in the field of IT. ⁵⁸	Advanced, digital expert
Malta	The SkolaSajf: this service offers children between the ages of 3 and 16 activities during the summer months in 57 centres. In 2022 fun robotics sessions were provided in 30 SkolaSajf Centres. ⁵⁹	Basic
Netherlands	Katapult: a nationwide network, which supports more than 450 public-private partnerships in the higher education and vocational training sector to bridge the gap between the skills that students develop at university, and the skills the labour market needs. ⁶⁰	Basic, intermediate, advanced, digital expert
Austria	Digital Pioneers: A digital year for women aged 17-27 interested in STEM professions including funded 8-week basic training and funded work on projects in a partner company for at least eight months. ⁶¹	Basic, intermediate, gender convergence
Poland	Digital School of Wielkopolsk@2020: a regional project with training for teachers and extra-curricular activities for students to improve the quality of education in 700 schools by 2023. ⁶²	Basic
Portugal	Digital literacy courses for people with intellectual and developmental disabilities for better employment opportunities. ⁶³	Basic, intermediate
Romania	First AI course for secondary school and high-school pupils developed by AI specialists to introduce young people to AI and encourage them to embark on tech careers. ⁶⁴	Basic, intermediate, digital expert
Slovenia	Female Engineer of the Year: an award to inspire young girls to choose engineering careers by providing role models and highlighting their	Advanced, digital expert, gender

⁵⁶ <https://digital-skills-jobs.europa.eu/en/inspiration/good-practices/digital-skills-knowledge-sharing-seminar-latvia>.

⁵⁷ <https://digital-skills-jobs.europa.eu/en/inspiration/good-practices/digital-learning-hub-luxembourg>.

⁵⁸ <https://digital-skills-jobs.europa.eu/en/inspiration/good-practices/internship-programme-it-students-mentoring-scheme>.

⁵⁹ <https://digital-skills-jobs.europa.eu/en/inspiration/good-practices/skolasajf-malta>.

⁶⁰ <https://digital-skills-jobs.europa.eu/en/inspiration/good-practices/katapulteu-netherlands>.

⁶¹ <https://digital-skills-jobs.europa.eu/en/inspiration/good-practices/digital-pioneers-austria>.

⁶² <https://digital-skills-jobs.europa.eu/en/inspiration/good-practices/digital-school-wielkopolsk-2020-initiative>.

⁶³ <https://digital-skills-jobs.europa.eu/en/inspiration/good-practices/digital-literacy-course-people-intellectual-and-developmental-disability>.

⁶⁴ <https://digital-skills-jobs.europa.eu/en/inspiration/good-practices/first-ai-course-pre-university-education-romania>.

	work. ⁶⁵	convergence
Slovakia	IT Fitness Test: a self-assessment test available on two difficulty levels targeting primary school pupils and teachers, high school and university students, and all citizens curious to assess and certify their digital skills level. ⁶⁶	Basic, intermediate
Finland	OdigO Project – Lapland: an accessible online programme for seniors to increase Lapland residents’ awareness of supporting the digital skills of adults and aging populations. ⁶⁷	Basic, intermediate, advanced, digital expert
Sweden	Smart Industry Step 2: a project to develop advanced level courses linked to the SMART Industry to match the actual skills needed on the labour market. ⁶⁸	Advanced, digital expert

Table 3 and

Table 4 provide some further details regarding two selected good practice examples, providing a short description of main aims of the different examples as well as further background information (e.g., with regard to impact).

Table 3: Good practice example from the Netherlands – Katapult.eu⁶⁹

Main aim	<ul style="list-style-type: none"> - Katapult is a national network created by the Dutch National STEM Platform, which supports various public-private partnerships in the higher education and vocational training sectors. Its aim is to improve cooperation between the two sectors and bridge the gap between the skills that students develop at university, and the skills the labour market needs. - Katapult.eu produces toolkits addressing a variety of topics (e.g., lessons for VET providers on supervising students). - Examples of partnerships include university visits and lessons by business professionals, or students who conduct research for SMEs during their studies.
Why is this a good practice?	<ul style="list-style-type: none"> - Katapult has achieved substantial results so far: <ul style="list-style-type: none"> o More than 450 public-private partnerships between education and business o 124 000 participating students o 12 000 participating companies o 8 000 participating teachers - Katapult includes virtually all VET providers within the Netherlands. - The Katapult business model scores high in both sustainability and accessibility and is based on contributions by approx. 10 000 participating companies (1/3 of the overall budget) as well as funding via the Dutch Regional Investment Fund VET. - Toolkits are available in different EU languages and can be used free of charge.

⁶⁵ <https://digital-skills-jobs.europa.eu/en/inspiration/good-practices/female-engineer-year-slovenia>.

⁶⁶ <https://digital-skills-jobs.europa.eu/en/inspiration/good-practices/it-fitness-test>.

⁶⁷ <https://digital-skills-jobs.europa.eu/en/inspiration/good-practices/odigo-project-lapland-finland>

⁶⁸ <https://digital-skills-jobs.europa.eu/en/inspiration/good-practices/boosting-competitiveness-manufacturing-smart-industry-sweden>.

⁶⁹ <https://digital-skills-jobs.europa.eu/en/inspiration/good-practices/katapulteu-netherlands>.

Table 4: Good practice example from Germany – KI Campus (AI campus in English)⁷⁰

Main aim	<ul style="list-style-type: none"> - The AI campus, funded by the German Federal Ministry of Education, provides a free digital learning platform for artificial intelligence with free online and research courses, videos and podcasts on various topics of AI and data literacy. - The platform is also building networks between learners, training providers and educational experts, and thereby improves the quality and quantity of AI teaching provision, skills and competences. - The AI Campus promotes knowledge exchange and research mobility of experts across the EU and has built sustainable partnerships with similar platforms/initiatives. - The AI Campus also has AI Expert Labs that serve as the central innovation hubs to facilitate networking and knowledge exchange between experts in AI implementation, researchers, teachers, and IT practitioners.
Why is this a good practice?	<ul style="list-style-type: none"> - Since its start in 2020, the AI Campus has successfully built a nation-wide (and international) ecosystem of relevant players in the digital field (from research to academia, to industry and business, education, and politics). - The AI campus aims to achieve high impact: i.e., to train at least 100 000 people in AI by 2025 and that at least 100 higher education institutions in Germany, Austria and Switzerland use the ecosystem.

1.5.2 Actions at EU level

1.5.2.1 Policies and initiatives at EU level

The **European Commission** has also considerably stepped up its efforts to boost digital skills over the last years through a number of initiatives. Concretely, digital skills development was one of the strategic priorities of the **Digital Education Action Plan 2021-2027**, defining the Commission’s long-term vision for the digital transformation of education⁷¹. More precisely, the Action Plan proposed a coordinated effort at EU level to support education and training systems through a number of key actions, including on digital skills, such as launching the Structured Dialogue on digital education and skills⁷².

For the European Year of Skills, the EU will build on many additional ongoing initiatives in the area of skills or will launch new initiatives to underpin ongoing efforts. The following non-exhaustive list includes both initiatives, which have either a direct emphasis on digital skills, or address digital skills within the wider aim of boosting skills in general, , including⁷³:

- The **European Skills Agenda**⁷⁴, which is the framework for EU skills policy cooperation, will continue to help individuals and businesses to develop skills and to apply them.

⁷⁰ For further information on the AI campus, see: <https://ki-campus.org/about> and <https://digital-skills-jobs.europa.eu/en/inspiration/good-practices/ki-campus-germany>.

⁷¹ COM(2020) 624 final

⁷² <https://education.ec.europa.eu/focus-topics/digital-education/action-plan/action-1>.

⁷³ Many of the listed bullet points were included here: https://commission.europa.eu/strategy-and-policy/priorities-2019-2024/europe-fit-digital-age/european-year-skills-2023_en or here: https://ec.europa.eu/commission/presscorner/detail/en/ip_23_1501_

⁷⁴ https://ec.europa.eu/commission/presscorner/detail/en/ip_20_1196

- The **Pact for Skills**⁷⁵: with 1 500 members and 18 large-scale partnerships in strategic sectors, there are pledges to help upskill up to 6 million people. The new Pact for Skills partnership in the **digital ecosystem** aims at enabling the upskilling and reskilling of workers and attracting more people to the digital industry. Partnerships for **onshore renewable energy, heat pumps skills and energy efficiency** are in the making.
- The Council Recommendations on **Individual Learning Accounts and Micro-credentials**⁷⁶, which help people to update or complete their skill sets in a more flexible and targeted way.
- The European **Digital Skills and Jobs Coalition**⁷⁷ and its National Coalitions, which tackle the digital skills gap by bringing together all relevant partners to raise awareness, exchange good practices, and encourage training to boost digital skills across Europe.
- The European **Digital Skills and Jobs Platform**⁷⁸, which is the EU's one-stop-shop for digital skills. It gathers 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 Coalition, and a meeting place for stakeholders looking for partners. Stakeholders can also make pledges, which are commitments made to reduce the digital skill gap. These contribute to the reaching of the Digital Decade targets and can inspire others to take similar actions.
- The **New European Innovation Agenda**⁷⁹ which includes a set of actions to create the right framework conditions for talents.
- The **European strategy for universities**⁸⁰ which proposes several actions to develop high-level and future-proof skills for a wide range of learners, including lifelong learners.
- Digital skills-related elements of the Council Recommendation on **Upskilling Pathways: New Opportunities for Adults**⁸¹.
- Preparatory action for the **data space for skills**⁸² preparing the ground for the future deployment of the European Data Space for Skills.
- Provision of **digital competence frameworks** for Citizens (**DigComp**⁸³) and educators (**DigCompEdu**⁸⁴) and associated tools for educational contexts (**SELFIEforTEACHERS**⁸⁵) and work-based learning (**SELFIE WBL**⁸⁶).⁸⁷
- The **European Digital Education Hub**⁸⁸, which is a community for cooperation across all levels and sectors of education and training with the aim to support digital education and skills. The Hub

⁷⁵ https://pact-for-skills.ec.europa.eu/index_en

⁷⁶ https://ec.europa.eu/commission/presscorner/detail/en/ip_21_6476

⁷⁷ <https://digital-skills-jobs.europa.eu/en/about/digital-skills-and-jobs-coalition>

⁷⁸ <https://digital-skills-jobs.europa.eu/en>

⁷⁹ https://ec.europa.eu/commission/presscorner/detail/en/IP_22_4273

⁸⁰ https://ec.europa.eu/commission/presscorner/detail/en/IP_22_365

⁸¹ https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=OJ%3AJOC_2016_484_R_0001.

⁸² <https://ec.europa.eu/info/funding-tenders/opportunities/portal/screen/opportunities/topic-details/digital-2021-prepacts-ds-01-skills> and <https://www.skillsdataspace.eu>.

⁸³ https://joint-research-centre.ec.europa.eu/digcomp_en.

⁸⁴ https://joint-research-centre.ec.europa.eu/digcompedu_en.

⁸⁵ <https://education.ec.europa.eu/selfie-for-teachers>.

⁸⁶ <https://education.ec.europa.eu/selfie/selfie-for-work-based-learning>.

⁸⁷ These frameworks and tools are in use in a large majority of EU countries for a variety of purposes (e.g., providing a common conceptual approach to digital skills development; as a basis for the development of teaching, learning and assessment content and/or for digital skills certification).

⁸⁸ <https://education.ec.europa.eu/focus-topics/digital-education/action-plan/european-digital-education-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**⁸⁹.

Moreover, several new EU proposals and initiatives have been adopted or will be adopted during the Year of Skills to underpin ongoing efforts and further boost skills development across the Member States,⁹⁰

- Adoption of a **digital education and skills package**⁹¹ to improve digital skills, education, and training, including two proposals for Council Recommendations. On the one hand, the **proposal for a Council Recommendation on the key enabling factors for successful digital education and training**⁹² calls on Member States to ensure universal access to inclusive and high-quality digital education and training for everyone. On the other hand, the **proposal for a Council Recommendation on improving the provision of digital skills in education and training**⁹³ calls on Member States to start providing digital skills early to develop digital skills in a coherent way through all levels of education and training.
- The launch of the **EU talent pool**⁹⁴ would facilitate international recruitment and provide opportunities for qualified third-country nationals to work in sectors identified as of strategic relevance at EU level, notably by facilitating the matching between vacancies in the EU and skilled non-EU third-country nationals. This is an initiative under the Skills and Talent Package adopted in April 2022.
- The roll-out of **Talent Partnerships**⁹⁵ with selected non-EU partner countries would help identifying skilling and training needs to enhance mobility opportunities and legal pathways to the EU. This is a key initiative under the New Pact on Migration and Asylum⁹⁶.
- As announced in the **Green Deal Industrial Plan**⁹⁷, the Commission proposed in the Net Zero Industry Act⁹⁸ to establish **Net-Zero Industry Academies** to roll out up-skilling and re-skilling programmes in strategic industries for the green transition like raw materials, hydrogen and solar technologies.
- The **Cybersecurity Skills Academy**⁹⁹ which aims at increasing the number of professionals trained in cybersecurity and ensuring a more coordinated approach to closing the growing cyber talent gap. The Academy will bring together existing initiatives aimed at promoting cybersecurity skills and will make them available on an online platform. To facilitate the cooperation between Member States, the Commission and relevant stakeholders, the Academy could take the form of a

⁸⁹ <https://digieduhack.com/en>.

⁹⁰ https://ec.europa.eu/commission/presscorner/detail/en/ip_23_1501.

⁹¹ https://ec.europa.eu/commission/presscorner/detail/en/ip_23_2246.

⁹² COM(2023) 205 final. Further information available here: <https://education.ec.europa.eu/focus-topics/digital-education/action-plan/action-10><https://education.ec.europa.eu/focus-topics/digital-education/action-plan/action-1>.

⁹³ COM(2023) 206 final. Further information available here: <https://education.ec.europa.eu/focus-topics/digital-education/action-plan/action-10>.

⁹⁴ https://eures.ec.europa.eu/eu-talent-pool-pilot_en.

⁹⁵ https://home-affairs.ec.europa.eu/policies/migration-and-asylum/legal-migration-and-integration/talent-partnerships_en

⁹⁶ https://commission.europa.eu/strategy-and-policy/priorities-2019-2024/promoting-our-european-way-life/new-pact-migration-and-asylum_en

⁹⁷ https://ec.europa.eu/commission/presscorner/detail/en/ip_23_510.

⁹⁸ https://single-market-economy.ec.europa.eu/publications/net-zero-industry-act_en.

⁹⁹ For further information, see COM(2023) 207 final (eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52023DC0207) as well as: <https://digital-skills-jobs.europa.eu/en/cybersecurity-skills-academy>.

European Digital Infrastructure Consortia (EDIC), a new instrument introduced by the Digital Decade Policy Programme¹⁰⁰.

- The [Deep Tech Talent Initiative](#)¹⁰¹, a flagship initiative under the New European Innovation Agenda, which will help train 1 million pupils, students, and professionals in the 'deep tech' fields by 2025.
- The [European Digital Skills Awards 2023](#)¹⁰², which aim to give visibility to and reward regional, national and European projects and initiatives that are helping to bridge the digital gap in Europe. This year, 330 applications from highly ambitious and exciting initiatives were received. 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 that are supporting digital skills for everyone the attention they deserve also serves as inspiration for other initiatives as well as upscaling existing ones.

The European Commission is currently also working on the development of a [European Digital Skills Certificate](#)¹⁰³ which aims to serve as a quality label for (existing and future) schemes delivering digital skills certificates, in order to help people have their digital skills widely, quickly and easily recognised and accepted by governments, employers, education and training providers and other stakeholders. A feasibility study including broad stakeholders' consultation, launched in 2022, is due for finalisation at the end of 2023, and a pilot of the certificate was launched with Member States in April 2023, as part of the adoption of the Digital Education and Skills Package, and as a deliverable of the 2023 European Year of Skills.

Furthermore, the Commission is also supporting [EU Code Week](#)¹⁰⁴, which is a grassroots initiative bringing coding and digital literacy to everyone in a fun and engaging way with activities organised around the world by teachers and coding enthusiasts. The 10th edition of Code Week took place between 8 and 23 October 2022. The main goal of the initiative is to encourage children and young people to discover and master the basics of coding and computational thinking and make them interested in taking up STEM subjects at school and, eventually, in pursuing studies and 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 to all subjects and classrooms. In 2022, a total of 3 425 838 participants took part in Code Week events, of which just over 49% were women or girls, the same share as in 2021. The average age of a Code Week participant was 11 years old. A total of 77,541 events were registered in 2022, with Italy, Turkey, and Poland at the top of the table in terms of events organised, with 20,986, 20,254 and 13,909 events respectively.

1.5.2.2 Funding instruments at EU level

In terms of funding, several EU funding instruments (besides the RRF) aim to strengthen digital capacities and the skills needed for their deployment through experimenting, evaluating, and scaling up innovative education and training programmes and specialised digital technology training and education programmes. The [Digital Europe Programme \(DEP\)](#)¹⁰⁵ supports, for example, **short-term training** in key capacity areas, such as High-Performance Computing (HPC), cybersecurity, Artificial

¹⁰⁰ Decision (EU) 2022/2481 of the European Parliament and of the Council of 14 December 2022

¹⁰¹ <https://www.eitdeeptechtalent.eu/>

¹⁰² <https://digital-skills-jobs.europa.eu/en/european-digital-skills-award-2023>

¹⁰³ https://joint-research-centre.ec.europa.eu/digcomp/european-digital-competence-certificate-edsc_en

¹⁰⁴ <https://codeweek.eu/>

¹⁰⁵ <https://digital-strategy.ec.europa.eu/en/activities/work-programmes-digital>

Intelligence and other emerging technologies, targeted at businesses and in particular at SMEs. The programme also supports the development of **education and training programmes** (e.g., bachelor's and master's programmes) in cutting-edge technologies in order to support excellence in higher education institutions, making them world leaders in training of digital specialists, and to increase the capacity of the training offer for advanced technologies. The budget for the DEP work programmes 2021 and 2022 in the area of advanced digital skills within the strategic objective 4 amounted to 72 and 84 million Euros, respectively. More precisely, the first two DEP calls for master programmes and short-term training courses in key digital technologies awarded 21 new consortia, gathering 230 partners in all, including businesses, universities and research and training centres. The third call in the area of specialised education programmes resulted in the selection of 8 additional projects. Moreover, the Digital Europe Programme work programme for 2023 in the area of advanced digital skills, with an overall budget of 58 million Euros, will continue supporting specialised education programmes or modules in key capacity areas and will also support the creation of the aforementioned **Cybersecurity Skills Academy**, the strengthening of the skills needed for the **semiconductor ecosystem**, as well as boosting the development of **digital skills from an early age** (e.g., via school holiday camps, upscaling the EU Code Week initiative, etc.).

Apart from that, additional programmes that can support skills development (including on digital skills) include the [European Social Fund Plus \(ESF+\)](https://ec.europa.eu/european-social-fund-plus/en)¹⁰⁶ with a budget of more than EUR 99 billion for 2021-2027, which is the EU's main instrument for investing in people. Moreover, [Horizon Europe](https://research-and-innovation.ec.europa.eu/funding/funding-opportunities/funding-programmes-and-open-calls/horizon-europe_en)¹⁰⁷ underpins skills for researchers, entrepreneurs and innovators notably through its [Marie Skłodowska-Curie Actions](https://marie-sklodowska-curie-actions.ec.europa.eu/)¹⁰⁸, the [European Innovation Council](https://eic.ec.europa.eu/index_en)¹⁰⁹ and the [European Institute for Technology](https://eit.europa.eu/)¹¹⁰. Horizon Europe is currently also co-funding several innovation actions for the development, application and testing of eXtended Reality technologies in education as well as skills development. Furthermore, [Erasmus+](https://erasmus-plus.ec.europa.eu/)¹¹¹, with a budget EUR 26.2 billion, includes a transversal priority which focuses on addressing digital transformation in all education and training sectors¹¹², as well as in the youth and sports fields and supports the personal and professional development of learners, staff and organisations in all supported fields. . The programme also funds flagship initiatives, such as the European Universities, the Centres for Vocational Excellence and the Erasmus+ Teacher Academies, which aim to have a leading role in the digital transformation of education and training systems. More generally, Erasmus+ supports the implementation of the Digital Education Action Plan, in close alignment with the Plan's two strategic priorities, developing a high performing digital education ecosystem and enhancing digital skills and competences for the digital transformation. A specific Resource Centre has been set up in 2022 to contribute to high-quality and inclusive implementation for the digital dimension of the programme. Other programmes that can support (digital) skills development include also the [InvestEU programme](https://investeu.europa.eu/index_en)¹¹³, the [European Globalisation Adjustment Fund](https://ec.europa.eu/social/main.jsp?catId=326&langId=en)¹¹⁴ for displaced workers, the [European Regional Development Fund](https://ec.europa.eu/regional_policy/en/funding/erdf/)¹¹⁵, the [European agricultural fund for rural development](https://ec.europa.eu/regional_policy/en/funding/erdf/)¹¹⁶, the [Just Transition Fund](https://ec.europa.eu/regional_policy/en/funding/erdf/)¹¹⁷,

¹⁰⁶ <https://ec.europa.eu/european-social-fund-plus/en>

¹⁰⁷ https://research-and-innovation.ec.europa.eu/funding/funding-opportunities/funding-programmes-and-open-calls/horizon-europe_en

¹⁰⁸ <https://marie-sklodowska-curie-actions.ec.europa.eu/>

¹⁰⁹ https://eic.ec.europa.eu/index_en

¹¹⁰ <https://eit.europa.eu/>

¹¹¹ <https://erasmus-plus.ec.europa.eu/>

¹¹² i.e. higher education, school education, adult education, vocational education and training (VET).

¹¹³ https://investeu.europa.eu/index_en

¹¹⁴ <https://ec.europa.eu/social/main.jsp?catId=326&langId=en>

¹¹⁵ https://ec.europa.eu/regional_policy/en/funding/erdf/

the [Public Sector Loan Facility](#)¹¹⁸ under the Just Transition Mechanism, the [European Solidarity Corps](#)¹¹⁹, the [Programme for Environment and climate action](#)¹²⁰ (LIFE), the [Modernisation Fund](#)¹²¹, the [Technical Support Instrument](#)¹²², and the [Neighbourhood, Development and International Cooperation Instrument](#)^{123, 124}.

1.6 Digital Decade Targets

1.6.1 Challenges in digital skills provision: Structured Dialogue findings

The study by Cosgrove et al. (2023)¹²⁵ provides a cross-country synthesis of the main themes discussed in the Structured Dialogue with respect to digital skills. The Structured Dialogue allowed, besides the identification of ongoing national reforms, investments and initiatives described in section 1.6., for the identification of challenges that are being experienced across most Member States and thus need to be addressed by concerted policy actions, including amongst others the issues summarized in Table 5.

Table 5: Overview of challenges in the provision of digital skills¹²⁶

Challenges in the provision of digital skills outside of formal education	Mismatch between digital skills training offerings and current market needs, both for general training and for ICT specialists
	Shortage of ICT specialists
	Challenge in engaging adult population in lifelong learning initiatives including those related to digital skills
	Low representation of women in the ICT sector
	Challenge to upskill and reskill SME employees particularly in those Member States where large percentages of the workforce are employed in SMEs

¹¹⁶ https://commission.europa.eu/funding-tenders/find-funding/eu-funding-programmes/european-agricultural-fund-rural-development-eafrd_en

¹¹⁷ https://ec.europa.eu/info/strategy/priorities-2019-2024/european-green-deal/finance-and-green-deal/just-transition-mechanism/just-transition-funding-sources_en

¹¹⁸ https://cinea.ec.europa.eu/just-transition-mechanism_en

¹¹⁹ https://youth.europa.eu/solidarity/mission_en

¹²⁰ https://ec.europa.eu/info/funding-tenders/find-funding/eu-funding-programmes/programme-environment-and-climate-action-life_en

¹²¹ <https://modernisationfund.eu/>

¹²² https://ec.europa.eu/info/funding-tenders/find-funding/eu-funding-programmes/technical-support-instrument/technical-support-instrument-tsi_en

¹²³ https://international-partnerships.ec.europa.eu/funding/funding-instruments/global-europe-neighbourhood-development-and-international-cooperation-instrument_en

¹²⁴ <https://ec.europa.eu/social/main.jsp?langId=en&catId=1223&furtherNews=yes&newsId=10431>

¹²⁵ Cosgrove, J., Tsotsou, I., Cachia, R., Centeno, C., Sala, A., Punie, Y., Thematic analysis in support of the Staff Working Document for Council Recommendations: Improving the provision of digital skills in education and training, and Digital education – enabling factors for success, JRC Science for Policy Report, 2023, available as Annex 3 to the Commission Staff Working Document SWD(2023) 205 final, available here: [deap-swd-digital-skills-180423_en.pdf \(europa.eu\)](#)

¹²⁶ Cosgrove, J., Tsotsou, I., Cachia, R., Centeno, C., Sala, A., Punie, Y., Thematic analysis in support of the Staff Working Document for Council Recommendations: Improving the provision of digital skills in education and training, and Digital education – enabling factors for success, JRC Science for Policy Report, 2023, available as Annex 3 to the Commission Staff Working Document SWD(2023) 205 final, available here: [deap-swd-digital-skills-180423_en.pdf \(europa.eu\)](#)

	Challenge tackling the digital divide of groups at risk of social and economic exclusion regarding equitable provision of digital skills to achieve digital inclusion
Challenges in the provision of digital skills in formal education	Low levels of interest/motivation/participation in digital skills continuous professional development among education staff
	Challenge in assessing or monitoring digital skills levels of education staff
	Challenge in implementing digital skills and assessing learning targets within a transversal approach , where the responsibility for achieving learning targets is shared between teachers of different subjects
	A low emphasis on the assessment of learners' digital skills in national curricula and various challenges associated with curricular reforms
	Low number of ICT graduates and low retention rates in university courses
Other cross-cutting challenges	Whole-of-government implementation of digital education and skills strategies
	Challenges regarding monitoring and evaluation of digital skills provision (e.g., complexity in developing micro-credentials and digital skills certifications)
	Challenge regarding the timely availability of appropriate data for digital skills forecasting

1.6.2 Policy Recommendations included in a proposal for a Council Recommendation on improving the provision of digital skills in education and training

In line with the challenges described in the chapter above, many policy actions need to be put forward and pooled (both at EU level as well as at national level) to achieve the EU digital skills targets. In fact, the above-mentioned **Council Recommendation proposal on improving the provision of digital skills in education and training**¹²⁷ included high-level policy recommendations targeted towards **Member States** to boost digital skills in a lifelong learning perspective (from young people to adults) and to increase the number of ICT specialists and graduates in the EU while striving for gender convergence. The proposal considers all levels of education and training and calls for engagement by various stakeholders and complements another proposal for a **Council Recommendation on the key enabling factors for successful digital education and training**¹²⁸. Both proposals are under negotiation in the Council.

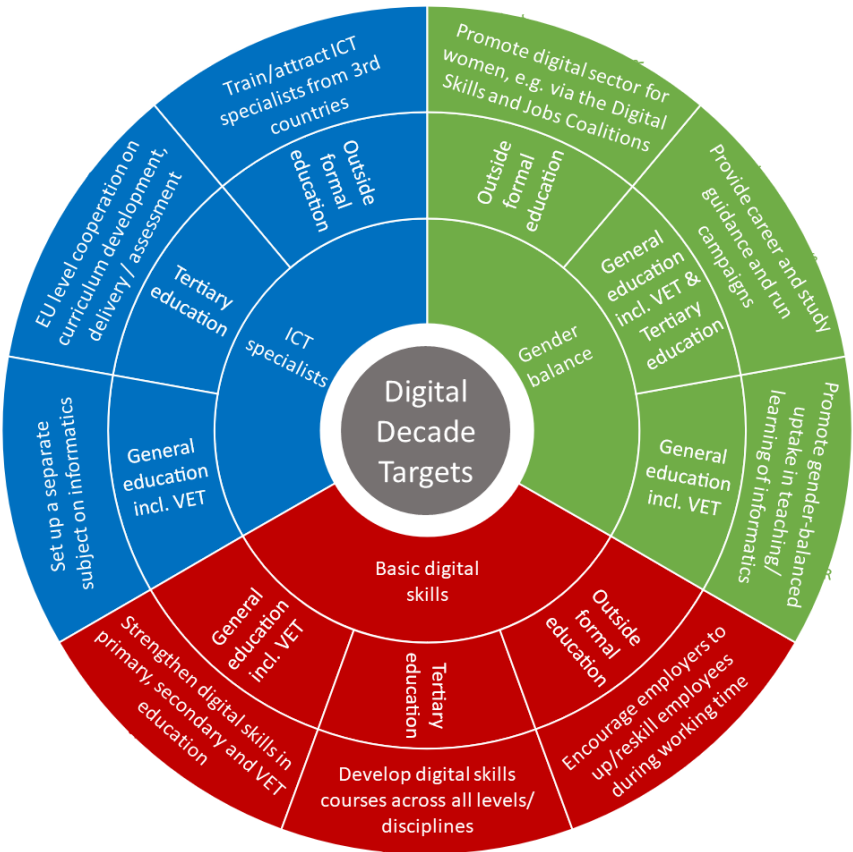
Figure 12 includes a selection of those recommendations on the provision of digital skills in education and training, which have been targeted to Member States, and which have direct relevance to achieving the Digital Decade targets. The figure attempts to link each proposed recommendation with the Digital Decade indicator that the recommendation will most likely impact: basic digital skills, ICT specialists or gender balance. The table also attempts to categorise whether the recommendations target: a) general education programmes (primary and secondary level as well as Vocational Education and Training (VET), b) tertiary formal education, and/or c) outside formal education (which also includes training for employees). For instance, the recommendation regarding setting up a separate subject on informatics in primary and secondary education including VET is considered to impact the Digital Decade target of "ICT specialists", given that evidence shows that pupils who are involved in learning about coding or computational thinking from an early age are

¹²⁷ COM(2023) 206 final. See further information here: <https://education.ec.europa.eu/focus-topics/digital-education/action-plan/action-10>.

¹²⁸ COM(2023) 205 final. See further information here: <https://education.ec.europa.eu/focus-topics/digital-education/action-plan/action-10>.

more likely to continue studying ICT or digital-related fields, and this has an impact on the number of students choosing this study path as well as young people embarking on a digital career. The main purpose of this figure is therefore to convey how different proposed Council Recommendations relate to the Digital Decade targets set for 2030. It is important to highlight that for achieving the Digital Decade targets, an overarching transversal approach is required, including the need to follow a whole-of-government approach and to work with key stakeholders to achieve coherence and integration across various actors and actions involved, in line with the first recommendation of the Commission proposal for a Council Recommendation on improving the provision of digital skills in education and training. The recommendations pictured in Figure 12 shall be considered as indicative given that the final selection of the recommendations included in the Council Recommendation on improving the provision of digital skills in education and training is still under negotiation with the Council.

Figure 12: Selection of Commission proposal for Council Recommendation



^a Note: This graph gives a simplified version of selected proposed recommendations of the Commission proposal for a Council Recommendation on improving the provision of digital skills in education and training¹²⁹.

^b VET = Vocational Education and Training

There is no digital future without the appropriate digital skills. Without the right digital skills, the European Union will not be able to cope with current and future strategic dependencies. Only by stepping up efforts in boosting digital skills and the number of ICT specialists, the EU will continue to be able to master the rapid evolution of digital technologies and to ensure its digital sovereignty.

¹²⁹ COM(2023) 206 final. See further information here: <https://education.ec.europa.eu/focus-topics/digital-education/action-plan/action-10>

2 Digital Infrastructures

2.1 Overall context: why are digital infrastructures critical and where is Europe in this regard in 2023 at the outset of the Digital Decade?

Broadband connectivity

In today's changing geopolitical, economic, social and environmental landscape, the need for sustainable, resilient, secure and efficient digital infrastructures has become increasingly essential. The COVID-19 pandemic highlighted the unequivocal importance of digital communications networks, as the basis for a digital society. The war in Ukraine has taught us the importance of having **secure and resilient infrastructure**, highlighting also our dependencies and the need to reinforce the EU's digital ecosystem. The crucial importance of protecting Europe's critical infrastructure and making it resilient in the face of emerging threats was highlighted in the EU Security Union Strategy¹³⁰. This political impetus calls for an intensification of the work begun in the past decade to accelerate Europe's digital transformation, building on progress towards a functioning Digital Single Market and intensifying actions defined in the strategy for [Shaping Europe's digital future](#). The Declaration on Digital Rights and Principles recalls the importance of ensuring access to affordable and high-speed digital connectivity.

The [Digital Decade Policy Programme](#) (DDPP), sets concrete targets and objectives up to 2030 to equip the Union with secure, performant and sustainable digital infrastructures. The targets build on the 2025 ones and continue the focus on improving and developing sustainable, "future proof" **5G and fibre network infrastructures**, that can accommodate exponential growths in data traffic. More specifically, the aim is to achieve **gigabit connectivity for all and enable 5G in all populated areas by 2030** with a specific attention to rural and remote regions.

At the outset of the **Digital Decade, the Union is still far from achieving these objectives**. While overall fixed very high-capacity network (VHCN)¹³¹ coverage stands at 73% and fibre to the premises coverage at 56% of the households, we can reasonably expect that cable networks will not widen their footprint significantly and that the remaining investment will be in fibre and Fixed Wireless Access. Overall 5G coverage may stand at 81%¹³² of the households, however its quality still falls short of end-users' expectations, and industry needs.

The Commission has recently commissioned a study¹³³ to evaluate the investment gap required to reach the Digital Decade objectives for 2030: gigabit connectivity for all and enable 5G in all populated areas. Its main findings, reveal that:

- a) About EUR 114 billion are required to achieve complete coverage of FTTP (of which EUR 40 billion in public funding). 5G Fixed Wireless Access (FWA) services could reduce the gap in fixed connectivity to around Euro 108 billion and Euro 29 billion in public subsidies if most rural households are 5G FWA covered.

¹³⁰ COM(2020) 605. See further information on the implementation of the EU Security Union Strategy: https://commission.europa.eu/strategy-and-policy/priorities-2019-2024/promoting-our-european-way-life/european-security-union_en.

¹³¹ Networks with the capability to offer gigabit connectivity.

¹³² The current KPI for the 5G target does not take into account the quality of service provided under peak time conditions. A key challenge is to ensure that the deployed networks respond to future needs, notably support key industry sectors and critical applications that will benefit consumers and businesses in all sectors. To measure Member States readiness to overcome this challenge, further examination is required to enhance and broaden the measurement framework for 5G.

¹³³ IHS Markit, Omdia and Point Topic, Broadband coverage in Europe studies.

- b) An additional EUR 33.5 billion is estimated to be needed for the provision of “full 5G service”. The total investment for fixed and mobile is EUR 148 billion of which EUR 43 billion in public subsidies (if fixed and mobile networks are deployed independently).
- c) Alternatively, the study estimates EUR 120 billion in total investment for fixed and mobile of which EUR 33 billion in subsidies, if full 5G deployment and FTTP deployment are deployed in parallel.
- d) In addition to the two previous points on fixed and mobile infrastructure investments, EUR 26 billion which could go up to EUR 79 billion, in investment is estimated for full 5G coverage of transport paths including roads, railways and waterways. Seamless 5G connectivity along transport paths will be indispensable for the development of connected and automated mobility, which will be based on advanced standalone 5G features, such as distributed computing, network slicing and improved positioning systems, to enable innovative use cases for connected and automated mobility. This brings the **total investment gap in a range of EUR 174 billion to EUR 227 billion.**

Semiconductors

Semiconductors technologies are the backbone of the digital transformation and green transitions. Semiconductor chips are designed, manufactured, and packaged to perform tailored functions and are the building blocks of a variety of digital products, from computers and smartphones to the infotainment and safety of cars or from gaming consoles to domestic appliances. Emerging data processing capabilities, the shift towards edge-computing, the future autonomous and electrical mobility, the growing need to support a distributed workforce, the deployment of modern energy and broadband communication infrastructures, all require the computational power, the reduced energy consumption and the added security offered by advanced semiconductor technologies.

Beside the strategic importance for the economy of the whole semiconductor sector, the recent shortage of chips has highlighted the fragility of its globalized value chain. It has also made clear the extent of European dependency in many segments, from the production of wafers to the manufacturing of chips, or packaging. Geopolitical tensions further undermine a level playing field and harm competition.

In 2022, sales of chips surpassed EUR 615 billion worldwide, and in the coming years, the market for chips is expected to increase above approximately EUR 1 trillion in 2030¹³⁴. To ensure that the whole European society can embark on the twin transformation train it is thus crucial to address weaknesses and support the semiconductor values chain with a long-term policy, notably in the sectors as mentioned below.

As of 2021, the EU has a small amount of total manufacturing capacity compared to other regions in the semiconductor value chain. This creates dependencies in EU industries (e.g., automotive, industrial automation, communications) from third-country chip manufacturers.

Concerning digital processors, Europe is leading in microcontrollers, but misses the necessary design capacity and manufacturing facilities for the more advanced logic components and is therefore highly dependent on imports and foreign foundries.

As AI proliferates, as computing shifts towards the edge of the network, **and as secure chips become a precondition for the security of networks and data infrastructures**, the EU needs to step up its capabilities in digital logic, in particular the processor chips that are needed to help make sense of the ever-increasing quantities of data.

¹³⁴ <https://www.techinsights.com/manufacturing-analysis-formerly-VLSIresearch>

Future mobility is quickly moving towards electric and automated vehicles which require on one side new power electronics, assuring longer autonomy and faster charging, and on the other side fast computation of huge quantities of data and images. The EU needs to support this growing sector to defend the leading position of its car industry.

During the State of the Union address in 2021, President von der Leyen announced the European Chips Act whose package, including Communication, Regulation and Recommendation was adopted by the Commission in February 2022¹³⁵. The Chips Act emphasizes the crucial importance of semiconductors for our society and citizens and to further commit for a thriving semiconductor ecosystem and resilient supply chain. The European Union should take advantage of this unique opportunity and act to the benefit of the whole of Europe.

Edge nodes

Already in 2020, the European strategy for data¹³⁶ predicted a fundamental change in the way in which data is stored and processed. In 2020, 80% of the processing and analysis of data took place in data centres and centralised computing facilities, and only 20% in smart connected objects and computing facilities close to the user ('edge computing'). The European strategy for data predicted that by 2025 these proportions to be inverted with 80% of data processing at the edge, and only 20% in data centres and centralised computing facilities.

Owing to the availability of ultra-low latency data processing services offered through the cloud and edge compute continuum, individuals, businesses, and organisations should be able make better decisions based on data insights.

Edge computing makes it possible for decentralised sites at the edge of the network to provide data processing services, reducing the volume of data that needs to be transmitted over the network along with improving cloud computing's overall performance.

Through the use of edge computing, Europe is given an unprecedented market opportunity to meet the demand for next-generation data processing infrastructures, allowing it to improve its data processing capacity and, as a result, its technical sovereignty. In particular, edge computing enables transitioning away from today's completely centralised data processing models, which are dominated by international players, and allows for the ability to meet the rising compute needs that sophisticated AI, IoT and 5G scenarios are bringing to the Edge.

In addition, the move to decentralised Edge data processing services can aid Europe in maximising benefits of its already-existing data processing infrastructures by allowing the exploitation of the geographic capillarity of the various European cloud providers and their adherence to European legislation.

Data suggests that by 2025, edge computing will complement cloud computing for nearly every enterprise.¹³⁷ Global spending on edge computing is steadily on the rise. It has reached EUR 190 billion in 2023, an increase of 13.1% over 2022, and is expected to reach nearly EUR 289 billion in 2026.¹³⁸

Market figures show that in 2021, edge spending accounted for 15% of total infrastructure spending by European businesses¹³⁹. In terms of uptake of emerging technologies, in 2021 one in three

¹³⁵ <https://digital-strategy.ec.europa.eu/en/library/european-chips-act-communication-regulation-joint-undertaking-and-recommendation>

¹³⁶ <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A52020DC0066>

¹³⁷ <https://www.gartner.com/en/doc/750789-infographic-understanding-edge-computing>

¹³⁸ IDC Worldwide Edge Spending Guide

¹³⁹ UNLOCK-CEI, Cloud-Edge-IoT Demand Landscape (April 2023), <https://zenodo.org/record/7821330#.ZD0wTnZByUk>

European firms were reported to use edge computing solutions in any capability linked to their daily operations. Organisational dimensions also affect adoption levels, with large enterprises embracing Edge technologies at greater speed than smaller organisations. Even though the adoption trends are promising, maturity of the adoption continues to be still rather low: only 17% of organisations are employing edge computing in production - and only half of those make edge computing production solutions available to the entire organisation. A larger share (83%) of organisations is in the process of building awareness and getting familiarised with the technology (35%) and developing early-phase pilots of edge solutions with mainly a single business unit focus (48%)¹⁴⁰.

The European Telecommunications Network Operators' Association, which represents a large part of the telecom market and - the edge market's fastest growing spending area - reports a total of three commercial deployments of edge computing in Europe in 2022. According to the same report, another 18 edge cloud offers were announced in Europe in 2022, making Europe the region with the second most announced edge offers in that year (19 announced offers in the Asia-Pacific and five in North America).¹⁴¹.

At present, edge computing in Europe is still considered to be in its infancy with a focus on awareness raising, education and small-scale pilot projects. The baseline for 2022 and the start for Europe's path towards the deployment of 10.000 climate-neutral and highly secure edge nodes by 2030 can therefore be set at zero.

Quantum computing

Quantum technologies have the potential to solve some of the major challenges of our time, whether that is by tracking future pandemics or finding new pharmaceutical solutions, modelling extreme weather patterns in an era of climate change, protecting critical infrastructures from cyber-attacks, enhancing the ability to detect movement below ground and underwater, and provide other functionalities that may not even have been imagined yet. Quantum computers and simulators in particular will solve problems that today need hundreds of days, if not years, in much shorter timeframes while consuming much less energy than today's highest performance computers. The global market in quantum technologies is expected to reach EUR 3209 million by 2030.¹⁴²

Europe can be considered the birthplace of quantum technologies: over the past century, it has nurtured numerous research breakthroughs.¹⁴³ In 1999, the EU was the first global player to launch a research programme focused on quantum information processing and communications.¹⁴⁴ Since then, combined EU and Member State investments in quantum technologies have totalled over EUR 1 billion, and currently more than 5000 researchers in the EU are working on quantum science and technology development, resulting in the highest concentration of quantum researchers (231 per million people) of any world region.

Nevertheless, the great strategic and economic potential of quantum computing means that the race towards worldwide leadership in this field is a highly competitive one. Government investment in quantum technologies is continually rising, with cumulative worldwide public investments in

¹⁴⁰ UNLOCK-CEI, Cloud-Edge-IoT Demand Landscape (April 2023),

<https://zenodo.org/record/7821330#.ZD0wTnZByUk>

¹⁴¹ ETNO, The State of Digital Communications 2023 (February 2023), <https://etno.eu/library/reports/112-the-state-of-digital-communications-2023.html>

¹⁴² <https://www.reportlinker.com/p06285788/Quantum-Technologies-Global-Market-Forecast-to.html>

¹⁴³ European Nobel laureates in the field have included Albert Einstein, Erwin Schrödinger, and Werner Heisenberg and, in recent years, Alain Aspect, Theodor Hänsch, Albert Fert, Peter Grünberg, Serge Haroche, and Anton Zeilinger – to mention only a few names.

¹⁴⁴ The Fifth European Framework Programme for Research's Quantum Information Processing and Communication FET Proactive initiative.

quantum research and development now reaching an estimated EUR 27 billion.¹⁴⁵ The EU and its Member States collectively have announced a total of EUR 7.2 billion of planned government funding for quantum technologies – second only to China’s EUR 14 billion. 97.5% of that European funding comes from the EU itself and from four Member States (France, Germany, the Netherlands, and Sweden). However, Europe is behind other world regions when it comes to private investments: in the middle of 2021, around 25% of quantum industry participants globally were based in Europe, yet the region had received less than 5% of global funding.¹⁴⁶

Strong, coordinated action at European level, and a higher priority for quantum technologies on the agenda of all Member States, will be needed for the EU to capitalise on its strengths in research, thrive in the global quantum race, and achieve its Digital Decade targets of having its first computer with quantum acceleration by 2025 and subsequently being at the cutting edge of quantum capabilities by 2030.

2.2 Overall outlook based on DESI digital infrastructure indicators

The DESI digital infrastructure indicators measure both the demand (take-up) and the supply (coverage) sides of fixed and mobile broadband. Under fixed broadband, they assess the take-up of at least 100 Mbps, at least 1 Gbps broadband, the coverage of fixed very high-capacity networks (VHCNs), and of Fibre to the Premises networks. Under mobile broadband, they include the 5G population coverage, the assignment of radio spectrum for 5G (5G spectrum indicator) as well as the take-up of mobile broadband.

¹⁴⁵ <https://qureca.com/overview-on-quantum-initiatives-worldwide-update-2022/>

¹⁴⁶ [McKinsey & Company, Quantum Technology Monitor June 2022](#)

Table 6: DESI 2023 digital infrastructure indicators grouped into two classes: 2a. fixed broadband and 2b. mobile broadband¹⁴⁷

	EU DESI 2023	EU 2030 target
2a1 At least 100 Mbps broadband take-up	55%	
% households	2022	
2a2 At least 1 Gbps broadband take-up	13.8%	
% households	2022	
2a3 Fixed Very High-Capacity Network (VHCN) coverage	73%	100%
% households	2022	
2a4 Fibre to the Premises (FTTP) coverage	56%	
% households	2022	
2b1 Mobile broadband take-up	87%	
% individuals	2021	
2b2 Overall 5G coverage	81%	100%
% populated areas	2022	
2b3 5G spectrum	68%	
Assigned spectrum as a % of total harmonised 5G spectrum	2023	

Source: DESI 2023, European Commission. Indicators' description and details in 2023 DESI methodological note. Key performance indicators for the 2030 targets of the Digital Decade Policy Programme are highlighted.

2.2.1 Gigabit connectivity

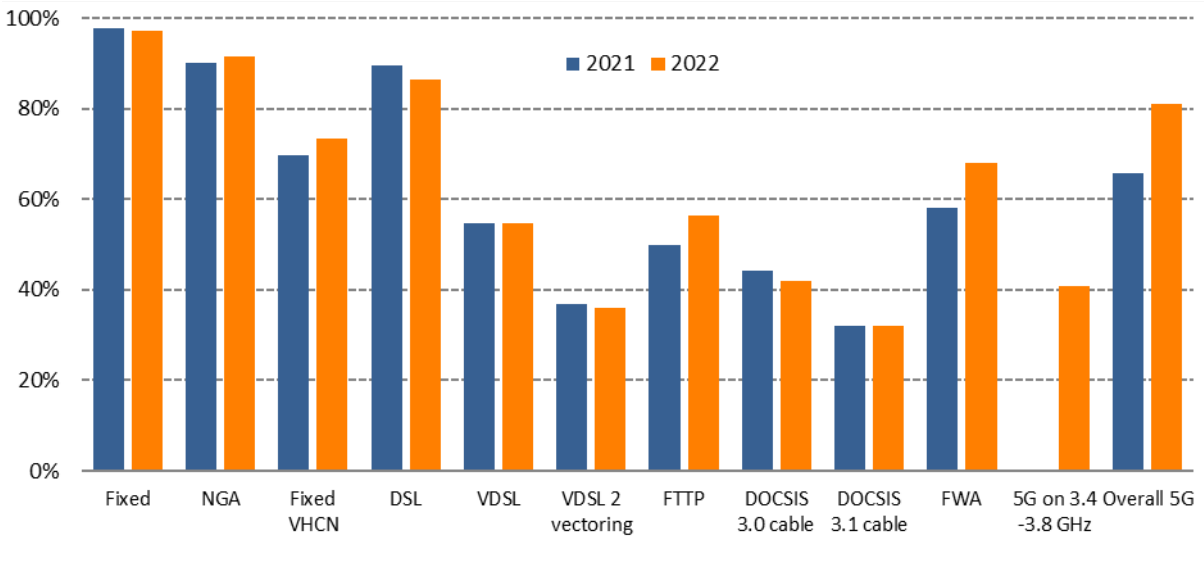
2.2.1.1 Broadband coverage

At least one broadband network has been available to all households in the EU since 2013, when considering all major technologies (xDSL, cable, fibre to the premises - FTTP, fixed wireless access - FWA, 4G, 5G and satellite). Internet access at home is provided mainly through fixed technologies, with overall coverage at 97%. Among these technologies, xDSL continued to have the largest footprint (87%) followed by FWA (68%), FTTP (56%) and DOCSIS 3.0 cable (42%).

Fixed very high-capacity networks (VHCN) covered 73% of EU homes in 2022, following a slight increase of 3 percentage points compared to the previous year. FTTP deployments were mainly responsible for this increase, as the FTTP coverage went up from 50% in 2021 to 56% in 2022.

¹⁴⁷ Indicators' full description can be found in the "DESI 2023 methodological note", SWD(2023) 574: <https://digital-strategy.ec.europa.eu/en/news-redirect/798352>

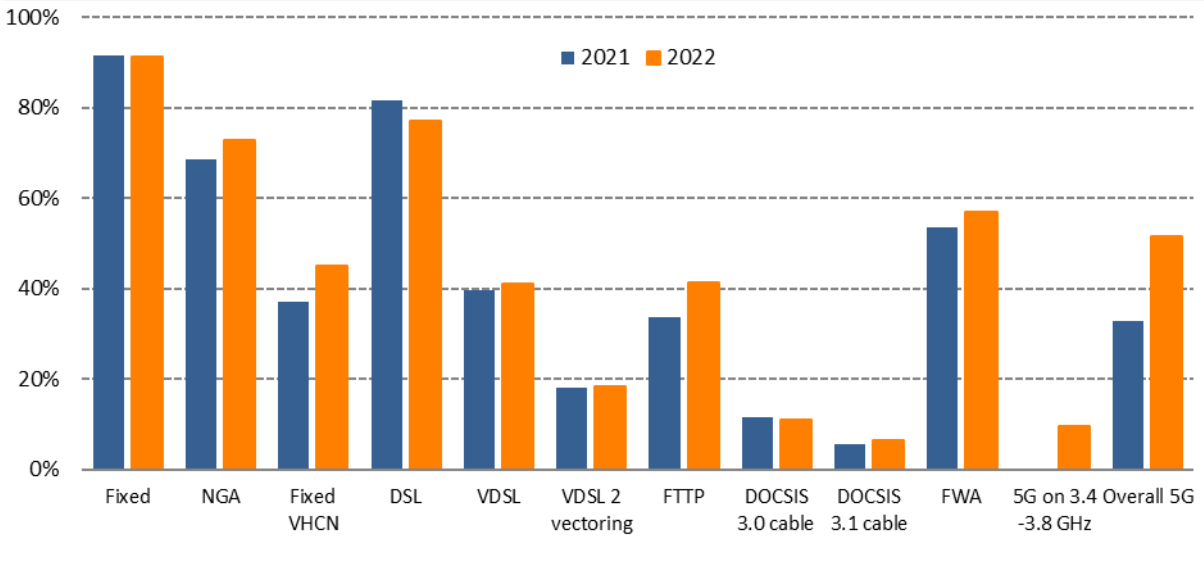
Figure 13 Total coverage by technology at EU level (% of households), 2021-2022



Source: IHS Markit, Omdia and Point Topic, Broadband coverage in Europe studies

Broadband coverage of rural areas¹⁴⁸ remains challenging, as 9% of households are not covered by any fixed network, and 55% are not served by any fixed VHCN technology. Rural coverage of 5G reached 51% of populated areas, up from 33% in the previous year, while rural coverage using the 3.4-3.8 GHz is low (10%). On fixed technologies, there was a further marked increase in the rural coverage of FTTP (from 34% in 2021 to 41% in 2022).

Figure 14 Rural coverage by technology at EU level (% of households), 2021 – 2022



Source: IHS Markit, Omdia and Point Topic, Broadband coverage in Europe studies

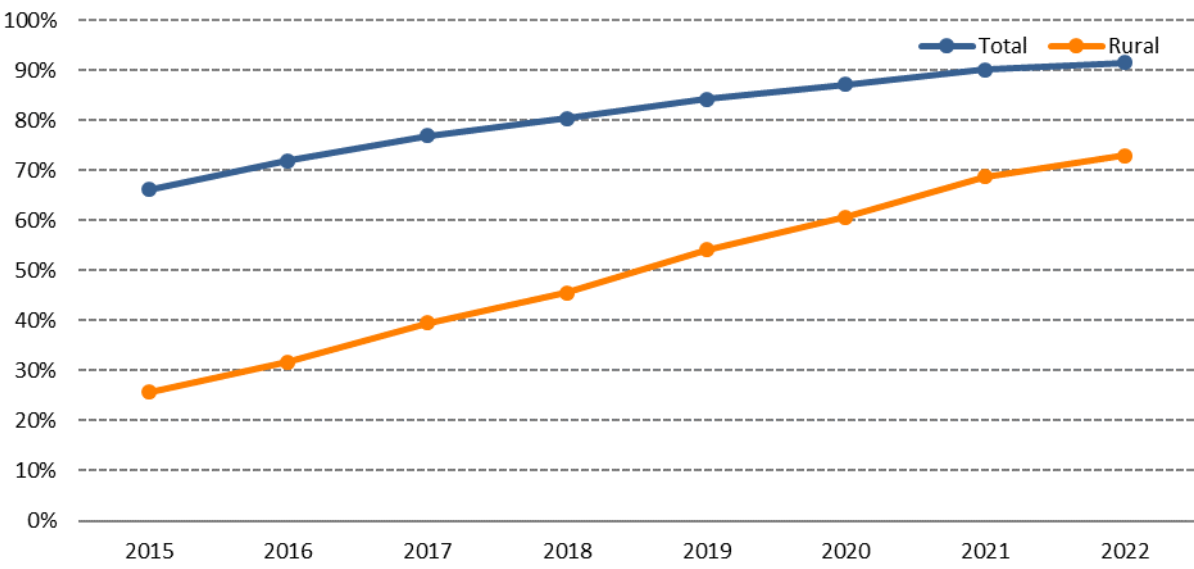
VHCN coverage increased significantly between 2014 and 2022 from 19.5% to 73%. This growth is thanks to large scale deployments of FTTP networks e.g., in Ireland, Cyprus, Bulgaria, Hungary, France and Romania and major upgrades of cable networks to DOCSIS 3.1 (e.g., in Malta, Luxembourg, the Netherlands, Belgium, Denmark and Germany).

¹⁴⁸ For the definition of rural areas see sub-chapter ‘3.2 Defining households and rural areas’ in the methodology of the study ‘Broadband Coverage in Europe 2018’, page 16, by IHS Markit and Point Topic (<https://ec.europa.eu/digital-single-market/en/news/study-broadband-coverage-europe-2018>).

In rural areas, growth was stable and substantial, from 4% to 41% over the same time period. FTTP is mainly responsible for this improvement. The large gap between total and rural VHCN coverage shows the regional disparities in digital opportunities and confirms that more investment is needed for rural areas to catch up.

To close the digital divide in rural and remote areas, the EU supports investments in an unprecedented manner. Around EUR 16 billion Recovery and Resilience Facility (RRF) reforms and investments have been approved to roll out digital connectivity networks in the next four years, especially in rural regions. Moreover, the EU will also leverage connectivity investments through the new Cohesion Funds (ERDF EUR 2.4 billion), the EAFRD, InvestEU and EIB loans, and, last but not least, through CEF Digital (EUR 2.1 billion. CEF Digital, a programme directly managed by the Commission through its HADEA Agency, will grant EUR 2 billion over 7 years for high-performance connectivity infrastructures, with the aim of leveraging between EUR 3 and 6 billion targeted investments in line with the 2030 digital connectivity targets.

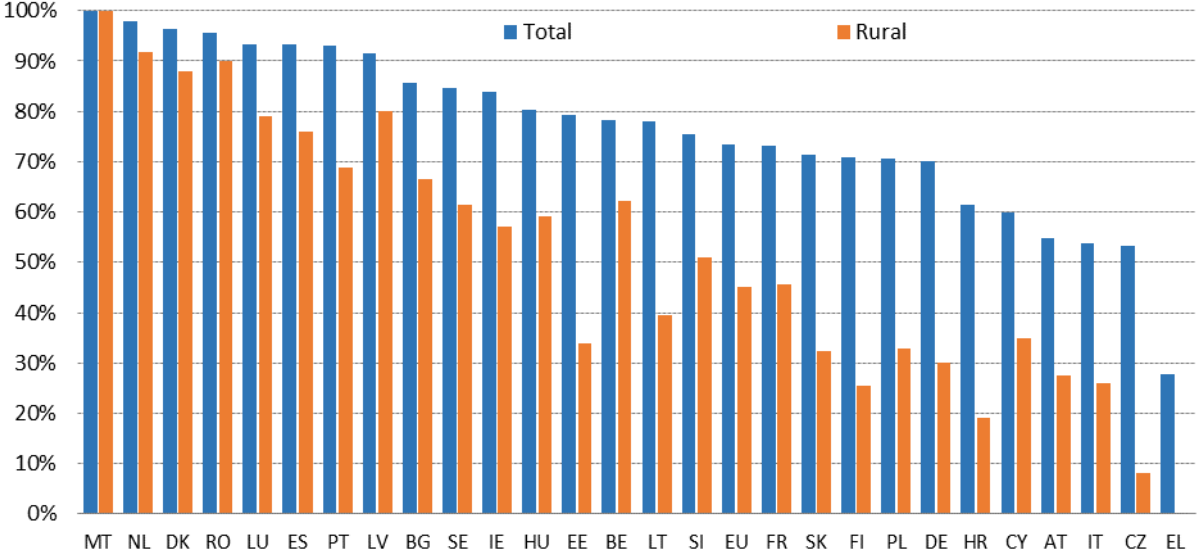
Figure 15 Fixed very high-capacity network (VHCN) coverage (% of households) in the EU, 2015-2022



Source: IHS Markit, Omdia and Point Topic, Broadband coverage in Europe studies

In mid-2022, Malta had the highest rate with 100% of total VHCN coverage, followed by the Netherlands, Denmark, Romania, Luxembourg, Spain, Portugal, and Latvia with above 90% coverage. On the other hand, VHCN covered less than two thirds of households in Greece (28%), Czechia (53%), Italy (54%), Austria (55%), Cyprus (60%) and Croatia (61%). There has been significant progress in Cyprus (19 percentage points), France, Croatia, and Italy (each 10 percentage points). The average rural coverage across all countries is 53%, which is well below the average total coverage of 77%.

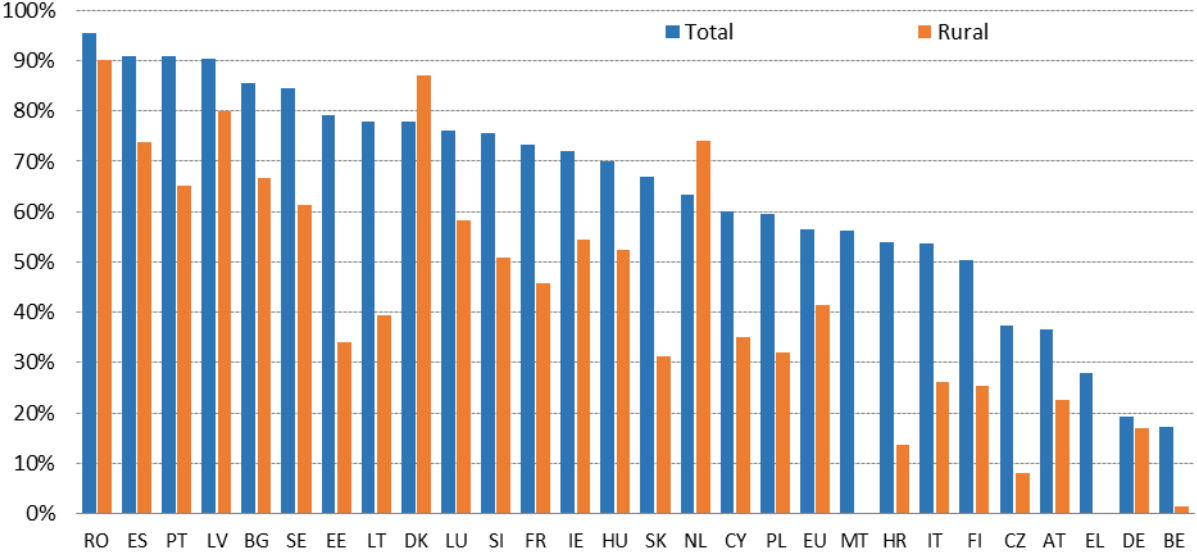
Figure 16 Fixed very high-capacity network (VHCN) coverage (% of households), mid-2022



Source: IHS Markit, Omdia and Point Topic, Broadband coverage in Europe studies

Fibre to the premises (FTTP) coverage almost doubled in the last 5 years and reached 56% in 2022 in the EU. Romania, Spain, Portugal, Latvia, and Bulgaria had the highest rates, at or above 85% FTTP coverage, while Belgium, Germany and Greece are still lagging behind the other EU countries, with below 30% coverage. FTTP coverage increased most in Cyprus (19 percentage points) and in the Netherlands (11 percentage points). Rural FTTP coverage is catching up, and reached 41% of households in 2022, as opposed to 11% five years ago.

Figure 17 Fibre to the Premises (FTTP) coverage (% of households), mid-2022

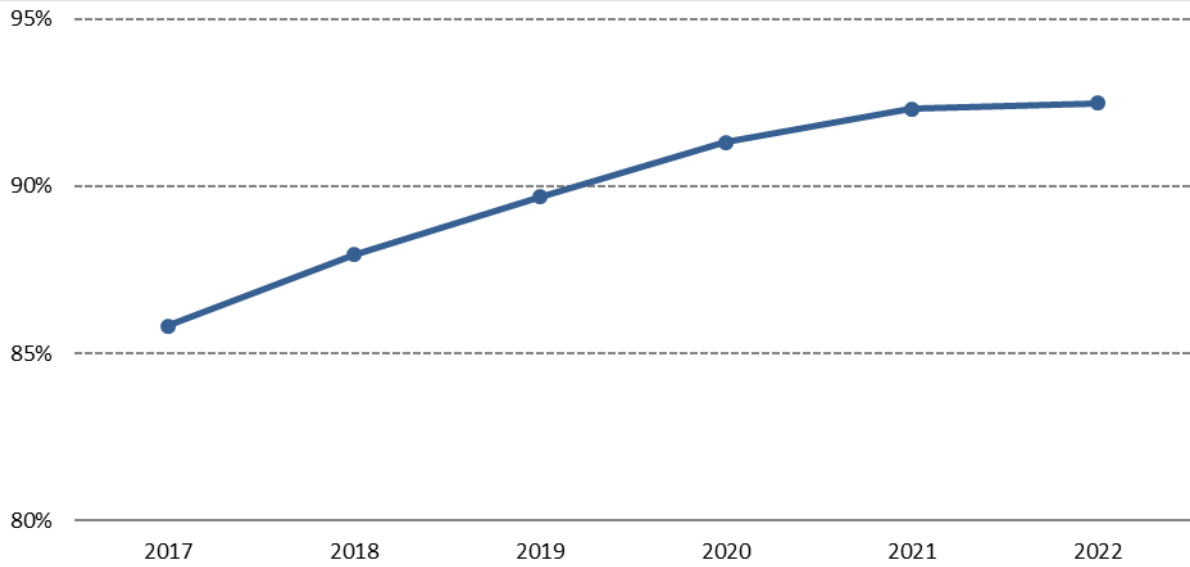


Source: IHS Markit, Omdia and Point Topic, Broadband coverage in Europe studies

2.2.1.2 Fixed broadband take-up

92% of households had access to internet in 2022, compared to 86% 5 years ago.

Figure 18 Households with access to Internet in the EU (% of households), 2017-2022



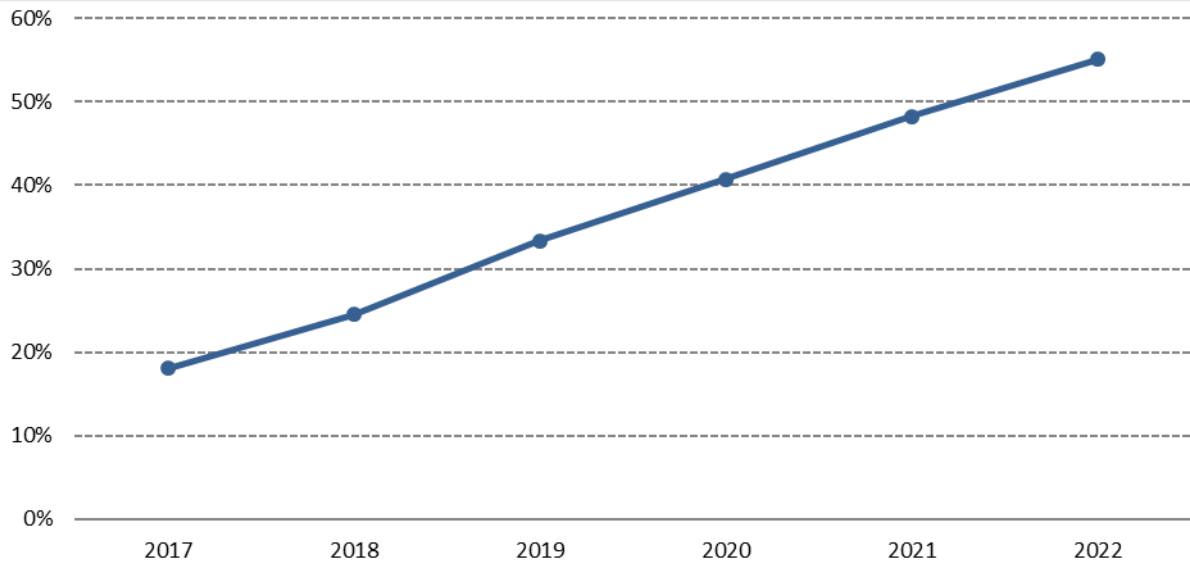
Source: Eurostat, European Union survey on the use of ICT in Households and by Individuals; Households - level of internet access (ISOC_CI_IN_H)

National take-up rates ranged from 85% to 98%. The Netherlands, Luxembourg and Finland registered the highest figures, while Greece, Croatia and Bulgaria had the lowest.

There is a small difference in overall broadband take-up between rural areas and cities: 90% of rural households have a broadband subscription compared with 94% of households in cities.

Looking at broadband speeds, there has been a sharp upward trend in at least 100 Mbps broadband penetration in the last 5 years. In 2022, 55% of EU households subscribed to such a service, up from 18% in 2017.

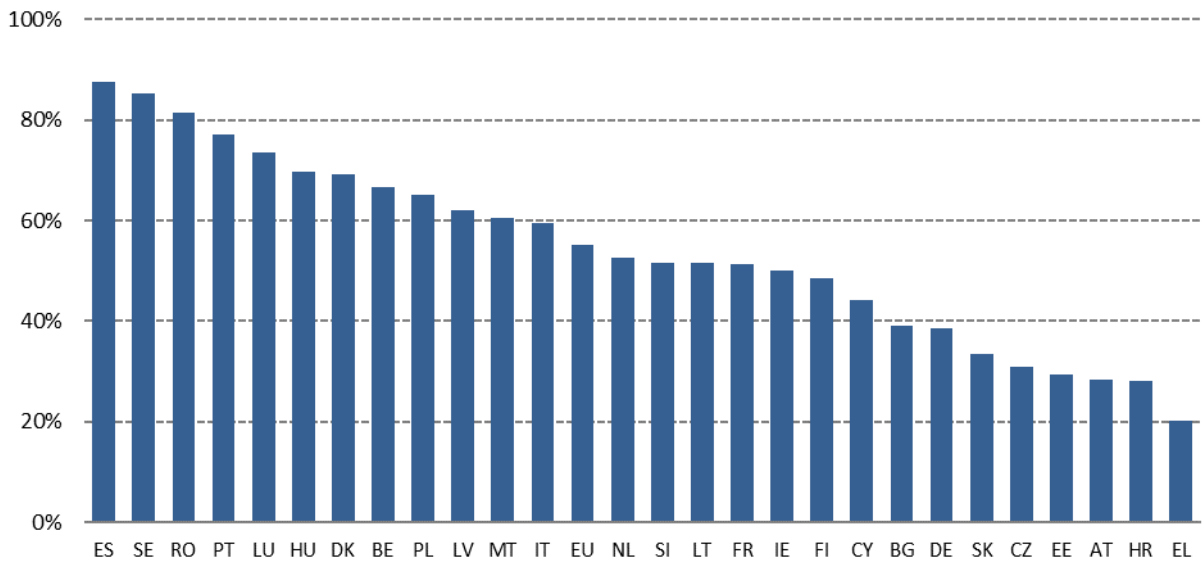
Figure 19 Households with a broadband subscription of at least 100 Mbps (% of households) 2017 – 2022



Source: Estimated based on the European Union survey on the use of ICT in Households and by Individuals and data from the Communications Committee (COCOM)

Over three quarter of households in Spain, Sweden, Romania, Portugal, and Luxembourg subscribed to at least 100 Mbps in 2022. In Greece, Croatia, Austria, and Estonia, by contrast, uptake is still low (less than 30%).

Figure 20 Households with a broadband subscription of at least 100 Mbps (% of households), 2022

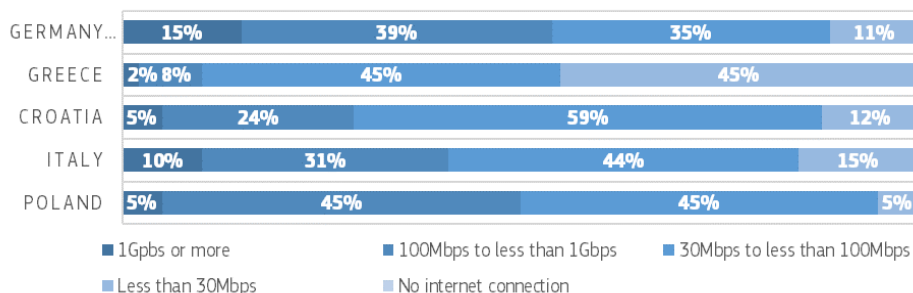


Source Estimated based on the European Union survey on ICT usage in Households and by Individuals and data from the Communications Committee (COCOM)

Regarding connectivity coverage in schools, Member States are on average still far from achieving the EU’s 2025 strategic connectivity target of high-speed broadband connectivity (at least 1 Gbps or more) for all schools.¹⁴⁹ A recent 2023 European Court of Auditors (ECA) report¹⁵⁰ showed that in the Member States covered by their survey¹⁵¹ very few schools had access to a gigabit broadband connection and are therefore able to take full advantage of ICT for digital education. In addition, poor infrastructure of the school buildings was marked as another issue preventing schools from good quality internet access. In their Recovery and Resilience Plans (RRPs), Member States have allocated large investments to measures improving school connectivity.

¹⁴⁹ Communication from the Commission on Connectivity for a Competitive Digital Single Market - Towards a European Gigabit Society, COM (2016)587.
¹⁵⁰ European Court of Auditors (2023). EU Support for the Digitalisation of Schools: Significant investments, but a lack of strategic focus in the use of EU financing by Member States. Luxembourg: Publications Office of the European Union.
¹⁵¹ The ECA report audited the following Member States: Germany, Poland, Austria, Croatia, Greece and Italy. Austrian schools were not covered by the specific survey. The survey covered ISCED (International Standard Classification of Education) levels 1-3.

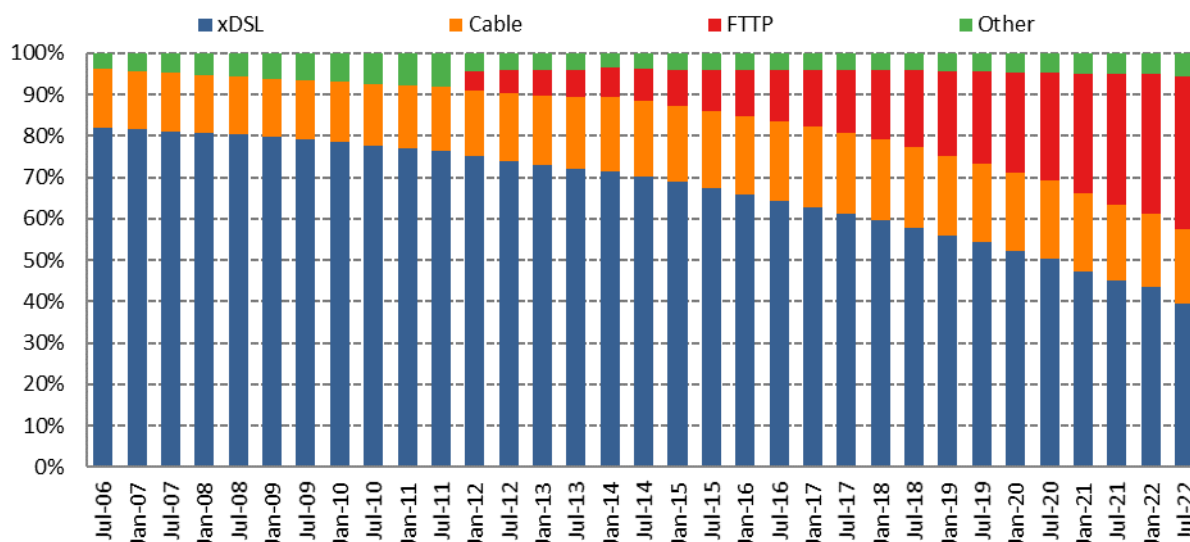
Figure 21 Download speed of schools according to contracts with telecoms providers



Source European Court of Auditors (2023). *EU Support for the Digitalisation of Schools: Significant investments, but a lack of strategic focus in the use of EU financing by Member States*. Luxembourg: Publications Office of the European Union.

xDSL remained the most widely used fixed broadband technology, although its market share decreased to 40% in 2022 from 82% in 2006. FTTP became xDSL's main challenger over the last years: the share of FTTP lines increased from 5% in 2012 to 37% in 2022. Cable lines¹⁵² represented 18% of fixed broadband lines in 2022, compared with 14% in 2006.

Figure 22 Fixed broadband subscriptions – technology market shares in the EU (% of subscriptions), July 2006-July 2022¹⁵³



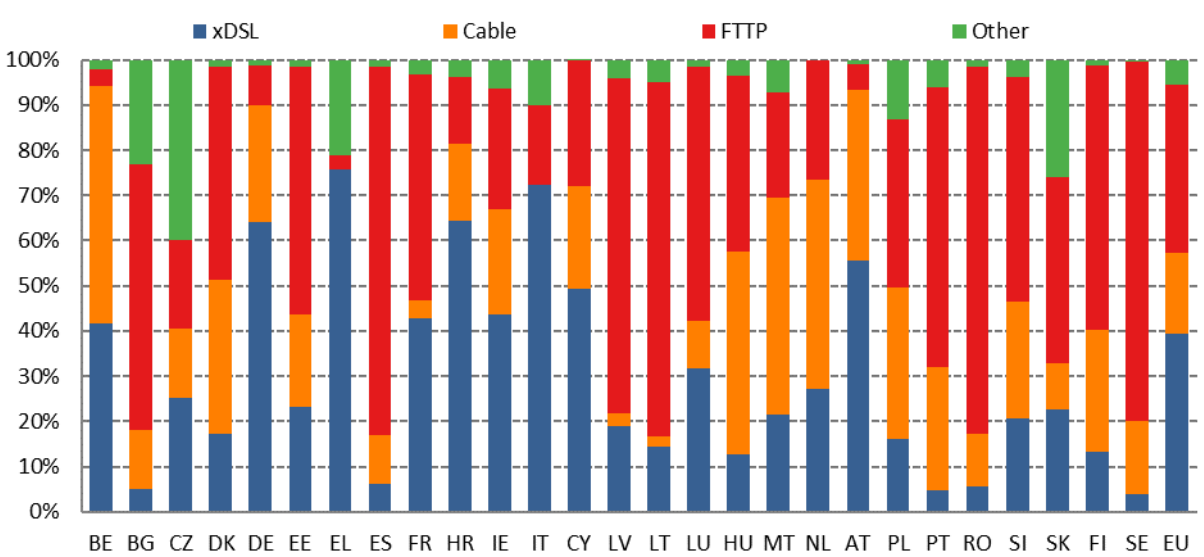
Source: Communications Committee (COCOM)

FTTP is the most widely used technology in a growing number of Member States and has the highest market share in Romania (81%), Spain (81%), Sweden (80%) and Lithuania (79%). On the other hand, cable is dominant in Belgium (53%), Malta (48%) the Netherlands (46%) and Hungary (45%).

¹⁵² Any DOCSIS standard.

¹⁵³ FTTP is part of 'other' technologies until June 2011 on the chart.

Figure 23 Fixed broadband subscriptions – technology market shares in the EU (% of subscriptions), July 2022

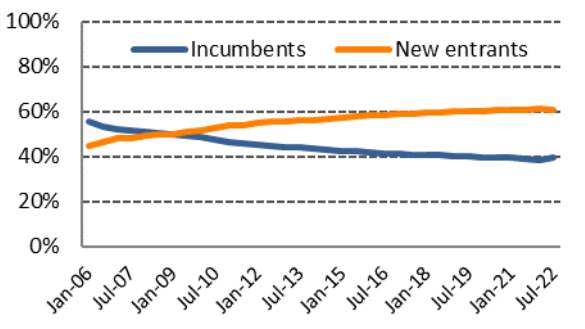


Source: Communications Committee (COCOM)

Market shares are calculated at national level for incumbents and new entrants. However, broadband markets are geographically fragmented, suggesting that a large number of households are served by only one provider (most likely the incumbent operator).

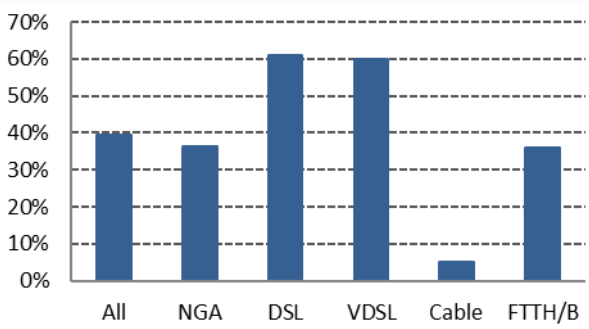
New entrant operators held 61% of fixed lines in 2022, compared with 45% in 2006. The market share of incumbents is the highest in Luxembourg (60%), Cyprus (58%), Estonia (57%) and Lithuania (53%) while it is lowest in Romania (11%) and Czechia (22%). However, incumbent operators remained predominant in the xDSL market.

Figure 24 Fixed broadband subscriptions – operator market shares in the EU (% of subscriptions), January 2006-July 2022



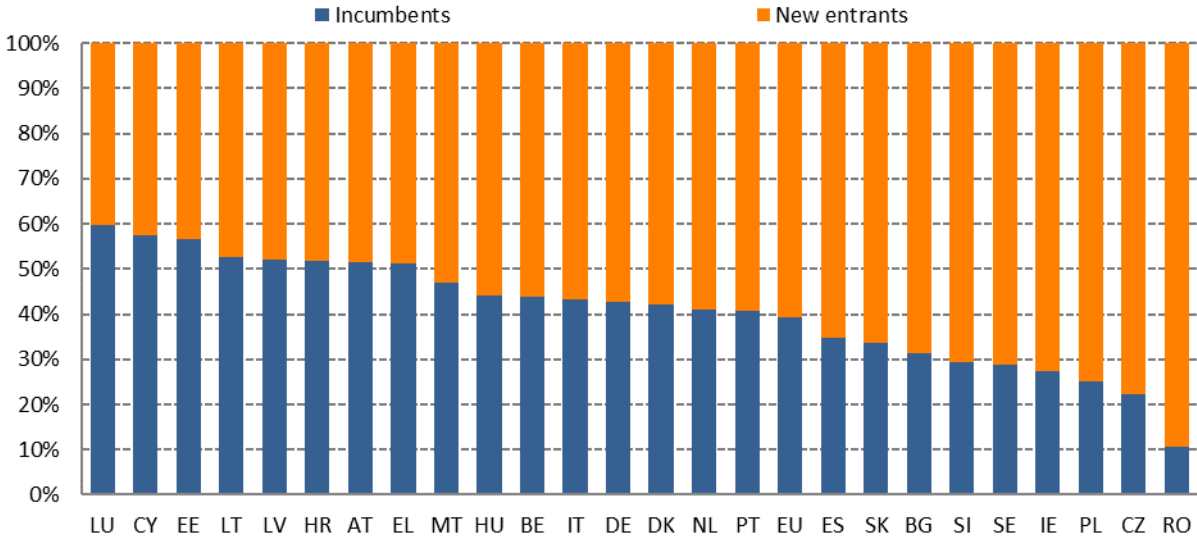
Source: Communications Committee (COCOM)

Figure 25 Incumbent operator market share by technology in the EU (% of subscriptions), July 2022



Source: Communications Committee (COCOM)

Figure 26 Fixed broadband subscriptions – operator market shares in the EU (% of subscriptions), July 2022



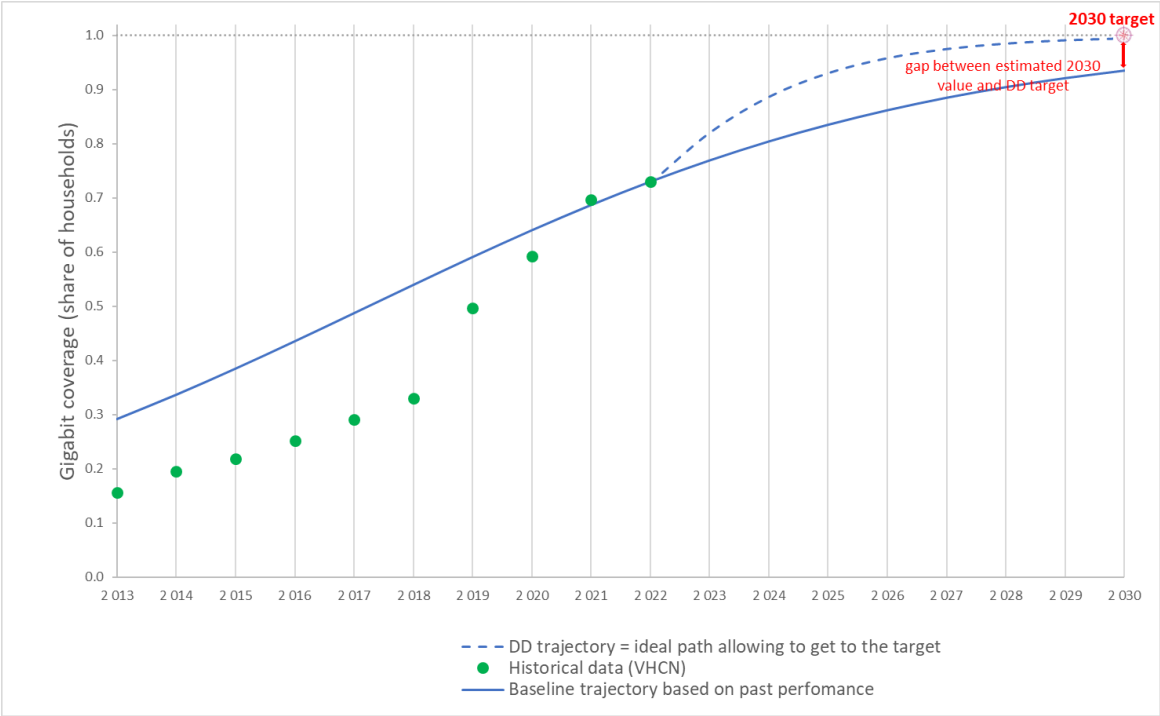
Source: Communications Committee (COCOM)

2.2.1.3 Trends towards 2030

The available historical data on the VHCN indicator show an S-shaped trend that is adopted for this KPI for both the Digital Decade and the baseline trajectory (Figure 27). This is in line with the conceptual model assumed for this measure where, typically, the additional deployments of optical fibre-based infrastructures start in areas with reasonable investment costs as well as in dense urban areas where existing cable networks are being upgraded. Conversely, the persistent investment gap affects households in the more cost-intensive suburban, semi-rural and rural areas, and remote regions.

The speed of diffusion of the VHCN baseline trajectory is based on the Fibre to the Premises (FTTP) historical data. This better reflects the expected investment costs of deploying optical fibre infrastructure under the assumption that future gigabit rollout will depend solely on FTTP infrastructure. Figure 27 shows that the baseline trajectory, based on the currently available data is expected to reach 94% by the end of the projection period.

Figure 27 Fixed Very-High-Capacity Networks coverage in the EU. Historical data, Digital Decade (DD) trajectory and baseline trajectory towards 2030¹⁵⁴



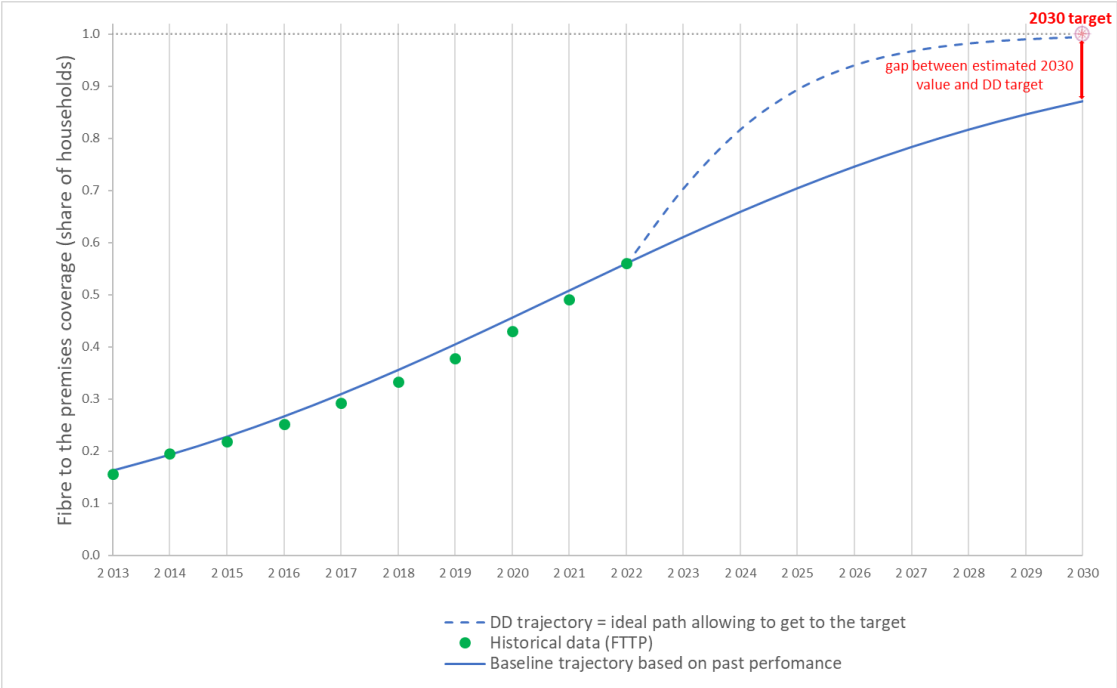
The current indicator for Fixed very high-capacity networks (VHCN), based on the current DESI indicator, covers networks currently able to deliver gigabit connectivity; however, this may include networks that are not at present delivering gigabit connectivity, not least at peak time conditions. This is for instance the case of DOCSIS 3.1 networks which do not have fibre deployed sufficiently close to the end-user. However, it is not currently possible to appropriately map and therefore exclude such networks from the measurement. In consequence, the measured values may be higher than the actual coverage. Moreover, the upgrade of DOCSIS 3.0 networks currently covering 11 % of homes will have a very limited impact on rural connectivity. Lastly, not all FTTP networks are currently sufficiently dimensioned to provide Gigabit speeds at peak time. More investments are needed in the core and backhaul parts of the network to be able to sustain the exponential growth in data transmission needs expected by 2030 and beyond. Further investments in hardware and software are expected to be necessary beyond the upgrade of the access networks to fibre. Additional work will be required to agree a common methodology for a KPI to measure gigabit connectivity to allow the comparison of data at EU level on the quality of service of VHCN infrastructures capable of delivering 1 Gbps under peak time conditions.

Fixed VHCN having the capability of offering gigabit connectivity, covered 73% of EU households in 2022, up from 70% a year earlier. This growth has been driven by the deployment of optical fibre networks (Fibre to the Premises or FTTP), which in 2022 covered 56% of EU households. The remaining 27% of households still not covered by VHCN will be reached mainly through further FTTP deployments, requiring sustained efforts. It is not excluded that the most rural areas will have to be reached by 5G Fixed Wireless Access networks. Moreover, gaps in rural areas persist, with 55% of households in rural areas not covered by VHCN, a factor that places further challenges to further gigabit rollout until full coverage. It shall be noted that the marginal cost of connecting a household substantially increases when reaching rural and remote areas.

¹⁵⁴ Details on Digital Decade and baseline trajectories are presented in the “Communication from the Commission establishing Union-level projected trajectories for the digital targets” [C\(2023\) 7500](#)

In order to track the progress of FTTP coverage, as outlined in the KPI Implementing Decision, EU-level trajectories are developed for this indicator as well (Figure 28). According to estimates along the baseline trajectory, by 2030, FTTP is projected to reach 87% of households in the EU.

Figure 28: Fibre to the Premises coverage in the EU. Historical data, Digital Decade (DD) trajectory and baseline trajectory towards 2030¹⁵⁵



2.2.1.4 Actions at EU and national level

Transposition of the European Electronic Communications Code (EECC)

Achieving the timely deployment of secure connectivity networks, available to all EU citizens and businesses, not only requires a good cooperation with Member States, but also a regulatory framework that can facilitate investments in the sector and measures that can address long-term challenges in the connectivity ecosystem.

The European Electronic Communications Code, adopted in 2018, brought the regulatory framework governing the European telecommunication sector up to date. Its transposition is a prerequisite to foster conditions for the achievement of the targets and objectives that the Digital Decade Policy Programme sets.

The Member States had two years to transpose the Code into their legal system and the Commission has been monitoring the process and providing them with guidance and assistance. However, in April 2022 the Commission referred 10 Member States (Spain, Croatia, Latvia, Lithuania, Ireland, Poland, Portugal, Romania, Slovenia, and Sweden) to the Court of Justice of the European Union over their failure to fully transpose and communicate to the Commission their respective national implementing measures. Since then, some of the Member States concerned have notified full transposition and currently 16 Member States (Austria, Belgium, Bulgaria, Czechia, Denmark, Finland, Germany, Greece, Hungary, Italy, Lithuania, Luxembourg, Malta, Slovakia, Spain, and Sweden) have communicated that the Code had been transposed in their national legal system.

¹⁵⁵ Digital Decade and baseline trajectories are presented in the “Communication from the Commission establishing Union-level projected trajectories for the digital targets” [C\(2023\) 7500](#)

The infringements remain open against 11 Member States, including Ireland, Latvia, Poland, Portugal, and Slovenia, which were referred to the Court of Justice of the European Union. Croatia and Romania have notified full transposition in July 2022, hence the Commission decided to suspend their referral to the Court. The completeness checks for the nine countries (the above mentioned 11 except for Ireland and Poland, which have yet to notify full transposition), as well as Cyprus, Estonia, France, and the Netherlands are ongoing.

Review and adaptation of the Regulatory Framework

The Union keeps modernising its Regulatory Framework for Electronic Communications to further promote competition and support the deployment of connectivity.

The proposal for a ‘Gigabit Infrastructure Act’ was adopted on 23 February by the Commission as part of a package of measures to support connectivity. It aims at **reducing the cost of rolling out gigabit infrastructure** across the EU by streamlining permits and limiting the associated charges and fees, digitalising the permit granting procedures, ensuring better and more information on infrastructure and planned civil works in electronic format. It also aims to foster fibre deployment by pre-equipping new and majorly renovated buildings with fibre and ensuring building fibre-readiness, in synergy with the building renovation wave triggered by Green Deal, and ensuring clearer conditions for access to physical infrastructure and coordination of civil works.

The EECC aims at stimulating infrastructure-based competition (e.g., access to passive network has a priority) and relaxing cumbersome regulation where it is no longer necessary (e.g., regulatory commitments, co-investments). The Commission has consulted BEREC on its draft Gigabit Recommendation, which is aimed at complementing the proposed Gigabit Infrastructure Act. The draft Gigabit Recommendation aims to support the EU internal market for electronic communications and services by favouring investment and enhancing effective competition. It emphasizes the importance of provisions introduced by the Code (i.e., access to civil engineering infrastructure as the first, and, under certain conditions, the only remedy, co-investment, commitments, promotion of cooperative arrangements and wholesale-only operators).

At national level, Member States have intensified their efforts to achieve the Digital Decade objective. In order to facilitate network deployment, Belgium has launched a website fibreinfo.be which provides information on fibre deployment. In Ireland, the MPBT, made up of state actors and industry representatives, is tasked with identifying and overcoming barriers to improved connectivity, e.g. in the areas of permit granting, planning and licensing processes and more efficient use of infrastructure and assets. A nation-wide analysis (“Potenzialanalyse”) was conducted in Germany to ensure greater transparency of the potential for future roll-out of fibre networks at local level and for the funding of broadband. The analysis quantitatively estimates the scope of private roll-out in areas that are underserved.

The exploratory consultation has gathered views on the future of the electronic communications sector and its infrastructure was launched on 23 February 2023 to allow a broad reflection on the future of the connectivity infrastructure, investigating the impact of technological and market developments on future networks and business models of electronic communications providers, consumer related aspects, the existing barriers to the consecution of a real single market and the issue of the fair contribution by all players benefitting from the digital transformation.

The consultation closed on 19 May 2023. The Commission received 437 contributions and 164 position papers from different participants from industry stakeholders, to citizens, NGOs, Academia and research institutes and EU Member States, as well as contributions from the United Kingdom and the USA. A summary of the contributions will be published.

Overall, it is important to ensure that Europe remains on top of innovation and technological developments. R&D and legislation should evolve accordingly and accompany these developments.

Europe should further reap the benefits of a truly internal market, including for electronic communications.

To achieve the ambitious 2030 targets, the EU has established an effective policy programme and governance mechanism to ensure good collaboration between Member States, businesses, local communities, industry, and other sectors, while also setting a strong regulatory framework to facilitate massive connectivity investments for the future.

The principle of the open internet is embedded in Regulation (EU) 2015/2120, which has applied in all Member States since 30 April 2016. The Commission recently reviewed, for the second time since 2016, the Regulation's provisions on open internet access (Articles 3, 4, 5 and 6) and submitted a report to the European Parliament and the Council. It concluded that the Regulation and its implementation have been able to stand the test of time and confirmed that the principle-based approach of the Regulation continues to guarantee the essential balance between the protection of end-user rights and the need to foster a competitive EU digital single market. It also concluded that the principles of an open internet remain relevant, from the perspective of end-users, content and application providers, and internet access service providers.

Several NRAs have already used the new regulatory tools put at their disposal by the Code. The DK NRA has imposed access obligations on wholesale-only operators in its recent wholesale broadband market review¹⁵⁶. The French¹⁵⁷ and Finnish NRAs have enforced regulatory commitments under their regulatory measures for the wholesale broadcasting markets.

With the spreading of deployments an increasing level of competition can be observed, in particular in the most densely populated areas. The NRAs are therefore gradually deregulating the markets, targeting their regulation in the geographic areas and services where regulation is still needed to ensure competition. The segmentation of the geographic market or the segmentation of remedies is a flexible regulatory approach that many NRAs are adopting. The NRAs of Finland, Hungary, Poland, Spain, Germany, Ireland, Slovenia, Austria, and Croatia have defined separate geographic markets for local and central access or/and for dedicated capacity. The NRAs of Cyprus, Belgium, France, Denmark, and Slovenia have differentiated remedies on geographic basis on the markets for local and central access or/and for dedicated capacity. Finally, the NRAs of Italy, Belgium and Portugal have mixed defining separate geographic markets with differentiation of remedies.

The FR NRA defined a separate geographic market for access to the civil engineering infrastructure. The Commission called upon the NRAs of Spain and Estonia to consider the same for the next round of market reviews. The Commission also encouraged the DE NRA to have a price differentiation between legacy and newly built assets.

As the markets for (fixed and mobile) call termination was withdrawn in 2020 from the list of markets recommended for ex ante regulation, the Commission consistently asks those regulators that still maintain regulation of these markets to reassess their current findings even prior to the end of the current market review cycle¹⁵⁸.

Furthermore, the Commission, in its role of ensuring consistency of regulatory obligations in the EU, opened four Phase 2 investigations in 2022 and 4 in 2023. In two Polish cases the Commission questioned the lack of mandatory public consultations for the proposed regulatory measures and in two Czech cases the Commission expressed its serious doubts with respect to the compatibility of the analysis of wholesale broadband markets with competition law. In all those cases, the Commission's

¹⁵⁶ DK/2021/2346.

¹⁵⁷ FR/2022/2365, FI/2022/2401.

¹⁵⁸ LV/2022/2410, DE/2023/2425.

assessment was supported by BEREC and the notifying regulators eventually withdrew their notifications.

Measures for the financing of the connectivity investment gap

At EU level, there are several financial instruments that were put in place to bridge the digital gap, including the urban/rural one: the RRF, the European Regional Development Fund (ERDF), the European agricultural fund for rural development (EAFRD), the Connecting Europe Facility (CEF) – Digital programme, the Connecting Europe Broadband Fund (CEBF) and the InvestEU initiative, which in particular will allow the European Investment Bank and National Promotional Banks to make use of the EU guarantee and leverage public resources by attracting additional resources from the private sector. For example, the Nordic Investment Bank (NIB) has signed in December 2022 an InvestEU guarantee agreement worth up to EUR 114 million. The agreement will unlock NIB financing of up to EUR 480 million specifically for digital investments across the Nordic and Baltic countries as well as Poland.

For the period 2021-2027, the financing of broadband will mostly come from the RRF, ERDF and CEF. The total digital expenditure in the Recovery and Resilience Plans (RRPs) amounts to EUR 130 billion, about 26% of the total plan allocation. Investments in digital connectivity have attracted about 13% of the RRF digital expenditure amounting to about EUR 16.4 billion¹⁵⁹, including Very High-Capacity Networks and 5G roll-out in market failure areas (e.g., rural, sparsely populated areas). More specifically for Gigabit networks the expected expenditure is close to EUR 13 billion. For example:

- Italy (allocation to connectivity: EUR 6.7 billion) will implement five connectivity measures, providing around 7 million street addresses with fixed gigabit connectivity, facilitating the development of 5G mobile networks in market failure areas, securing approximately 10000 schools with free gigabit internet connectivity services, providing approximately 12 300 healthcare facilities with (at least) gigabit connectivity and connecting 19 smaller islands with fibre optic core network cables.
- The Croatian plan (allocation to connectivity: EUR 157.5 million) includes a reform and investment package with the aim to provide gigabit connectivity to households and socio-economic drivers. The reform aims to identify and address the administrative burden and regulatory barriers related to the construction of gigabit connectivity networks, as well as to implement the necessary regulatory framework and the objectives of the National Broadband Plan. The reform is accompanied by investments in the deployment of broadband infrastructure to at least 100 000 Croatian households.
- Estonia plans substantial investments (EUR 24.3 million) in very high-capacity networks in rural areas, which is expected to ensure broader access to online services. Overall, 8000 sites (residential, companies, establishments) will be covered by very high-capacity networks under this investment.

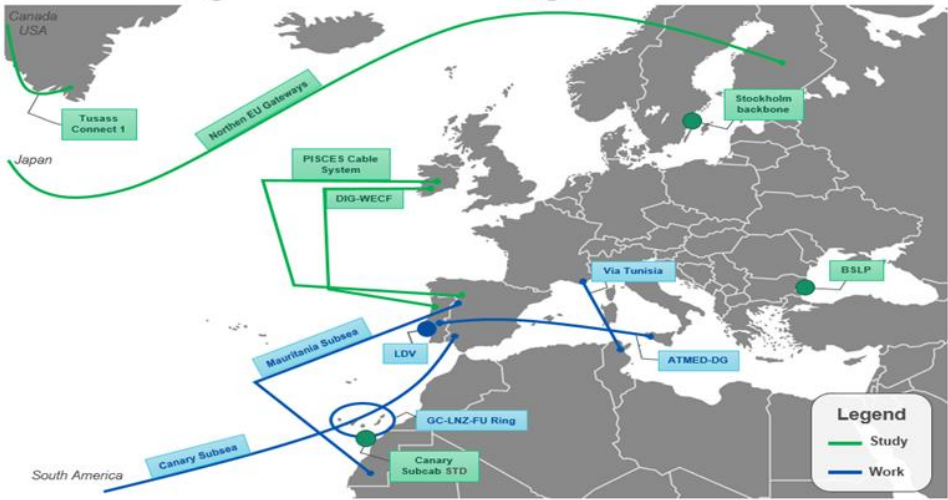
The CEF Digital programme, moreover, will also support and catalyse both public and private investments in digital connectivity infrastructures with a budget of EUR 2.1 billion over 7 years. It is the first programme under the Multiannual framework 2021-2027 directly managed by the European Commission. DG CNECT has already approved some excellent proposals for the first set of calls and have received an overwhelming number under call two. CEF Digital projects inter alia support submarine cables, a key infrastructure for secure connectivity links within the EU and with like-minded countries. Overall, the goal of this CEF Digital action is to support the deployment of backbone networks as part of the **Digital Global Gateway Strategy of the EU**, by strengthening the quality of connectivity and improving network reliability within the Union, including its most remote parts i.e. the Outermost Regions, as well as with third countries. More specifically, this means

¹⁵⁹ https://ec.europa.eu/economy_finance/recovery-and-resilience-scoreboard/disbursements.html?lang=en

creating the necessary infrastructure, like submarine cables, to ensure internet connectivity despite any outages or significant increases in data traffic.

Out of the 25 projects submitted, **13 projects** were selected (depicted in the below map), the first one starting its deployment on 1 June 2022.

Figure 29: Selected Global Gateways projects



In addition, the Connecting Europe Broadband Fund (CEBF), an equity fund of EUR 555 million, of which about 30% are from private investors, created in 2018 at the initiative of the Commission with the participation of the EIB and five national promotional banks, is currently investing in state-of-the-art networks in predominantly greenfield areas (grey or white areas, typically semi-dense or rural areas) across the EU. So far, the Fund has invested in the roll-out of FTTH to 1.7 million premises in the Union.

Furthermore, the Commission supports the implementation of the new Union’s Secure Connectivity Programme 2023-2027 IRIS (Infrastructure for Resilience, Interconnectivity and Security by Satellite) with a budget of EUR 2.4 billion of the total cost of about EUR 6 billion, which also includes satellite broadband coverage in rural areas. While not contributing directly to the achievement of the Digital Decade targets, satellites could provide resilient and flexible connectivity allowing Europe to always remain connected, including in the event of large-scale cyber-attacks.

Finally, the EU is also leveraging connectivity investments through the Cohesion Funds like the ERDF (about EUR 2.36 billion). Member States, which are planning to use ERDF for higher Gigabit investments during the next years, are Poland (ca. EUR 800 million), Greece (ca. EUR 246 million), Spain (ca. EUR 244 million), Hungary (ca. EUR 208 million) and Portugal (ca. EUR 157 million)”.

Moreover, the Commission adopted a revised [Communication on State aid for broadband networks](#) ('Broadband Guidelines'), setting out the rules under which it will assess State aid measures notified by Member States to support the deployment and take-up of broadband networks in the EU. The new rules contribute to the EU's strategic objectives of ensuring gigabit connectivity for everyone everywhere by the end of the decade, which is essential to achieve the [digital transition](#) of the Union. In particular, the revised Guidelines align the threshold for public support to fixed networks with the latest technological and market developments and explain how public support can be used to incentivise the take-up of broadband services. They also simplify and clarify certain rules to facilitate the practical application of the Guidelines and to cut red tape for companies and public authorities, e.g., in the area of wholesale access products, mapping, wholesale access pricing, and claw back

mechanisms. Lastly, they update the criteria used for balancing the positive impact of the aid against its negative effects on competition and trade.

While all investments need to be in line with the applicable State Aid rules, the Commission also adopted a targeted amendment to the General Block Exemption Regulation ('GBER') to further facilitate, simplify and speed up support for the EU's green and digital transitions. Aid measures that are fully in line with all relevant criteria in the GBER can be implemented directly by the Member States without prior scrutiny by the Commission.

This includes support for the deployment of broadband networks, as well as mobile networks such as 5G networks, to bring high quality infrastructure to areas suffering from insufficient broadband coverage, in particular in rural and remote areas. It also includes support for backhaul networks, highly relevant for the further deployment of both fixed and mobile networks.

The GBER also fosters aid for certain projects of common interest, financed under CEF2 or awarded a Seal of Excellence under CEF2. This is particularly relevant for cross-border 5G corridors and certain backbone networks and submarine cables.

The revised GBER also exempts from notification certain aid measures in the form of a vouchers for consumers to facilitate teleworking, online education, training services or for SMEs, provided that certain conditions are fulfilled.

2.2.2 5G next-generation wireless high-speed networks

Three frequency bands have been identified and harmonised as the 5G pioneer bands in the Union. These are the 700 MHz (694-790 MHz), the 3.6 GHz (3.4-3.8 GHz) and the 26 GHz (24.25-27.5 GHz) frequency bands. To achieve the single market objectives *inter alia* for timely 5G deployment in the Union, Member States had to allow the use of the 5G pioneer bands by end 2020. So far, not all Member States have respected this deadline.

The 5G spectrum indicator in the DESI shows the portion of spectrum assigned for 5G purposes in each Member State in the 5G pioneer bands identified and harmonised in the EU. The percentage score of the 5G spectrum indicator is based on the amount of spectrum assigned in a specific Member State and ready for 5G use.

This score is calculated based on the portion of spectrum assigned in each 5G pioneer band in comparison with the maximum feasible amounts, which are as follows:

- 700 MHz band: 60 MHz (703-733 & 758-788 MHz);
- 3.6 GHz band: 400 MHz (3,400-3,800 MHz);
- 26 GHz band: 1000 MHz within 24,250-27,500 MHz.

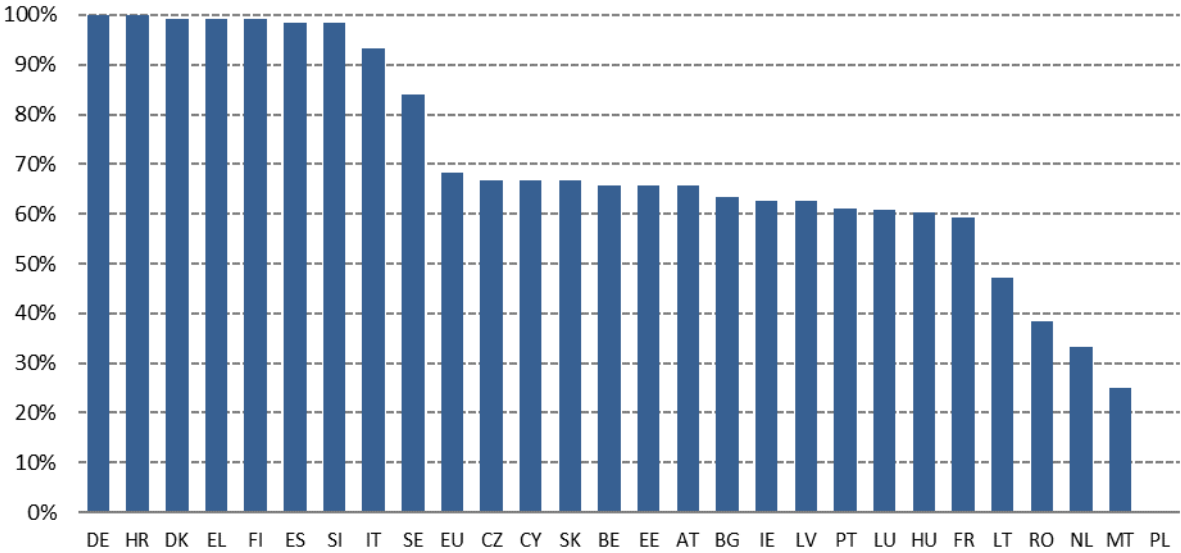
All three spectrum bands have an equal weight, so having the maximum feasible amount assigned – and ready for 5G use – in the range of one of these bands will result in a score of 33.3%, i.e., one third of the total maximum score.

Remarks:

1. For the 700 MHz band, there are a number of derogations allowing for a delay until 30 June 2022. However, the 5G spectrum indicator is about factual reporting, not a judgement on legal compliance.
2. For the 3,400-3,800 MHz band, only licences aligned with the latest technical conditions (in line with Commission Implementing Decision (EU) 2019/235) were considered ready for 5G use.
3. For the 26 GHz band, at least a portion of 1,000 MHz within the band must be assigned and ready for 5G use, as required by the European Electronic Communications Code.

By the end of March 2023, 26 of the 27 Member States had assigned spectrum in the 5G pioneer bands. Germany, Croatia, Denmark, Greece, Finland, Spain, Slovenia and Italy assigned more than 90% of spectrum. Poland has not yet assigned any 5G spectrum (according to the conditions mentioned above).

Figure 30 5G spectrum (assigned spectrum as a % of total harmonised 5G spectrum), end of March 2023



Source: Communications Committee (COCOM)

Therefore, overall 5G coverage of populated areas using any spectrum band grew to 81%¹⁶⁰. Looking at the 3.4-3.8 GHz band, 5G is available in 41% of populated areas. The pace of deployment of 5G depends not only on the timely availability of spectrum but also on the business strategy of each operator, their current network topology and the level of demand (cf. p. 212 of the study assessing the efficiency of radio spectrum award processes in the Member States, including the effects of applying the European Electronic Communications Code).

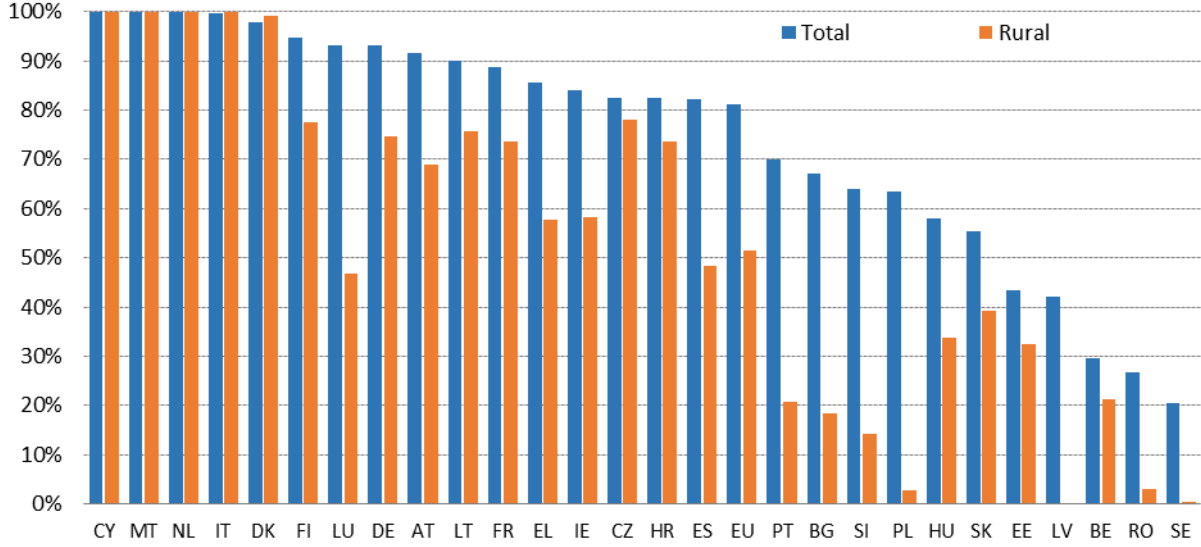
Commercial services were launched in all Member States as of mid-2022. Overall coverage is above 90% in 10 Member States: in Cyprus, Malta, the Netherlands, Italy, Denmark, Finland, Luxemburg, Germany, Austria, and Lithuania. A significant share of this coverage was achieved using 4G spectrum rather than 5G pioneer bands, which allow for higher performance potential. Spectrum sharing is deployed by operators to accelerate their 5G rollouts, but also to optimise overall spectrum use. This is a solution to enable frequency sharing between 5G and 4G (and sometimes 3G too). An area has 5G coverage if it is in the stated coverage area of at least one 5G mobile network as reported by

¹⁶⁰ European 5G Observatory, European 5G scoreboard, last updated in July 2022.

operators and national regulatory authorities. It is expressed as the percentage of populated areas. The user experience is not measured in this indicator, and it may be affected by a variety of factors such as the spectrum, the device used, environmental conditions, number of concurrent users and network capacity. Such factors make it difficult to compare operators' 5G rollouts using just population coverage metrics, headline data rates, etc.

Unlike the majority of current 5G networks in the Member States, which are non-standalone 5G, the standalone (SA) ones implement a 5G core network to manage connectivity, mobility, and user authentication, as well as other essential network management functions. Only the unconstrained SA 5G mode can deliver all the promised features of 5G New Radio (NR) (lower cost and more efficient delivery of better user experience and support for a variety of use cases).

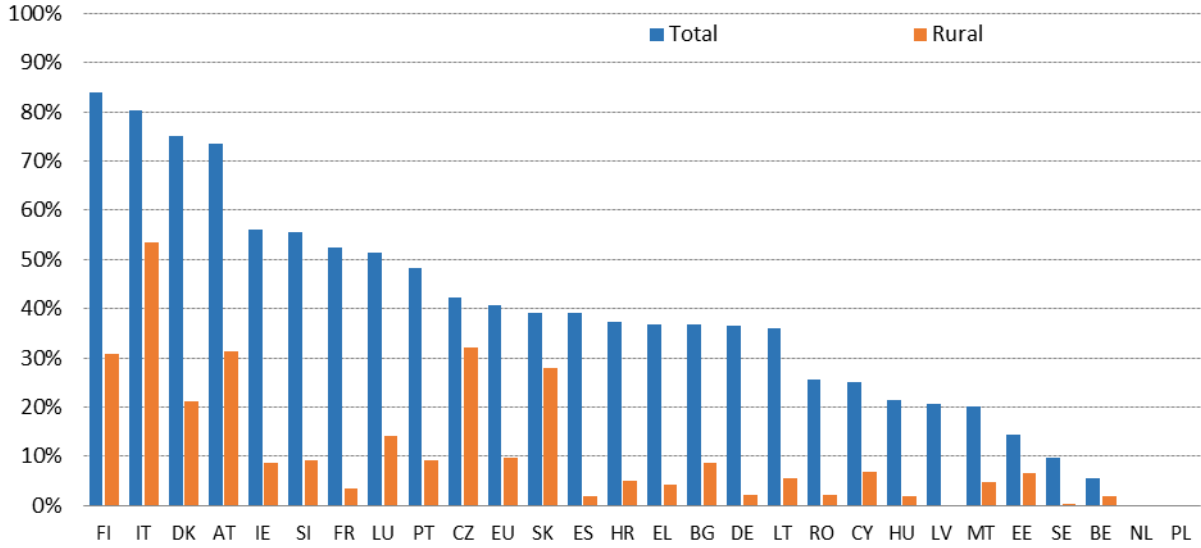
Figure 31 Overall 5G mobile coverage (% of populated areas), mid-2022



Source: IHS Markit, Omdia and Point Topic, Broadband coverage in Europe study

Looking at only the 3.4-3.8 GHz band, coverage of populated areas stands at 41%, with the highest rates recorded in Finland (84%), Italy (80%), Denmark (75%) and Austria (74%).

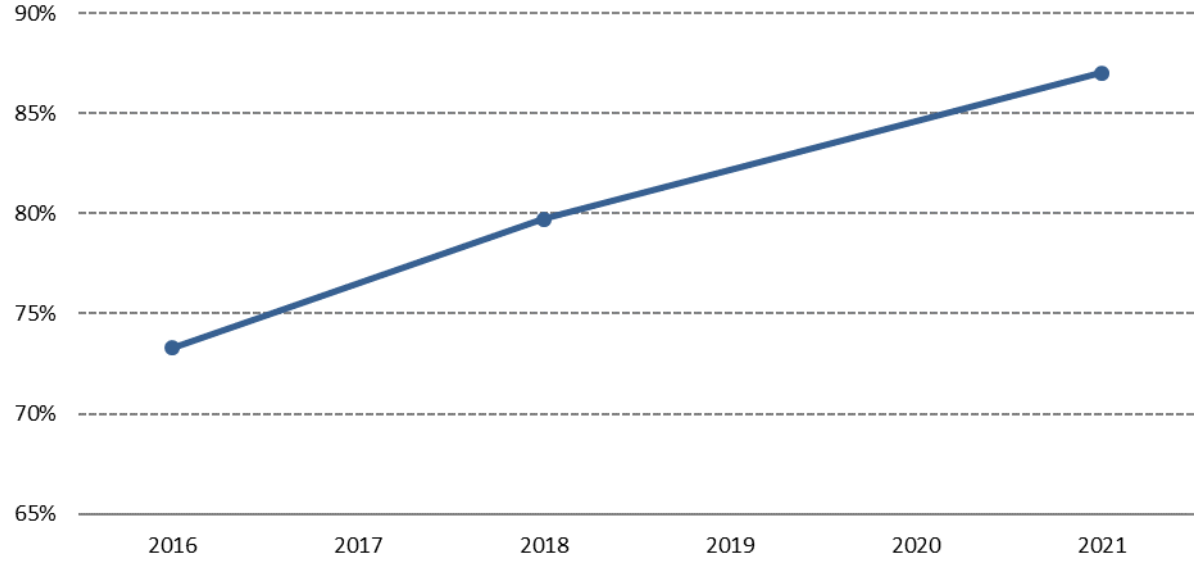
Figure 32 5G mobile coverage on the 3.4-3.8 GHz band (% of populated areas), mid-2022



Source: IHS Markit, Omdia and Point Topic, Broadband coverage in Europe study

In 2021, 87% of people used a mobile device to access the internet (up from 73% in 2016), which corresponds to the number of regular internet users (87% of people in 2021). Mobile internet access is a useful proxy indicator for measuring connectivity rate in the population.

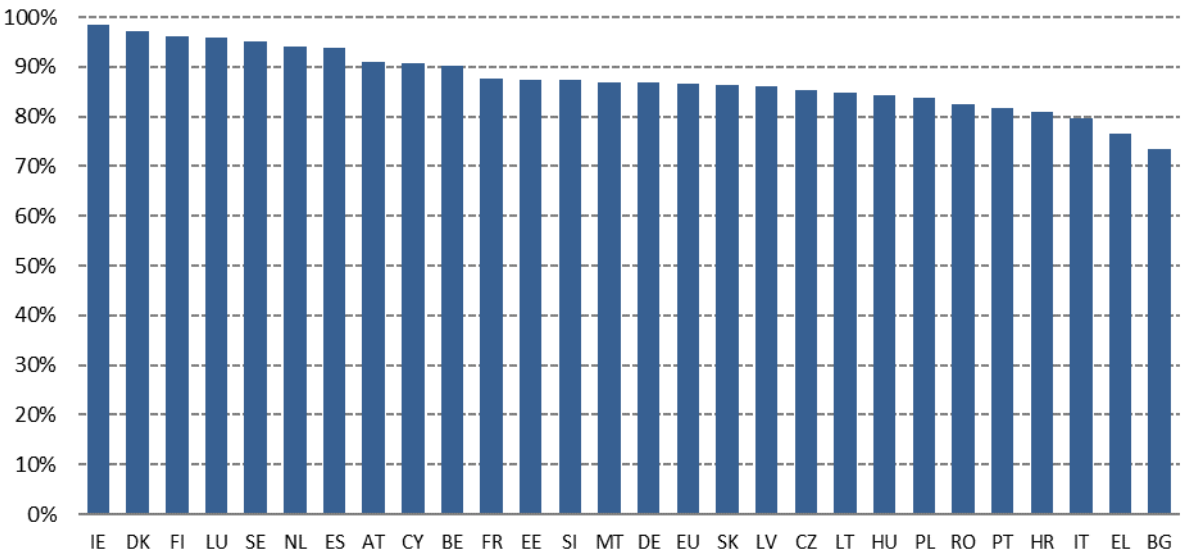
Figure 33 Mobile broadband penetration in the EU (% of individuals), 2016-2021¹⁶¹



Source: Eurostat, European Union survey on the use of ICT in Households and by Individuals

Mobile broadband is widely used in every Member State; national penetration rates vary between 73% in Bulgaria and 98% in Ireland.

Figure 34 Mobile broadband penetration (% of individuals), 2021¹⁶²



Source: Eurostat, European Union survey on the use of ICT in Households and by Individuals

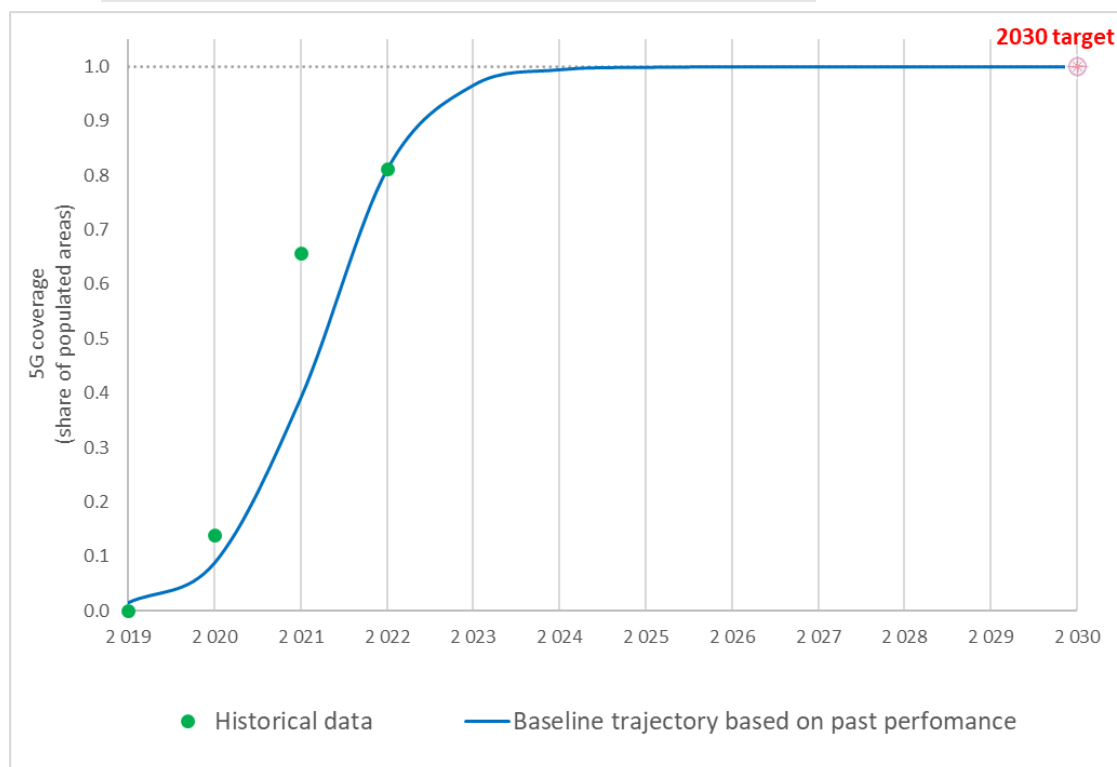
¹⁶¹ Data refers to individuals using a mobile device to access the internet.

¹⁶² Data refers to individuals using a mobile device to access the internet.

2.2.2.1 Trends towards 2030

Over the past few years, there has been a significant increase in 5G coverage, with the European Union value reaching 81.2% in 2022. Some Member States even reported values close to or at 100%. This expansion has relied on the utilization of dynamic spectrum sharing (DSS), which employs non-5G pioneer bands, such as 1.8 GHz or 2.1 GHz, enabling demand-based sharing between 4G and 5G. To determine the expected progress of this KPI, data from the years 2020 to 2022 has been analysed. Based on this analysis, the forecast along the baseline trajectory predicts that by 2024, 100% of populated areas in the EU will be covered by 5G networks overall. However, the current KPI for the 5G target does not take into account the quality of service provided under peak time conditions. Further significant investments will therefore be needed in 5G, primarily in the radio access network (i.e. building new base stations, interconnecting existing and new base stations). The use of more spectrum in the medium and high bands will be needed to gradually improve the quality of service on 5G networks and enable the deployment of 5G for Industry 5.0¹⁶³. A key challenge will be to ensure that the deployed networks support key industry sectors and critical applications that benefit consumers and businesses in all sectors. To measure Member States' readiness to overcome this challenge, further examination is required to improve and broaden the measurement framework for 5G to capture the actual quality of service as experienced under peak time conditions and encompass other "next-generation wireless high-speed networks" with performance equivalent to or surpassing 5G.

Figure 35 5G rollout in the EU, historical data and baseline trajectory towards 2030 ¹⁶⁴



¹⁶³ Industry 5.0 complements and extends Industry 4.0. It emphasises aspects that will be deciding factors, not just economic or technological, for the place of industry in the future European society.

¹⁶⁴Digital Decade and baseline trajectories are presented in the "Communication from the Commission establishing Union-level projected trajectories for the digital targets" [C\(2023\) 7500](#).

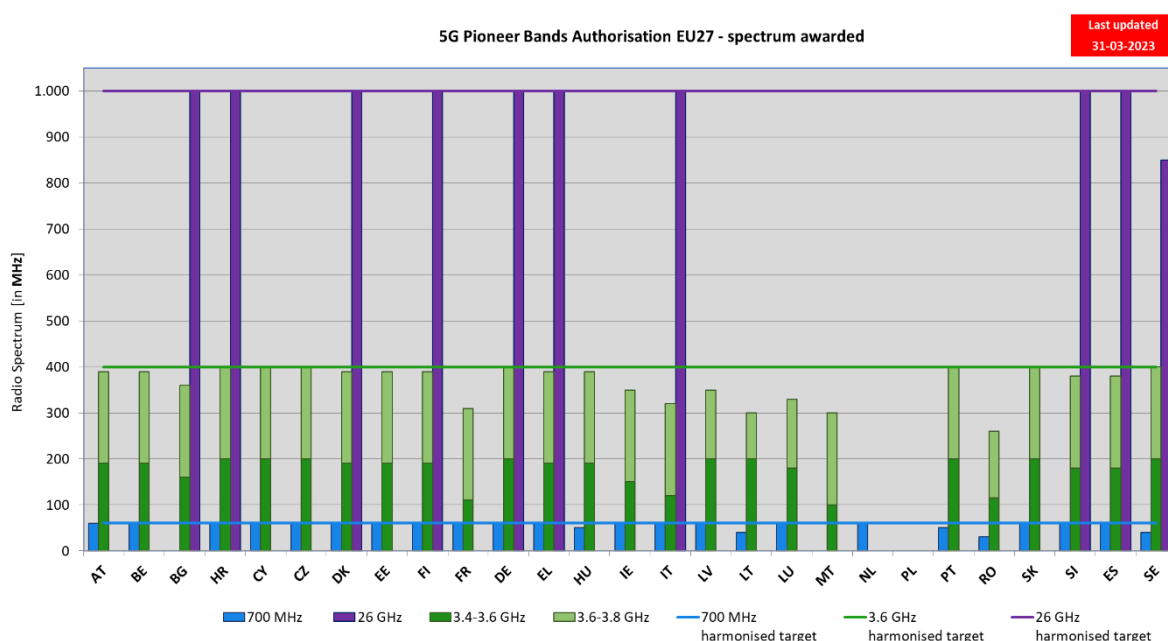
2.2.2.2 Actions at EU and national level

The successful deployment of 5G networks requires that the necessary spectrum resources are assigned under investment friendly conditions, low administrative or regulatory burden and access to financing. While the Union and the Member States have made considerable steps in this direction, additional efforts are needed to achieve the objectives.

Regulatory interventions

By the end of March 2023, 26 of the 27 Member States had assigned spectrum in the 5G pioneer bands, reaching an average volume of 68% of all the 5G pioneer spectrum (83% of 700 MHz band, 85% of the 3.6 GHz and 36.5% of the 26 GHz band). Germany, Croatia, Denmark, Greece, Finland, Italy, Spain, and Slovenia have assigned more than 90% of spectrum. Poland has not yet assigned any 5G pioneer band (according to the conditions mentioned above). The state of play in spectrum authorisation is depicted in Figure 36.:

Figure 36 5G Pioneer Bands Authorisation in the EU



The Commission is following closely the assignment procedures for the 5G spectrum. Pursuant to Article 35 EEC, Member States are required to notify the Radio Spectrum Policy Group (RSPG) when they intend to undertake a selection procedure to award EU-harmonised radio spectrum and at the same time, to indicate whether they wish the RSPG to convene a “Peer Review Forum” (PRF)

In 2022, the Commission adopted a number of harmonisation Decisions, for the availability and efficient use of spectrum for 5G, for Wi-Fi, and for short range devices (such as remote controls and IoT and to enhance the operation of mobile communications services on aircraft).

Moreover, the proposal for a new GIA also aims to accelerate rapid 5G deployment by ensuring new possibility to access public physical infrastructure, such as public buildings’ rooftops and non-network elements (e.g., street furniture, traffic lights, etc) as well as including the independent TowerCos in its scope.

In 2021, four Member States (Malta, Croatia, Lithuania, and the Netherlands) submitted formal notification and requested a Peer Review Forum (PRF). In 2022, Estonia and Spain held a PRF, while Slovakia, Romania and Lithuania submitted a formal notification without requesting a PRF. In 2023 (until end of March), Sweden held a PRF, while France and Belgium submitted a formal notification to the RSPG without requesting a PRF.

Moreover, to draw some lessons from these assignment procedures for the future, the Commission launched a study on the assessment of the efficiency of radio spectrum awards processes in the Member States, including the effects of applying the Code, (completed in January 2023). The study looked at the conditions attached to the rights of use in the context of spectrum awards processes run by the Member States (in light, notably, of the new provisions of the Code) to assess whether they are affecting the rollout of 5G networks in the internal market. The study found that, in general, current processes do not hamper network deployment but that a more coordinated, clarified approach would be beneficial.

Unsurprisingly, the study also found that the earlier spectrum is made available for 5G, the better the coverage that had been achieved and that the more 5G spectrum is sold, the greater is the 5G population coverage. Some notable exceptions to this pattern that may be explained by other factors. For example, both the Netherlands and Malta exhibit good 5G population coverage despite their generally delayed spectrum awards. The high population density in both Member States may have played a part, and in the Netherlands, the early availability of the 700 MHz band allowed one operator to roll out quickly, providing a high coverage figure.

The study found that the more competitive auctions and mobile markets are, the more they facilitate investment in 5G rollout. It also found that lower consumer prices are an indication of a faster 5G network rollout.

The study also noted several factors beyond the 5G pioneer bands that influence the 5G rollout (trend of using sub-3 GHz FDD legacy bands to support 5G network deployment). Indeed, the study concluded that the correlation between availability and coverage could have been stronger, but the option to use legacy spectrum (e.g., with DSS) may mitigate against high auction prices as a barrier to 5G rollout. Further, a metric that measured the deployment of “full 5G”, using 5G pioneer bands, might have a different relationship to relative prices paid in awards.

It also found that lower consumer prices are also an indication of a faster 5G network rollout.

In terms of regulation, the mobile markets remain unregulated. Early 2023, the Commission adopted two “veto” decisions, requiring the Czech regulator to withdraw its proposals to regulate the mobile access market. On the contrary, there is much scope for voluntary cooperation as the European Electronic Communications Code already provides an effective framework to facilitate network sharing, which has fostered the emergence in the EU of new models such as “neutral hosts” and independent infrastructure players. 5G is likely to bring network sharing to the next level by the introduction of “network slicing” and increasing possibilities to implement multi-tenant connectivity solutions based on network virtualisation and edge cloud functionalities. Therefore, EU progress in that field could become part of the regular best practice exchanges in the context of the Digital Decade process.

The new Roaming Regulation¹⁶⁵ that entered into force on 1 July 2022 gives increased guarantees for EU citizens travelling in Europe, to be able to benefit from the 5G quality of services, while roaming. End-users should be able to roam abroad with the same quality and speeds as at home. Operators should be able to guarantee the same level of quality while their customers are roaming abroad, if this is technically feasible on the network of the visited country. The new rules aim to ensure that when similar quality or speeds are available in the visited network, the domestic operator should not deliberately lower the quality of the roaming service. Operators in the visited country should allow reasonable access to all available networks and technologies. That means, if a consumer has 5G connectivity at home, they should not have 4G connectivity while roaming, if 5G is available at the location they are visiting. According to the new roaming rules, operators should inform their

¹⁶⁵ <https://eur-lex.europa.eu/legal-content/en/TXT/?uri=CELEX%3A32022R0612>.

customers of the quality of service they can expect to have while roaming by stating this in the service contract. BEREC adopted at the end of 2022 new retail and wholesale roaming guidelines to ensure consistent application of the new rules all over the EU.

Funding interventions

In terms of funding, the Member States' RRF plans include at least EUR 3,5 billion of investment in 5G.

Anticipating this development, the newly adopted Broadband Guidelines¹⁶⁶ introduce a new assessment framework for the deployment of mobile (including 5G) networks. The new Guidelines will enable Member States to support mobile networks where the investment would not otherwise have been undertaken by private operators and is not guaranteed by other measures, such as the coverage obligations attached to the use of some radio spectrum.

Following the first call for proposals of the Connecting Europe Facility Programme – Digital (CEF Digital), 15 projects were awarded EU funding to accelerate the deployment of 5G connectivity infrastructures along the main transport paths throughout Europe. All these projects are multi-country projects (MCPs) and are coordinated by the Smart Networks and Services Joint Undertaking.

The resulting portfolio of projects that will receive EU funding will pave the way for Connected and Automated Mobility (CAM) including safety and non-safety services, be it for road, rail, inland waterways, or multimodal transport.

More specifically, the projects will support 5G infrastructure deployment over cross border sections of 5G corridors and ensure service continuity when crossing said border, thus contributing to connecting different regions throughout Europe.

Seven of these projects will start deploying the needed infrastructure straightaway, both active and passive, to enable Connected and automated mobility services to develop in the coming years. At the same time, eight inception studies will prepare the groundwork for future large-scale 5G infrastructure deployment projects in view of upcoming CEF Digital Calls. More information on these projects and studies can be found below. A second 5G Corridors call for deployment works, and studies closed in April 2023. It included a call for a Coordination Support Action (CSA) aiming at integrating 5G connectivity infrastructure with edge nodes and European Cloud Federation infrastructure. 5G connectivity has huge potential to improve digital services in cities and local areas. By ensuring higher speeds, low latency, wider coverage, and increased network reliability, 5G networks can help modernise services of general interest in many sectors, notably in healthcare, education, public administration and transport, making them more efficient and resilient. Following the first Connecting Europe Facility – Digital (CEF Digital) call for proposals at the beginning of 2022, the Commission selected seven projects that will deploy 5G connectivity and enable innovative use cases for public services and services of general interest. The selected 5G for Smart Communities projects have started in Q1 2023 with a timeframe of 3 years. They will serve as European best practices, demonstrating what the deployment of 5G networks can bring to various sectors of society.

- One of the projects will implement a 5G Private Mobile Network (MPN) to support new functional approaches to education and training in universities and hospitals, as well as the creation of a continuous care system.
- Another project will deploy a leading-edge 5G infrastructure at the Frankfurt University Hospital in Germany, enabling innovative 5G use cases and improving the provision of public health services.

¹⁶⁶ <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A52023XC0131%2801%29&qid=1675764915102>.

- A 5G Mobile Private Network (MPN) Hub will be established at a Demonstration farm in Hungary to enable end-to-end solutions in agriculture. In Wavre (Belgium), a state-of-the-art 5G private network complying with current security standards and attaining the highest level of performance will transform the municipality into a smart city.
- The EU-funded Flanders Smart Fields project will provide standalone 5G coverage for the Westhoek region in Belgium to support innovative applications in healthcare and education. Lastly, Hi5 will roll out 5G technology in the Toulouse metropolitan area by 2025 delivering leading-edge connectivity to public services, building on the existing fibre-optic network and data centres, focuses on five use cases: city services, event connectivity, mobility lab, education and high-speed video data offloading.

A second 5G for Smart Communities call closed in April 2023.

Longer term impact of 5G on the digital transformation of Industry and Society

Deployment of 5G private networks is accelerating across EU countries, typically using network elements and resources to provide dedicated secure services, mainly to private enterprises such as factories, large campuses, harbours and airports.

This type of 5G network deployment is as important as 5G public networks because they are expected to unleash the truly innovative, and potentially disruptive, impact of 5G by enabling innovative applications and new ecosystems (especially around virtualisation of networks and increased flexibility). Europe is relatively well placed in this area with a strong industrial fabric in many Member States and this is illustrated by the high number of 5G private network pilot projects and early deployment initiatives that are taking place in the EU as compared to other regions. It will be important to continue leading deployment of 5G aimed at such B2B developments. In that context, the timely transition, by all operators, to 5G standalone core networks will also be an important factor to enable advanced connectivity applications.

An overview of 5G private networks featuring a searchable table of major private network projects in the EU can be found at this link: <https://5gobservatory.eu/5g-private-networks/>.

From 5G to 6G

It is crucial to reach our digital goals to maintain Europe's competitive position in 6G and advanced 5G, in particular through a close partnership with the European industry (such as with global telecom suppliers Nokia, Ericsson, telecom operators, as well as SMEs active in the field). The Commission has launched a major initiative to develop 6G systems concepts and technologies, the Smart Networks & Services Joint Undertaking (SNS JU). The SNS JU materialises the partnership between the Commission and the EU telecommunications industry and research community to establish a common strategy and the critical tools to develop technology capacities for 6G systems as a basis for future digital services towards 2030. The SNS JU has already launched 35 6G R&I projects for a total EU funding of € 250 million in 2022. Another call of EUR 132 million is taking place in 2023.

Network sharing:

The European Electronic Communications Code already provides an effective framework to facilitate network sharing, which has fostered the emergence in the EU of new models such as "neutral hosts" and independent infrastructure players. However, 5G is likely to bring network sharing to the next level by the introduction of "network slicing" and increasing possibilities to implement multi-tenant connectivity solutions based on network virtualisation and edge cloud functionalities. Therefore, EU progress in that field could become part of the regular best practice exchanges in the context of the Digital Decade process.

In terms of best practices, France adopted an "acceleration strategy" for 5G and future networks. The authorities lowered the price of 5G licences for industrial application and launched Franco-

German joint calls for projects since 2020, including in that call, four projects were selected in July 2022 to deploy cases of concrete uses of 5G dedicated to Industry 4.0. A total of 32 partners (16 German, 16 French) will be supported. France launched 21 projects worth 163 million euros for experimental 5G use cases and 6 major Campus Fablabs are upcoming.

Industrial 5G has started in France with 30 deployments and 750 experimental facilities as estimated by Arcep⁷. Operators announced major deployments in partnership with large industry players. Small enterprises are also active: for example, in Toulouse, Alsatys participated to an Arcep experimental project and started a European project of 5G for Smart Communities, funded at 75% by the CEF programme.

The 5G Coalition is a professional cooperation forum established in Hungary with the ambition to make the country one of the centres of European 5G developments, at the forefront of the world in the field of introduction, spread and practical application of 5G. Among the main achievements of the 5G Coalition (5GC) was the testing of the first traffic cases based on 5G at the vehicle industry test track in Zalaegerszeg and the achievements in the agricultural cases (e.g., development of innovative monitoring, data collection, analysis and intervention control solutions that take advantage of the possibilities of 5G, which support farmers' decisions with the help of AI-based analyses). Preliminary results from the exploratory consultation highlight that investments on the deployment of 5G networks are fundamental to enable the automation of network processes, ensure greater energy efficiency and help operators to identify network problems faster in many sectors such as healthcare and transport.

2.3 Semiconductors

Semiconductors are at the centre of strong geostrategic interests and of the global technological race. Currently, in terms of revenues across the semiconductors value chain, the US is the market leader, followed by South Korea, Taiwan, Japan, and the EU, whose revenues are around 10% of the market. The Path to the Digital Decade set the target that the EU's market share should double by 2030.

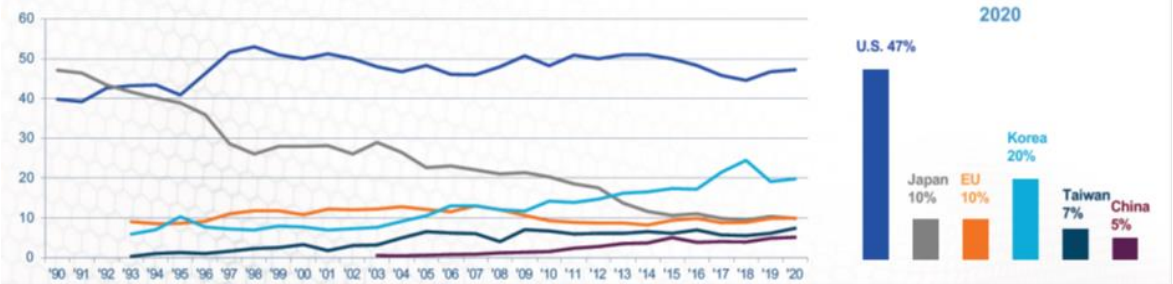
As the digital transition accelerates, worldwide demand for chips will grow rapidly and is expected to exceed USD 1 trillion by 2030, essentially doubling its value in this decade. This means that the EU will need to quadruple its revenues to reach its targeted market share of 20% in semiconductors by 2030.

The world's leading economies are keen to secure their supply in the most advanced chips as this increasingly conditions their capacity to act (economically, industrially, militarily) and drives the digital transformation. Public support measures to innovate and strengthen their production capacities are now being rolled out. The US Chips and Science Act allocates USD 52 billion of public funding to semiconductors manufacturing and R&D until 2026, coupled with USD 24 billion of tax credits for semiconductor facilities offered by the FABS Act with the possibility also for support at state level; China is on a path to surpass its targeted USD 150 billion investments in the decade 2015-2025, Japan is offering public support for semiconductor projects, among which more than USD 8 billion for two new fabrication plants and tens of billion USD for a new chip venture¹⁶⁷, and South Korea will bolster its semiconductor industry by supporting, through tax incentives, its domestic companies' private investments in R&D and manufacturing, which are estimated at USD 450 billion until 2030.

¹⁶⁷ Rapidus: a new state-backed Japanese consortium to develop and produce cutting-edge two-nanometre chips.

The bulk of global demand (close to 70%)¹⁶⁸ comes currently from end-use applications in computing (including PCs and data centre infrastructure) and communications (including smartphones and network infrastructure). In view of their centrality to digital transition, Europe’s share of these markets is quite small (telecommunications 4%, PC & data processing 5%). Europe has a strong position in components for embedded and professional systems, and consequently in the production of electronic systems. This is reflected also in the European demand for semiconductors from different market segments, which is particularly high in automotive and industrial automation, segments previously ruled by analogue and mechanical technology.

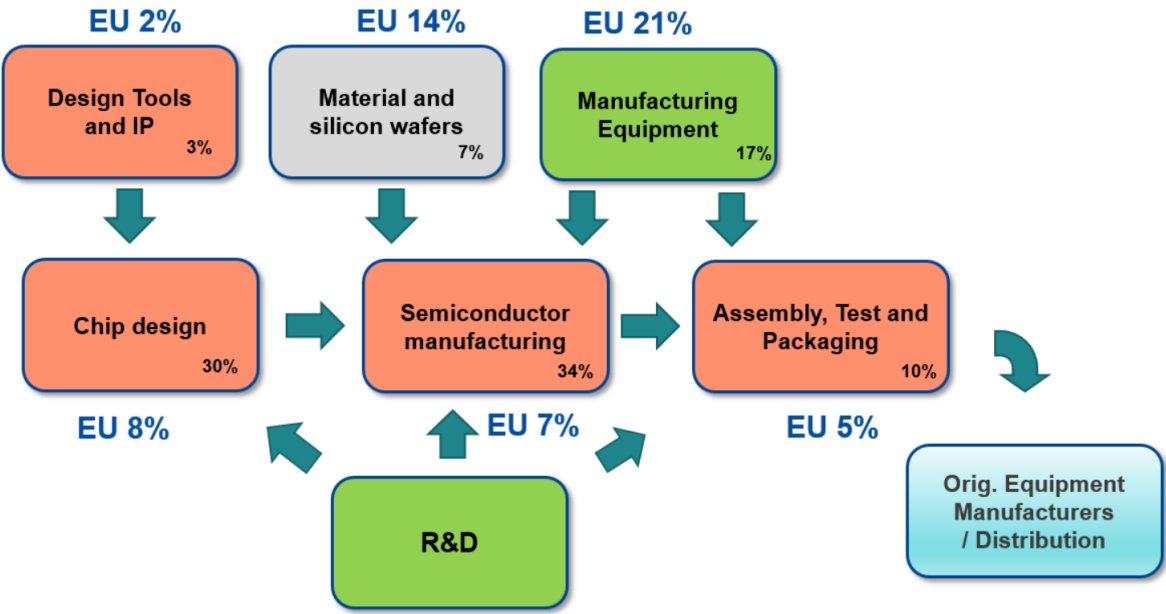
Figure 37 Global market shares in semiconductor industry evolution



Source: SIA, WSTS, Omdia

The EU has core strengths in R&D and in manufacturing equipment (see Figure 38), but besides advanced manufacturing, it would need to address current weaknesses in chip design and in packaging & assembly, that represent a good part of the added value in the supply chain.

Figure 38 Semiconductor value chain segments with EU market shares



Source: Data in % within each block represents added value of that segment in the value chain (from AT Kearney, CSET, IC insights, WSTS, SEMI) - EU % = EU share of global market in that segment; N% = added value of segment in the value chain.

Several factors explain why the EU is lagging in the semiconductor race. Investment has been insufficient to keep up with the sector growth. Moreover, the production of semiconductors in

¹⁶⁸ Semiconductor Market Size forecast by application (in USD billion, Source: Statista, ASML 2021)

Europe has focused on certain sectors important in the EU, such as automotive, which do not require the use of the most advanced semiconductors. Consequently, the European semiconductor sector had limited incentives to evolve and keep up with the technological advances of US, Korean and Taiwanese firms. Against this backdrop, reaching the Digital Decade target will require major investments, not only to increase production and designing capacity but also to boost the knowledge needed to produce cutting-edge semiconductors.

2.3.1 Trends towards 2030

No trajectory available yet.

2.3.2 Actions at EU and national level

On 7 December 2020, twenty-two Member States already signed a joint declaration¹⁶⁹ expressing their interest to work together to bolster Europe's electronics and embedded systems value chain with a strong focus on processors and semiconductor chips. The declaration, among other things, calls for the mobilisation of industrial stakeholders through a future industrial alliance. Moreover, it calls for the design of a multi-country projects through the development of proposals for Important Projects of Common European Interest (IPCEI).

Member States, after the first successful IPCEI on Microelectronics, have launched a second IPCEI on Microelectronics and Communication Technologies which will support a broad range of activities along the whole semiconductors value chain: IP design, equipment for manufacturing of leading-edge nodes, power electronics, AI, advanced packaging, photonics, and open network architectures (ORAN) boosting future 5G/6G Telecom networks. The Member States will provide up to EUR 8.1 billion in public funding, which is expected to unlock additional EUR 13.7 billion in private investments. As part of this IPCEI, 56 companies, including small and medium-sized enterprises ('SMEs') and start-ups, will undertake 68 projects. Under the first IPCEI on Microelectronics, direct participants have received around EUR 1.9 billion in public funding. This was combined with private funding around EUR 6.5 billion.

Finally, since the EU Chips Act has been proposed¹⁷⁰, the Commission, the Council and the Parliament, which have reached the political agreement in April 2023, have been working to link together Europe's world-class research capacities and to coordinate EU and national investment along the value chain. The EU Chips Act aims to build on Europe's strengths and address outstanding weaknesses, to develop a thriving semiconductor ecosystem and resilient supply chain. It is a key step for the EU's technological sovereignty and to support Europe's achievement of the relevant Digital Decade target. Since its announcement in February 2022, the Chips Act has mobilised over 100 billion private and public investments.

As already mentioned, beside important strongholds like in research, materials and equipment, several challenges are being experienced across Europe and along the semiconductor value chain:

- Europe has notable weaknesses in design and design automation tools. These parts of the supply chain are mainly under US proprietary control.
- The EU has no production capacity for the most advanced chips.

¹⁶⁹ [Joint declaration on processors and semiconductor technologies | Shaping Europe's digital future \(europa.eu\)](#)

¹⁷⁰ <https://digital-strategy.ec.europa.eu/en/library/european-chips-act-communication-regulation-joint-undertaking-and-recommendation>

- Vertical integration with key industry sectors in Europe, including future electric automated mobility, industrial automation and robotics, and economic strongholds such as 5G/6G communications.
- Packaging, assembly, and testing, as well as chip fabrication are located mostly in Asia. Advanced packaging technologies are increasingly important to address increasing power and energy-efficiency requirements.

In line with these challenges, several policy actions, at both EU and national level, like IPCEI projects and the announcement of the EU Chips Act, have already played an important role in stimulating public and private investment in the EU, notably in innovation and manufacturing.

The EU Chips Act aims to help in structuring and aligning Member States' actions to optimise their impact by supporting specific initiatives such as the creation of design platforms to explore virtual prototypes based on technology that does not yet exist physically; high level pilot lines to facilitate development of novel technologies by industry and validate their designs; investment in first-of-a-kind facilities which will be beneficial for the resilience of the semiconductor ecosystem in Europe; a network of competence centres to coordinate efforts across Member States including the provision of training and development of the necessary skills and workforce.

European end-user and vertical industries will require customised hardware solutions to increase their competitiveness. To benefit from a dynamic ecosystem, strategic collaborations with EU chip makers and the adoption of the advanced semiconductors developed in the EU will play a key role.

In addition, other types of action will also contribute positively, factors are likely to such as:

- National policies to stimulate domestic chip design capabilities and to attract foreign design companies, thereby increasing local competences in advanced technologies and strengthening engagement with the European ecosystem and creating demand for EU semiconductor manufacturing facilities.
- - National policies in public tenders (e.g., for communications networks and data infrastructures) can leverage trusted electronics adhering to European standards (certification and common requirements for secure chips) and could create markets for European semiconductor products.
- Stronger foreign direct investment policy instruments dealing with attempts by companies from other parts of the world to acquire EU semiconductor companies would help keep intellectual property in Europe.
- Lastly, national policies to increase the number of workers in the sector (also addressing inclusion and gender equality), and assure the acquired skills meet the job profiles required by industry; as well as to support joint initiatives across Member States and like-minded partners to stimulate students and workers mobility.

There is no digital future without chips. Only by stepping up efforts in boosting the whole semiconductor value chain, the EU will continue to be able to master the rapid evolution of digital technologies and to ensure its digital sovereignty and achieve the Digital Decade targets.

2.4 Edge nodes

The European Data Strategy¹⁷¹ highlighted the need for a change of paradigm in data processing, and it identified edge computing as the essential technology to cope with the requirement for highly distributed and decentralised data processing. Edge computing is the core technology to optimally handle and extract value from the ongoing exponential data deluge triggered by the widespread

¹⁷¹ COM/2020/66 final

deployment of connected objects such as connected cars, home appliances and manufacturing robots. The European Data Strategy also recognises that edge computing represents a significant opportunity for European leadership, which would unlock economic and sustainability advantages, while enabling enhanced data control for data producers.

To access cutting-edge data processing technologies, European industry is increasingly considering the deployment of edge computing nodes. Edge nodes are defined as the of compute nodes providing latencies below 20 milliseconds, such as an individual server or other set of connected computing resources, operated as part of an edge computing infrastructure, typically residing within an edge data centre operating at the infrastructure edge, and therefore physically closer to its intended users than a cloud node in a centralised data centre.¹⁷²

Total European edge computing spending across all market segments is expected to rise from EUR 34 billion in 2021 to EUR 68 billion in 2026, representing a five-year compound annual growth rate of 14.6%¹⁷³. Nevertheless, data shows that edge deployment is in its infancy and happens primarily as part of pilots, which are geographically distributed unevenly across the EU with Italy, France, and Germany presenting the highest levels of maturity. Logistics/retail, infrastructure (e.g., airport), and manufacturing are among the leading sectors, in which more than one in five adopters have moved past the pilot stage.¹⁷⁴ The European telecoms market also features many early adopters with three commercially available edge market offerings as reported by ETNO.¹⁷⁵ In this context, it worth noting that there is symbiotic relationship between 5G roll-out and edge computing. The large-scale deployment of 5G is the right moment to leverage synergies with edge deployment so that the resulting network infrastructure combines network and edge computing technologies.

Future commercial investments in edge deployment are expected to focus on areas with high commercial and industrial density. This could result in unequal opportunities for users and businesses outside of these areas and strengthen the urban-rural digital divide.

The IDATE Edge computing report¹⁷⁶ identifies the following market actors as able to deploy edge nodes solutions: device providers, chipset makers, network equipment providers, IT hardware providers, infrastructure companies, cloud providers, telcos and industrial solution providers. All of these actors supply different types of edge nodes and infrastructures that range from devices on-board processing, specific processors, gateways, standalone edge servers, edge micro-modular data centres to fully fledged data centres at the edge. The second-largest edge computing market, driven by spending on light-edge deployments, is the provision of hardware appliances for edge nodes by these providers. Cases of light-edge deployments, representing on-device and on-premises edge, are expected to be supplemented with heavy-edge computing platforms for near and far edge as new generations of edge-specific hardware reach the market.¹⁷⁷

Edge computing security and sustainability are crucial aspects for the future progress of the technology and there is significant research and innovation carried out in these areas.

¹⁷² [SWD\(2023\) 570](#) 'Implementation of the Digital Decade objectives and the Digital Rights and Principles'

¹⁷³ UNLOCK-CEI, Cloud-Edge-IoT Demand Landscape (April 2023), <https://zenodo.org/record/7821330#.ZD0wTnZByUk>

¹⁷⁴ Ibid.

¹⁷⁵ ETNO, The State of Digital Communications 2023 (February 2023), <https://etno.eu/library/reports/112-the-state-of-digital-communications-2023.html>

¹⁷⁶ IDATE, <https://en.idate.org/product/edge-computing/>

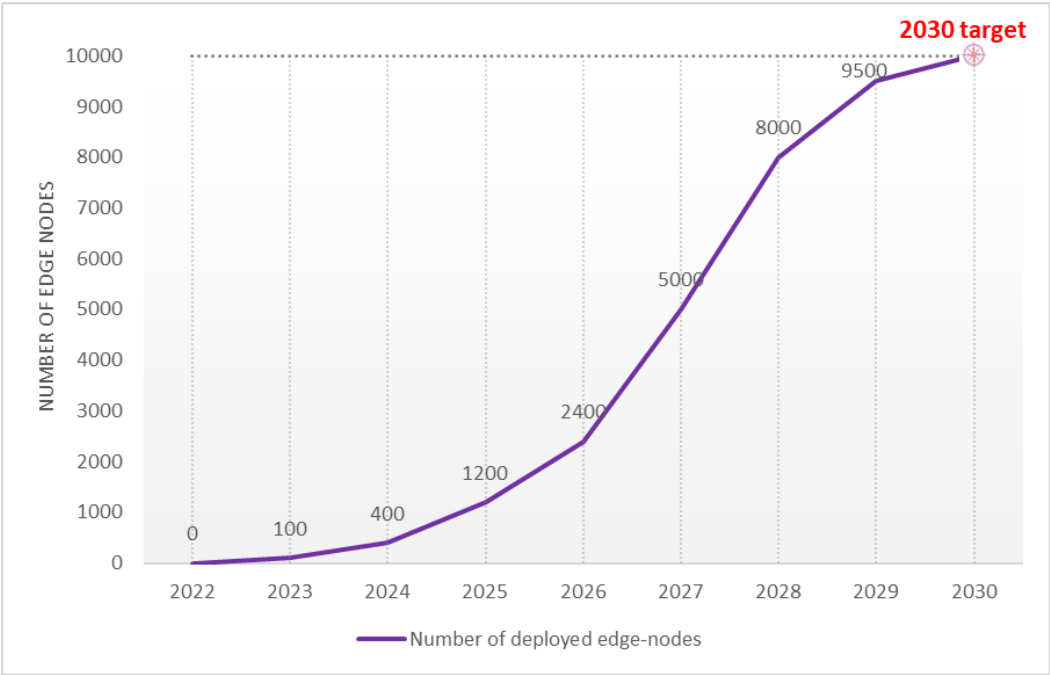
¹⁷⁷ UNLOCK-CEI, Cloud-Edge-IoT Demand Landscape (April 2023), <https://zenodo.org/record/7821330#.ZD0wTnZByUk>

2.4.1 Trends towards 2030

The baseline for 2022 is accounted as 0. The methodology to quantify the deployment of edge nodes and their location is still being developed. Available information in Business analysis's reports is limited and focuses only on anticipated spending on edge computing infrastructure, software, and services¹⁷⁸. These does not allow for direct assimilation to existing Edge nodes deployment in Edge computing facilities. According to the European Telecommunications Network Operators' Association there are three commercial edge computing services across Europe¹⁷⁹ but it does not provide enough information for determining the edge deployment's location or size.

The limited number of available data sources all concur that edge computing continues to be in its infancy in Europe in 2023, with the majority of interested organisations still in the awareness-raising and educational stages, along with some organisations implementing small-scale pilot projects.¹⁸⁰ This drives the anticipated relatively small uptake of edge nodes deployment in the years to come, between 2023 and 2026 (Figure 39). During the 2025-2027 period, the investments facilitated by the IPCEI-CIS (Important Project of Common European Interest on IPCEI on Next Generation Cloud Infrastructure and Services) are expected to make commercially available to the market edge computing technologies and solutions which will boost the adoption across Europe, enabling the exponential expansion of edge nodes deployment to meet the target by 2030¹⁸¹.

Figure 39 Number of deployed edge nodes (EU projection to 2030)¹⁸²



¹⁷⁸ UNLOCK-CEI, Cloud-Edge-IoT Demand Landscape (April 2023), <https://zenodo.org/record/7821330#.ZD0wTnZByUk>

¹⁷⁹ ETNO, The State of Digital Communications 2023 (February 2023), <https://etno.eu/library/reports/112-the-state-of-digital-communications-2023.html>

¹⁸⁰UNLOCK-CEI, Cloud-Edge-IoT Demand Landscape (April 2023), <https://zenodo.org/record/7821330#.ZD0wTnZByUk>

¹⁸¹ Subject to completion of the notification process and the assessment of the IPCEI’s compliance with state aid rules. Pre-notification by 12 Member States took place in April 2022.

¹⁸² Digital Decade and baseline trajectories are presented in the “Communication from the Commission establishing Union-level projected trajectories for the digital targets” [C\(2023\) 7500](https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A52023C07500).

2.4.2 Actions at EU and national level

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

As highlighted by the reports from the participating Member States (Germany, France, Italy, Spain, Latvia, Hungary, Poland, Slovenia, Belgium, Luxembourg, the Netherlands, and the Czech Republic), the Important Project of Common European Interest on Next Generation Cloud Infrastructure and Services (IPCEI-CIS) is expected to act as a key enabler for the development of cloud and edge technologies in Europe.¹⁸³

The initiative aims to make a significant contribution by supporting cutting-edge R&D&I on the critical rebalancing between highly distributed data processing at the edge, closer to users, and centralised data infrastructures. This is a brand-new field for digital deployment, in which European businesses have the opportunity to lead vis-à-vis their global competitors. Germany and France -as coordinators – jointly pre-notified the project in April 2022.

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

By means of the Simpl project, the Digital Europe Programme is procuring a large-scale open-source cloud-to-edge middleware platform. Simpl will enable cloud and edge federation as well as the integration of data infrastructures and services. By offering interoperability mechanisms, Simpl will provide generic common services for the establishment, management, and federation of cloud and data spaces. While Simpl's primary focus lies on software, cloud and edge deployment associated with Simpl is expected to be funded via a set of large-scale pilots for cloud-to-edge-based services. These pilots aim for the deployment at scale of innovative, sustainable, secure and cross border cloud-to-edge based services applied in a set of well-chosen application sectors, all together developing a portfolio of use cases in the public sector or of general public interest.

Digital Europe, European Reference Deployments of cloud-to-edge infrastructures and services

Support for European Reference deployments of cloud-edge services is one of the topics of the Digital Europe programme in 2024 for Cloud-to-edge Infrastructure and services. It intends to provide financial support for one or more pilots that demonstrate seamless integration and interoperability among industrial IoT Edge and Telco Edge in key applications and sectors.

Connecting Europe Facility Digital – 5G Corridors and 5G for smart communities

With a proposed budget of about EUR 1 billion for the years 2022–2027, the Connecting Europe Facility (CEF) Digital initiative will financially support the extensive deployment of 5G corridors across Europe. This work programme will support the deployment of 5G systems, including, if appropriate, integrated edge computing facilities, along major transport paths as well as in local communities. Tests have been conducted by the project not only within each Member State, but particularly across the borders from Italy to Austria and Austria to Germany. Edge computing platforms played a key role in coordinating 5G service continuity for these cross-border usage scenarios.

2.5 Quantum computing

In 2016, European quantum stakeholders published the Quantum Manifesto, which called on researchers from academia and industry to draw up a strategy for Europe to maintain a leading global position in quantum technologies and led in 2018 to the launch of the EU-funded Quantum Technologies Flagship (known as the Quantum Flagship). The objective of this 10-year, EUR 1 billion, collaborative research and innovation initiative is to consolidate European scientific leadership and

¹⁸³ Subject to completion of the notification process and the assessment of the IPCEI's compliance with state aid rules. Pre-notification by 12 Member States took place in April 2022.

research excellence in quantum technologies, and to transform the fruits of this excellence into products and applications that will have a major economic and societal impact.

In the first three years of its life, the Flagship recorded a number of notable achievements, including the construction of a quantum computing system of globally competitive performance based on superconducting circuits, as well as very promising work on other quantum computing platforms such as trapped ions and silicon qubits.¹⁸⁴ The resulting European experimental quantum computing platforms are becoming ready for concept validation and trial applications, and as part of the process the European High Performance Computing Joint Undertaking (EuroHPC JU)¹⁸⁵ is currently completing the installation in two supercomputing centres of quantum simulators that should soon be accessible to users.

In 2022, the Joint Undertaking also announced the selection of six sites across the EU to host and operate the first EuroHPC quantum computers, in Czechia, Germany, Spain, France, Italy, and Poland, which will be integrated into high-performance supercomputers: this will ensure that the EU's Digital Decade target of having its first computer with quantum acceleration by 2025 is met.

The Commission Communication *2030 Digital Compass: the European way for the Digital Decade*, sets the EU not just the target of having its first computer with quantum acceleration by 2025, but also the wider goal of being at the cutting edge of quantum capabilities by 2030. While the first objective is in sight, in the current highly competitive global context further action will be needed for the EU to attain the second.

2.5.1 Trends towards 2030

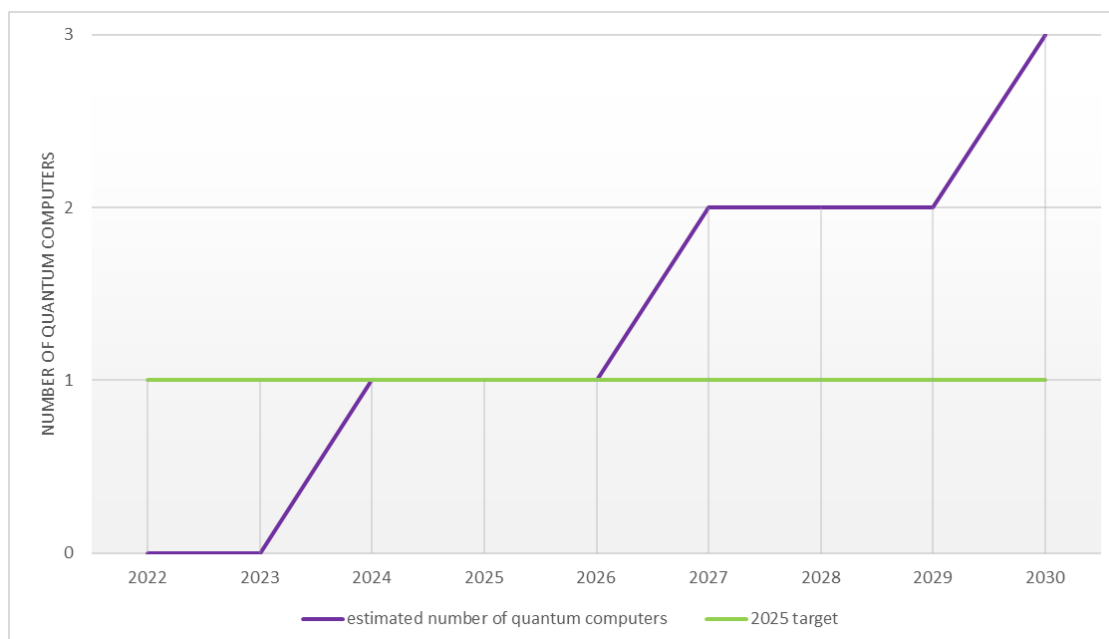
The starting value for 2022 for this KPI is 0. It is expected that at least one quantum computer will be deployed by 2024, followed by a second in 2027 and reaching at least 3 by 2030.

Given the specificity of this target, the EU achievements in this area depend on the successful implementation of joint, multi-country commitments and is monitored at the EU level only.

¹⁸⁴ <https://digital-strategy.ec.europa.eu/en/library/eus-quantum-technologies-flagship>

¹⁸⁵ https://eurohpc-ju.europa.eu/index_en

Figure 40: Number of quantum computers in the EU. Trajectory towards 2030¹⁸⁶



Note: The quantum computing trajectory is based solely on experts' assessment

2.5.2 Actions at EU and national level

As already described, the pioneering work on quantum computing platforms – as well as much else – of the Quantum Technologies Flagship has laid the groundwork for the EU to achieve its quantum target for 2025, as the European High Performance Computing Joint Undertaking is preparing to install Europe's first supercomputers with quantum acceleration. The newly launched framework partnership agreements¹⁸⁷ should also provide, towards the end of the current decade, prototype quantum computers with capacities in excess of 1 000 qubits and based on various technology platforms (trapped ions, superconducting qubits, and semiconducting qubits).

In addition, to develop the whole quantum computer and simulator stack, and more specifically on quantum software, Centres of Excellence for Science and Industry focusing on both academic and industrial use cases for quantum computers and simulators will be established. These centres will be a reference on academic and industrial quantum applications, providing services, support and libraries to organisations in Europe in a similar way to the current HPC Centres of Excellence. These actions, in cooperation with the quantum computers and simulators operated by EuroHPC, will exploit the results of the quantum software and applications projects funded by the 2021-2022 Horizon Europe work programme.

Moreover, the European Commission, together with all Member States and the European Space Agency, is developing and deploying a European quantum communication infrastructure (EuroQCI), which will use quantum-based cryptography to secure the EU's public communication assets, in particular its critical infrastructure and encryption systems, against cyber threats. As of 2023, EuroQCI is part of IRIS², the new Union Secure Connectivity Programme.¹⁸⁸ The EuroQCI will significantly boost Europe's capacities in quantum communication, fostering the development of a European ecosystem in this domain.

¹⁸⁶ Digital Decade and baseline trajectories are presented in the "Communication from the Commission establishing Union-level projected trajectories for the digital targets" [C\(2023\) 7500](#).

¹⁸⁷ See <https://opensuperqplus.eu/> and <https://www.millenion.eu/>

¹⁸⁸ Regulation (EU) 2023/588

Alongside these EU-level activities, many Member States are also recognising the strategic and economic importance of quantum technologies. Some have already established large national quantum programmes, including Austria, Denmark, Germany, France, the Netherlands, Spain, and others. These programmes have complementary objectives, including activities such as knowledge transfer from research labs to industry, and will make a significant contribution to the emergence of a European quantum industry, including design and production capabilities for quantum chips. In addition, a number of Member States are also using their national Recovery and Resilience Facility plans to invest in quantum, where the overall value of planned investments between now and the end of 2026 is estimated to be of at least EUR 1 billion.

3 Digitalisation of Businesses

3.1 Overall context: why is digitalisation of businesses important and where is Europe in this regard in 2023 at the outset of the Digital Decade

Digitalisation of businesses is one of the most crucial elements currently for the success and growth of the economy. Digitalisation is key in changing the business model of enterprises, to achieve greater efficiency in production processes, to explore new opportunities and generate new revenue streams. In terms of competitiveness digitalisation can contribute to growth, create new services, products and increase productivity. This is particularly important for SMEs at a time when they are struggling with inflation, energy costs and other challenges. Therefore, digitalisation is also a critical element in improving economic resilience. Additionally, a digitally skilled population (see more details on digital skills in the Digital cardinal points report on Digital Skills) increases the development and adoption of digital technologies and leads to productivity gains.¹⁸⁹ As highlighted in the EIB investment survey “Digitalisation in Europe 2022-2023”¹⁹⁰, the COVID-19 pandemic has accelerated the digital transformation of European enterprises, and therefore the European Union is closing the digitalisation gap with the United States. 53% of firms in the European Union invested in digitalisation in response to the pandemic. Nevertheless, the share of such firms is higher in the United States than in the European Union. Both external and internal factors are important enablers of digitalisation, among them adequate digital infrastructure, competition-friendly regulation, but also training employees and developing an innovation-enhancing environment.

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

Significant EU funds have been mobilised to support the achievement of these targets. In particular, the new Digital Europe programme (DIGITAL), the first EU programme specifically dedicated to supporting the roll out of digital technologies across the economy, foresees EUR 7.5 billion for projects in 5 key capacity areas: HPC, AI, cybersecurity, advanced digital skills and Digital Innovation Hubs. Digitalisation is also being supported through a number of other programmes including the Recovery and Resilience Facility (RRF), ERDF and Horizon Europe. Indeed, 26%, i.e. EUR 130 billion of RRF funds are targeted towards digital. 19%, i.e. EUR 24 billion of the RRF funds allocated to the digital transformation is dedicated to the digitalisation of businesses. Furthermore, out of the EUR 117 billion in EU funds expected to contribute to the Digital Decade targets, EUR 5 billion is considered relevant for cloud services, EUR 3.9 billion for big data, EUR 4.4 for AI, EUR 11.6 billion to unicorns and EUR 11.6 billion for SMEs with at least basic digital intensity¹⁹¹. As part of its digital strategy the European Commission attaches great importance to the digitalisation of industry and industrial ecosystems. There are several initiatives in this context. They include the KDT Joint

¹⁸⁹ See for example OECD (2019): OECD Economic Outlook, Digitalisation and productivity: A story of complementarities, [OECD Economic Outlook, Volume 2019 Issue 1 | OECD iLibrary \(oecd-ilibrary.org\)](#).

¹⁹⁰ [Digitalisation in Europe 2022-2023: Evidence from the EIB Investment Survey](#)

¹⁹¹ Each Recovery and Resilience Plan has to dedicate at least 20% of the plan’s total allocation to digital objectives. To this end, the plans had to specify and justify to what extent each measure contributes fully (100%), partly (40%) or has no impact (0%) on digital objectives, using Annex VII of the RRF Regulation. Combining the coefficients with the cost estimates of each measure allows assessing to what degree the plan contributes to digital objectives and whether it meets the 20% target. Furthermore, a further qualitative assessment of the data took place to allow for an estimation of the possible contribution of RRF measures to the Digital Decade targets.

technology Initiative and the Made in Europe public private partnership, as well as several multi-country projects, such as network of European Digital Innovation Hubs (EDIHs) under the Digital Europe Programme and the Important Project of Common European Interest Next Generation Cloud Infrastructure and Services (IPCEI-CIS).

AI research and innovation for the digitalisation of businesses.

Supporting the development and adoption of trustworthy AI solutions plays a key role in the promotion of a values-driven approach to Europe's digital economy. Thus, in parallel to the EU's proposed Regulation on Artificial Intelligence, the Commission has proposed to make the EU the place where AI excellence thrives from the lab to the market, joining efforts at EU level to ensure its sovereignty in AI. Together with Member States, the Commission is co-funding the AI Testing and Experimentation Facilities in several sectors/ domains to strengthen capacities to test and validate this technology, improve its uptake and contribute to more trustworthy AI made in Europe.

Nevertheless, only 8% (value refers to 2021, the latest available year with comparable data across the EU), so not even one in ten enterprises in the European Union have adopted an AI technology. The uptake rate varies widely across Member States from 1% to 24%. The difference between SMEs and large enterprises is also striking: there are four times more large enterprises (28.5%) than SMEs (7.3%) that adopt AI technologies. Additionally, double as much medium sized enterprises (12.8%) have taken up AI than small ones (6.4%).¹⁹²

The full engagement of Member States in promoting and contributing to these European initiatives is key to sustaining Europe's digital economy and to the success of Europe on the global scenario. Leveraging the Commission's work on data and chips, the European approach to AI has the twin objective of creating ecosystems of excellence and trust, to promote the development and uptake of AI while addressing the risks associated with certain of its uses. To make the EU the place where AI excellence thrives from the lab to the market, the European Commission takes a full lifecycle approach to AI. It focuses not only on basic and applied AI research, but also on boosting deployment.

The 2021 Coordinated Plan on Artificial Intelligence Review builds on the collaboration established between the Commission encouraging all Member States to develop their national AI strategies and Member States and is the next step in creating EU global leadership in trustworthy AI.

The Coordinated Plan describes, how all Member States have made substantial efforts in developing national AI strategies or including AI dimensions in existing strategies and programmes.

It sets out the strategy to:

- accelerate investments in AI technologies to drive resilient economic and social recovery aided by the uptake of new digital solutions;
- act on AI strategies and programmes by fully and timely implementing them to ensure that the EU fully benefits from first-mover adopter advantages;
- align AI policy to remove fragmentation and address global challenges.

It does so by:

- setting enabling conditions for AI development and uptake in the EU;
- making the EU the place where excellence thrives from the lab to market;
- ensuring that AI works for people and is a force for good in society;
- building strategic leadership in high-impact sectors.

¹⁹² Source: Eurostat, data from 2021.

The Coordinated Plan goes hand in hand with the Proposal for a Regulation on Artificial Intelligence. Member States are setting up a wide range of policy measures to foster the development of AI technologies from the lab to the market, including participation in Public-Private Partnerships (PPPs), setting up research excellence centres and experimentation and testing facilities. All national AI strategies set out policy actions to support start-ups and the scaling-up of firms and innovation ecosystems.

Cloud

Cloud computing is a key enabler for emerging technologies like AI, big data and digital ledger technologies and for many industrial and entertainment applications. In many sectors of the EU economy, cloud computing already supports daily business operations and the provision of innovative goods and services which ultimately fosters their industrial competitiveness.

Yet on average one in two companies still does not use cloud computing services across the European Union. The enterprise cloud uptake is at 41% (value refers to 2021, the latest available year with comparable data across the EU). When it comes to the enterprise's use of medium and sophisticated cloud services, measured under the Digital Decade, the situation is similar. On average, only one in three enterprises (34%) uses them across the EU.

There are also significant discrepancies in cloud uptake between enterprises of different sizes (large (72%); medium (53%) and small (38%) enterprises), across Member States (up to 62 percentage points), and between the different types of cloud services used (79% for email services and only 21% for platforms for application development, testing or deployment).¹⁹³

Regarding market shares, although the absolute value of the European cloud market increased, the market share of European cloud providers decreased over the last years, given the quality and breadth of services provided but also the fragmentation of the offers. In 2020, the value of the European cloud market was estimated to be worth EUR 5.9 billion, three times the value of the market in 2017.¹⁹⁴ Even in this context of significant growth, European cloud providers' market share has decreased from 26% in 2017 to 16% in 2020. The three global cloud providers Amazon Web Services, Microsoft Azure and Google Cloud (often referred to as cloud "hyperscalers") accounted for the 66% of the European cloud market in 2020. The European industrial technology roadmap for the next generation cloud-edge prepared by a group of CEOs of European companies explains that "While taken as a whole, European cloud offerings cover a wide spectrum of services, in practice, customers must work with many providers to achieve the quality and breadth of services provided by leading global cloud providers. End-users seek simplicity and efficiency and have become accustomed to 'one-stop-shop' offers that provide access to a suite of best-in-class cloud functionalities and tools they require and on a global scale".¹⁹⁵

¹⁹³ Source: Eurostat, data from 2021.

¹⁹⁴ [European Cloud Providers Struggle to Reverse Market Share Losses | Synergy Research Group \(srgresearch.com\)](https://www.srgresearch.com)

¹⁹⁵ European industrial technology roadmap for the next generation cloud-edge offering, 2021 (EU strategic dependencies and capacities: second stage of in-depth reviews – Commission Staff Working Document, 22.2.2022, page 60, [DocsRoom - European Commission \(europa.eu\)](https://ec.europa.eu/docsroom-external/pages/DocsRoom.aspx))

Figure 441 Cloud Infrastructure Services Market¹⁹⁶

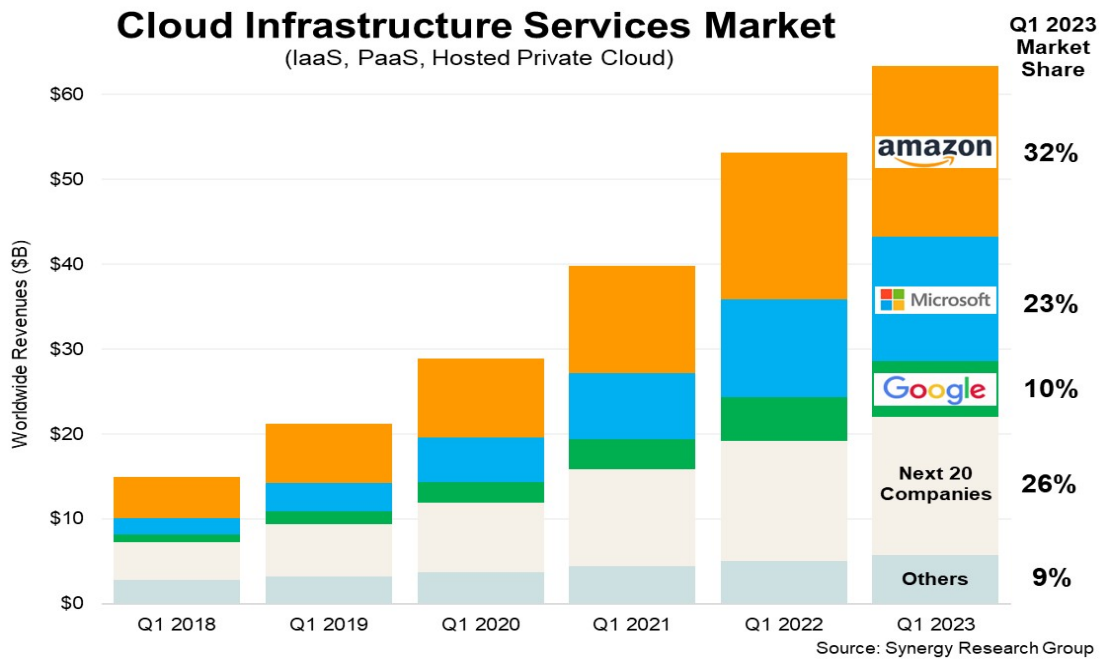
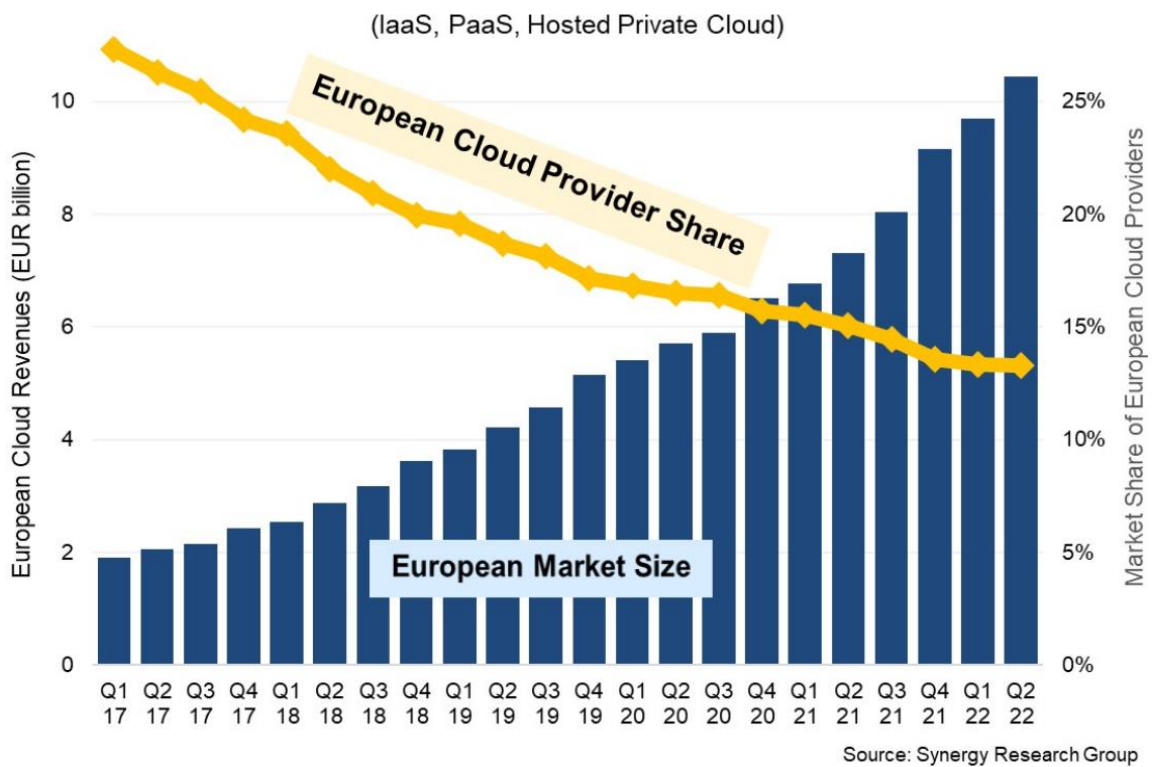


Figure 442 European Cloud provider Share of Local Market¹⁹⁷



¹⁹⁶ [Q1 Cloud Spending Grows by Over \\$10 Billion from 2022; the Big Three Account for 65% of the Total | Synergy Research Group \(srgresearch.com\)](https://www.srgresearch.com/news/q1-cloud-spending-grows-by-over-10-billion-from-2022-the-big-three-account-for-65-of-the-total)

¹⁹⁷ [European Cloud Providers Continue to Grow but Still Lose Market Share | Synergy Research Group \(srgresearch.com\)](https://www.srgresearch.com/news/european-cloud-providers-continue-to-grow-but-still-lose-market-share)

To fully reap the economic benefits of the data economy, cloud has the potential to act as a game changer. This is why at least twice more European enterprises should start using advanced cloud computing until 2030 in line with the Digital Decade target. This is of particular importance among SMEs, which constitutes the backbone of our European economy. Advanced cloud services will ultimately enable our businesses to build a truly sustainable and competitive advantage in this technology by the end of the decade.

This will however also require significant and joint efforts from European governments and businesses, investments and digital skills taking into account gender balance to successfully double the enterprise cloud uptake for medium and sophisticated cloud services by 2030.

Big data

Continuing supply chain constraints, IT skills shortages and severe energy shortages are expected to have an impact on the growth path of the EU data economy in the short and medium term.

In 2022, the EU data economy reached the threshold of EUR 500 billion, with an annual growth rate of 8.7% in 2021. Despite the economic turmoil, enterprises are increasingly recognising that business transformation and business performance is dependent on improved use of data. The estimated share of the data economy impacts on GDP in the EU27 increased from 3.7% in 2021 to 3.9% in 2022. According to the most recent estimates¹⁹⁸, the data economy for the EU27 is expected to remain slightly below the EUR 1 trillion threshold in 2023, with a 5.5% compound annual growth rate (CAGR) in 2025–2030. **In fact, the share of the EU27 data economy as a part of GDP will increase from 4.8% in 2025 to 5.7% in 2030.**

There were 190 796 data supplier companies in the EU27 in 2021 and this figure increased to 216 209 in 2022 representing a year-on-year growth rate of 13.3 %. Data supplier companies are expected to grow at a compound annual growth rate (CAGR) of 3.5 % in the period 2025-2030 period increasing to a total of 312 961 units in 2030.

As a consequence of the positive trends in the EU data economy at large, the number of data user companies in the EU27 increased to more than 579 000 companies by 2022 with a year-on-year growth rate of 3.3%. By 2030, data user companies will account for more than 905 000 companies in the EU27, growing at an annual rate of 6.9% between 2025 and 2030. Small and medium-sized companies account for 98% of all data user companies in the European Union. While larger companies show slightly higher growth between 2025 and 2030, 98% of the growth in the number of data user companies comes from the small and medium-sized sector: companies with fewer than 250 employees.¹⁹⁹

Take-up of big data analysis is at 14% among enterprises in the European Union (value refers to 2020, the latest available year with comparable data across the EU). Adoption rate ranges on a large scale between 5% and 31% among Member States. There are also significant differences in take-up of big data analysis by size class of enterprises. While 34% of large enterprise have taken up big data analysis, only 21% medium and 13% small sized enterprises carry out big data analysis.²⁰⁰

SMEs

Digitalisation of businesses and the economy is crucial to successfully meeting the present challenges; and for overall economic growth. Digitalisation will increase businesses' competitiveness

¹⁹⁸ <https://digital-strategy.ec.europa.eu/en/library/results-new-european-data-market-study-2021-2023>

¹⁹⁹ [Results of the new European Data Market study 2021-2023 | Shaping Europe's digital future \(europa.eu\)](#)

²⁰⁰ Source: Eurostat, data from 2020.

as it increases productivity, contributes to the creation of new products and services, consequently to the growth of the economy and resilience.

Yet digitalisation in Europe is sub-optimal. There were an estimated 1.35 million small firms in the European Union in 2022 with between 10 and 49 employees and approximately 206,592 were medium-sized firms that had 50 to 249 employees.²⁰¹ Businesses, especially SMEs', rates of digitalisation remain below the levels needed to enable the full potential of digitalisation for the economy more widely. While languishing at an average rate of around 56% over the last few years, in 2022 the percentage of SMEs recording at least a basic level of digital intensity jumped to 69% at EU level. This is a positive development which could mark the beginning of an upward change in trend. Indeed, it could be the first sign that the intensified policy efforts at national and EU level that have been made to support the digitalisation of businesses over the past few years are starting to pay off. However, it is important to note in this context that the digital intensity indicator fluctuates from year to year as components of the indicator (the questions asked to businesses) alternate on a biennial basis. Furthermore, we are still far from reaching the desired target of achieving 90% of SMEs with a basic level of Digital Intensity by 2030; only a handful of countries currently have rates near this level, and several are making insufficient progress. Further observations will be needed to confirm the change in trend, and it will be necessary to ensure that recent policy efforts are continued going forward so that business digitalisation continues to expand.

Unicorns

In the last two decades unicorns (start-ups that have passed the threshold of a \$1 billion market valuation) have been a key source of innovation, new products and services, employment and economic growth. The EU however has lagged other key regions – especially the US and China - in the numbers of unicorns that have been generated from its 'pipeline' of start-ups. This is reflected in the list of 10 top companies in the world, ranked by market capitalisation: none in the top 10 has emerged from the EU.

Encouragingly there has been a growth in the number of EU27 unicorns over the last 20 years, especially in the last decade. The set target – a doubling of the number of EU unicorns from a 2022 baseline of 249 - would represent a major increase. It would be a powerful and reassuring indicator that the EU delivers a better growth ecosystem for innovative start-ups, who can go on to deliver a new generation of European corporations that compete globally in key markets and business verticals.

There are, however, considerable challenges. Recent macro-economic trends, especially since Q1 2022, present a risk that growth levels of recent 'EU27 unicorn creation' may not be sustained. This new reality was already evident in the last 2 quarters of 2022 that saw investments in start-ups decrease and most leading tech companies (large caps and unicorns) laid off a significant percentage of their workforce. High inflation, rising interest rates, and profound geopolitical crises, such as the war in Ukraine are possible contributors to the recent decline in the unicorn 'birth rate'.

Given the above it would be prudent to assume that the high growth of unicorn numbers observed in the EU in recent years may not be replicable in the medium term. The scale of the jump seen in 2022 (a total of 249 unicorns in the EU27 in 2022, an increase of 38 compared to the 2021 total) is unlikely to be repeated in the near or medium term.

Nevertheless, there are reassuring developments underway and achievement of the goal of doubling the number of EU27 unicorns by 2030 remains achievable.

²⁰¹ [SMEs in the EU 2022, by size | Statista](#)

Consensus has emerged in recent years among key stakeholders in the EU - founders, investors, incubators - on the need for a stable, predictable, and supportive regulatory environment that allows companies to start up, scale, innovate, and compete across – and beyond - Europe. Moreover, since 2021 a total of 26 EU Member States have agreed on best policy practices that can deliver growth friendly environment for start-ups. They also committed to facilitate the exchange of best practices across Member States.

The initiative that catalysed this pan-European commitment was the EU Startup Nations Standard (EU SNS) launched by the European Commission and the Portuguese Presidency of the European Council [in March 2021](#). The EU SNS mobilises Member States to take action under their national competencies to improve the framework conditions for start-ups in their country [in 8 policy areas](#) (such as access to finance, treatment of stock options, procurement from start-ups of innovations by public authorities, and access to talent). This political aspiration is now being operationalised with the establishment, by the participating countries, of the [Europe Startup Nations Alliance](#) (ESNA). ESNA is a first-of-a-kind entity that has as its mission to identify and share with its member countries best policy practices that benefit start-ups. ESNA also has as its mission to support member countries in implementing such policies while also measuring progress.

There are also initiatives from member states to use the public funding to crowd in private capital for late-stage investments in high potential EU start-ups (such as European Tech Champions Initiative, which is being implemented in cooperation with the EIB). Initiatives of this nature are key to ensure EU start-ups have access to the capital necessary to scale up towards – and beyond - the unicorn milestone of a \$1 billion valuation.

Flanking such possibilities at the national level are EU legislative initiatives. A notable example is the Digital Markets Act that which will open up new, unprecedented opportunities in the data economy for nimble start-ups. These new opportunities will start in March 2024, when obligations kick in for large platforms (“Gatekeepers”) to allow users in the EU to easily port their data to competing platforms.

The cumulative effect of these policy efforts – when coupled with the ambitious and innovative nature of EU start-ups - can play a positive and measurable contribution to the growth of start-ups in the EU and the number who go on to become a unicorn.

3.2 Overall outlook based on DESI digitalisation of businesses indicators

The Digitalisation of businesses indicators that are part of DESI 2023²⁰² are grouped into three classes: , 3a. the first one measures the digital intensity level of SMEs, 3b. the second the digitalisation of businesses and 3c. the third e-commerce. The indicators which make up the targets of the Digital Decade are: SMEs with at least a basic level of digital intensity, and the percentages of enterprises using big data, cloud and artificial intelligence.

²⁰² See Annex VI Digital Economy and Society Index (DESI) 2023 Methodological Note for more information.

Table 7 DESI 2023 digitalisation of businesses indicators grouped into three classes: 3a digital intensity of SMEs; digitalisation of businesses; and e-commerce

	DESI 2023	2030 target
3a1 SMEs with at least a basic level of digital intensity	69%	90%
% SMEs	2022	
3b1 Electronic information sharing	38%	
% enterprises	2021	
3b2 Social media	29%	
% enterprises	2021	
3b3 Big data	14%	75%
% enterprises	2020	
3b4 Cloud	34%	75%
% enterprises	2021	
3b5 AI	8%	75%
% enterprises	2021	
3b6 e-Invoices	32%	
% enterprises	2020	
3c1 SMEs selling online	19%	
% SMEs	2022	
3c2 e-Commerce turnover	11%	
% SME turnover	2022	
3c3 Selling online cross-border	9%	
% SMEs	2021	

Source: DESI 2023, European Commission. Indicators' description and details in 2023 DESI methodological note. Indicators and 2030 of the Digital Decade Policy Programme are highlighted. By 2030, 90% of SMEs are expected to reach at least a basic level of digital intensity and 75% of enterprises have taken up big data, cloud or AI.

3.4 Take-up of technologies by businesses

3.4.1 Artificial intelligence

Overview

Member States and the Commission have agreed to ensure that more than 75% of EU companies adopt AI technologies, big data or cloud by 2030.

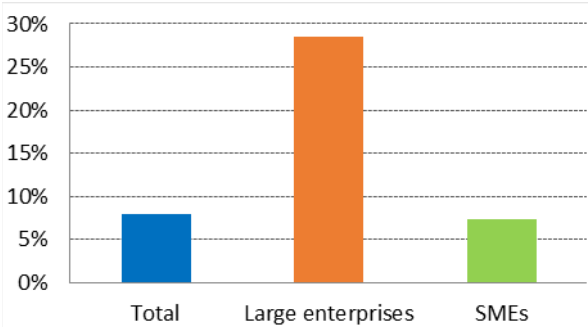
The adoption of AI technologies was very low among the Member States, at 8% in 2021, the last year for which data was available to the Commission. No more recent data is available in this area where technology uptake is accelerating and many measures already undertaken by Member States are therefore not reflected in available data. As reported in the 2022 DESI exercise, nevertheless, there were countries with a much higher uptake than others already in 2021. Denmark had the highest adoption rate with 24%, followed by Portugal (17%) and Finland (16%). There were seven countries with an uptake of 10% to 13% (the Netherlands, Luxembourg, Slovenia, Germany, Belgium, Malta and Sweden) and another seven countries with an uptake rate between 5% and 10%, Austria, Croatia, Ireland, Spain²⁰³, France, Italy and Slovakia. Another 10 countries had a very low adoption rate, and did not reach 5% (such as Czechia, Lithuania, Latvia, Bulgaria, Hungary, Poland, Estonia,

²⁰³ 2022 data shows substantial progress as 12.3% of enterprises use AI in Spain, the only country for which ESTAT data is available for 2022.

Greece²⁰⁴, Cyprus and Romania). With 1%, Romania had the lowest uptake in the EU. This was in line with the very low level of overall digitisation of enterprises in Romania. Even basic technologies were not widely used by enterprises (the share of SMEs with at least a basic level of digital intensity was the lowest in the EU), consequently more advanced technologies were not widespread either.

As with most advanced technologies, the uptake of AI technologies was much higher in large enterprises compared to SMEs. In 2021 the share of large enterprises adopting AI was three times higher than those of SMEs (29% versus 7%).

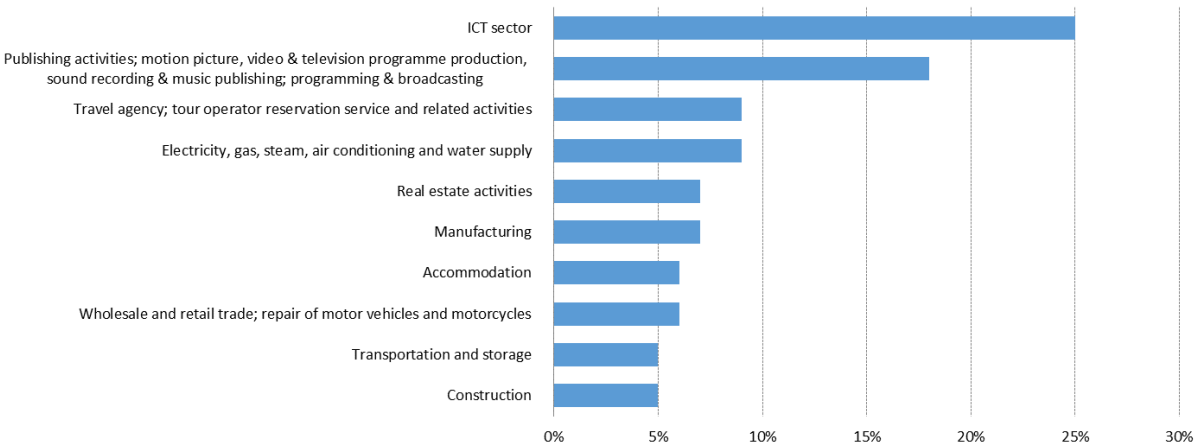
Figure 443 Use of AI technology by enterprise size (% of enterprises), 2021



Source: Eurostat, European Union survey on ICT usage and e-commerce in enterprises.

When looking at a sectoral overview, the ICT sector was clearly much ahead in the use of AI technologies with 25% of enterprises adopting AI, followed by publishing activities at 18%. Other sectors, such as real estate activities and manufacturing were much further behind with only 7% of enterprises using AI. The transportation and storage and the construction sector were the least likely to use AI technologies, with an uptake of about 5%.

Figure 444 Use of AI technology by sector (% of enterprises), 2021



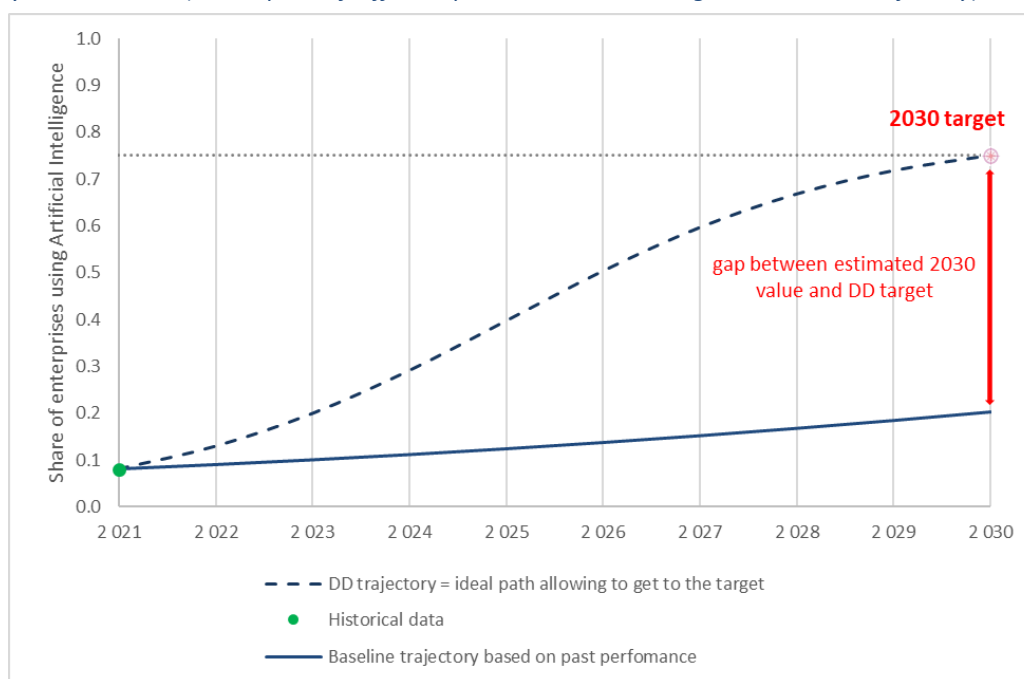
Source: Eurostat, European Union survey on ICT usage and e-commerce in enterprises.

²⁰⁴ Please note that the 2021 data on AI for Greece was revised backward by the Greek authorities after the publication of DESI 2022. Eurostat database was revised accordingly.

Trends towards 2030

The lack of time series data for AI adoption does not allow for the construction of a DD trajectory based on historical data²⁰⁵. The technology adoption literature suggests that an S-shaped curve should be used as the appropriate functional form for the diffusion this indicator. AI adoption is usually a process complementing big data adoption because, for example, AI methodologies are very much suited to exploit the full potential of big data. To overcome the lack of AI data points, the baseline trajectory for AI uses the same speed of diffusion parameter as the one estimated for the Big Data baseline trajectory (see section on Big Data). Figure 445 shows the Digital Decade and baseline trajectories for the share of firms using AI. Also in this case, the estimated 2030 value is far below the 2030 target.

Figure 445 Share of enterprises using AI in the EU. Historical data, Digital Decade (DD) trajectory and baseline trajectory towards 2030 (same speed of diffusion parameter as in the Big Data baseline trajectory)



The adoption of digital technologies by enterprises remains uneven, varying depending on the technology considered and with sharp differences among Member States and economic sectors. The use of cloud computing services experienced a major growth over the last years, reaching 34% of EU enterprises in 2021 (60% among large companies and 33% among SMEs). The uptake of big data analytics and AI technologies remains substantially more limited, used – respectively – by only 14% and 8% of enterprises. Reaching the Digital Decade targets will require substantial efforts by Member States, through comprehensive and integrated policies aimed to boost uptake and address obstacles hindering progress (including the lack of specialised skills and technical expertise, obstacles to use of data). Without additional targeted actions, especially the uptake of big data and AI will significantly fall short of the set targets.

²⁰⁵ Digital Decade and baseline trajectories are presented in the “Communication from the Commission establishing Union-level projected trajectories for the digital targets” [C\(2023\) 7500](#).

Actions at EU and national level

European Ecosystem of Excellence in Trustworthy AI

The 2021 review of the Coordinated Plan on AI proposed seven policy areas for joint actions between Commission and Member States, including chapters focusing on AI for the Green Deal and concrete actions and funding possibilities to support the AI ecosystem of excellence, through the Horizon Europe and Digital Europe Programmes.

Under Horizon Europe, the Commission is:

- Funding **basic and applied research** covering a variety of domains, aiming to develop **Trustworthy AI and robotics** which is, robust, safe and secure, unbiased and energy efficient.
- Setting up **AI research networks of excellence** to increase cooperation among the best research teams in Europe, to join forces to expand the research frontiers including large AI models and tackle major scientific and technological challenges that hamper the deployment of AI.
- Establishing a European **public-private partnership on AI, data and robotics**, to bring stakeholders from those three communities, from research to deployment, together with the public sector, to define a European strategy and leveraging funding to boost the development and deployment of these technologies.

Through the Digital Europe Programme, which has an emphasis on deployment and uptake, the Commission has initiated or given continuity to a set of important measures:

- To bridge the gap between AI research and deployment, together with Member States, co-funding **AI Testing and Experimentation Facilities** in several sectors, where companies will be able to test their latest AI-based technologies in real-world environments, an important step before bringing AI solutions to the market.
- Scaling up the AI-on-demand platform, a European **marketplace for trustworthy AI solutions**, connecting resources and services to support innovators in developing and deploying trustworthy AI solutions.
- To reach even the small low-tech SMEs across the EU, setting up the network of **European Digital Innovation Hubs**. These will help SMEs and public sector organisations to use AI and other digital technologies. The goal is to increase the digital maturity of the organisations supported by the hubs and to contribute the digital decade goals on businesses including to reach 75% of all EU companies using AI, big data and cloud by 2030.

Other measures, such as increasing equity financing for innovative start-ups in AI through InvestEU and launching a new programme ('Adopt AI') to support public procurement of AI systems, are:

- The Commission has proposed to invest at least EUR 1 billion per year in AI in the programming period 2021–2027, from the Horizon Europe and the Digital Europe programmes. The objective is to gradually increase public and private investment in AI to a total of EUR 20 billion per year over the course of this decade.
- As 26% of RRF investments are in the digital sphere, the Facility has the potential to be a game changer by enabling further investments in AI and accelerating the development and uptake of human-centric, trustworthy, and sustainable AI technologies.
- One of the key actions in the 2018 Coordinated Plan was the encouragement for all Member States to develop their national AI strategies. The Coordinated Plan 2021 Review describes,

how all Member States have made substantial efforts in developing national AI strategies or including AI dimensions in existing strategies and programmes.²⁰⁶

- Member States are setting up a wide range of policy measures to foster the development of AI technologies from the lab to the market, including Public-Private Partnerships (PPPs), setting up research excellence centres and experimentation and testing facilities. All national AI strategies set out policy actions to support start-ups and the scaling-up of firms and innovation ecosystems.

The institutionalised European Partnership KDT develops technologies enabling the migration of many AI applications from power-hungry platforms to more sustainable solutions at the edge of the network, including the next generation of low-power processors for AI applications, thus contributing to the reduction of CO2 emissions;

Artificial intelligence (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, enable new sustainable business models, support citizens in their green transition, and improve our understanding of environmental and climate risks and support mitigation and adaptation efforts.

A group of Member States on AI and Digitalisation of Businesses has been set up to continue to strive for coordinated action at EU level. The group aims to develop efficient mechanisms to ensure continuous and strategic monitoring of the Coordinated Plan on AI; develop concrete links between national AI actions; and identify new policy areas and actions for cooperation.

3.4.2 Cloud

Overview

Cloud computing gives businesses access to a scalable, shareable and elastic pool of computing resources. As these can be hosted remotely, businesses are no longer required to invest as much capital in their own IT infrastructure as with on premise data storage and processing.

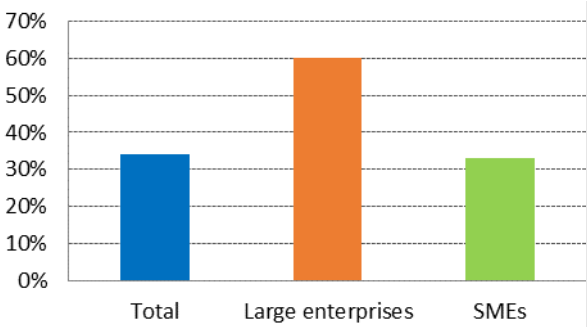
The enabling potential of cloud computing far exceeds file storage and email, which today remain the most common application scenarios for cloud in European companies. Cloud computing is a key enabler for emerging technologies like AI, big data and digital ledger technologies. As a core enabling technology, cloud computing lies at the heart of the European data economy and is an essential underpinning for the continued competitiveness of European businesses vis-à-vis their international competitors. In fact, the continued uptake of advanced cloud solutions by EU businesses is essential for Europe's ability to continue adopting data-driven technologies and capitalise on the associated economic opportunities. This is particularly important for SMEs, which represent the majority of the EU's industrial basis and are today mostly employing basic cloud services. Cloud computing underpins the future competitiveness of EU businesses in the digital economy. That is why secure and sustainable cloud capacities are considered a key pillar of Europe's digital sovereignty in the Digital Decade.

The Path to the Digital Decade proposal requires that more than 75% of EU companies adopt cloud computing services, AI or big data by 2030. No recent data is available in this area where technology

²⁰⁶ The [AI Watch](#). National strategies on Artificial Intelligence: A European perspective. 2022 edition. report provides an in-depth analysis of the national strategies structured along the categories and priorities agreed between EC and Member States in the Coordinated Plan on AI review 2021. Further information is available on: [AI Watch \(europa.eu\)](#).

uptake is accelerating and many measures already undertaken by Member States are therefore not reflected in available data. As reported in the 2022 DESI exercise, which contains the latest available data, in 2021, 34% of EU enterprises purchased sophisticated or intermediate cloud computing services (i.e. at least one of the following: 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); computing platform providing a hosted environment for application development, testing or deployment) and incorporated cloud technologies to improve their operations while reducing costs. The cloud uptake of large companies (60%) is almost double that of SMEs (33%) in 2021.

Figure 446 Cloud computing services of sophisticated or intermediate level (% of enterprises), 2021

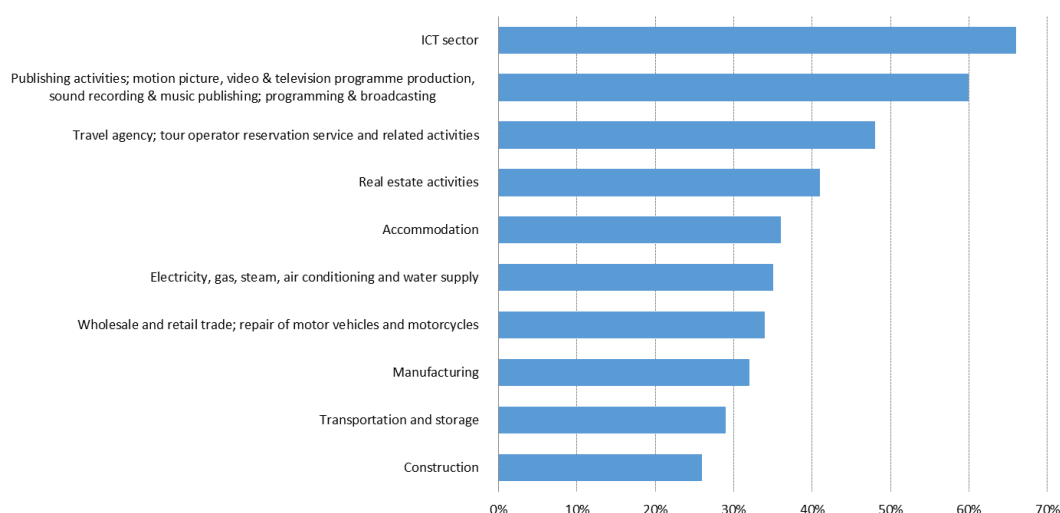


Source: Eurostat, European Union survey on ICT usage and e-commerce in enterprises.

Enterprises in Nordic countries were leading in the adoption of sophisticated or intermediate cloud services. More than 60% of enterprises in Sweden, Finland, Denmark and the Netherlands were buying such services. Italy and Estonia followed at more than 50%. However, the gap between top and low performers remained large, with Bulgaria and Romania scoring below 15%.

When looking at cloud usage by sector, two out of three enterprises in the ICT sector (66%) used cloud computing services of sophisticated or intermediate level, followed by publishing activities with 60%. The sectors with the least cloud usage were the construction sector (26% of enterprises) and the transport and storage sector (29% of enterprises). These were followed by manufacturing at 32% of enterprises. This sectoral distribution is coherent with the general digitisation of sectors, as construction and transport displayed the lowest level of overall digitisation. This was partly inherent to the characteristics of these sectors that rely less on digital technologies.

Figure 447: Cloud computing services of sophisticated or intermediate level per sector (% of enterprises), 2021



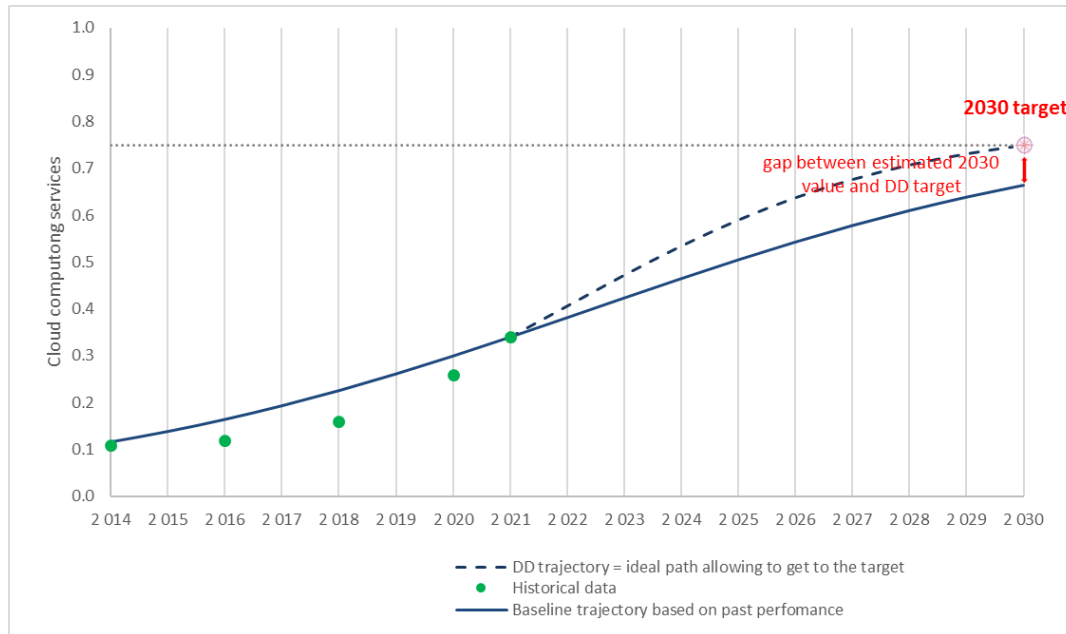
Source: Eurostat, European Union survey on ICT usage and e-commerce in enterprises.

Trends towards 2030

According to the relevant literature, an S-shaped adoption curve is the most appropriate approach to estimate the evolution of enterprise cloud computing intermediate and sophisticated services take-up. The adoption of this technology might still present some economic (e.g., limited choice), security and technical challenges (e.g., vendor lock-in) associated to lack of advanced skills across enterprises in particular amongst Small and Medium Enterprises (SMEs), which might delay a full adoption in particular of sophisticated cloud services leading to a flatter growth rate near to the saturation point of the curve. The functional form adopted for this KPI is therefore the S-shaped one, typical for describing this type of technological diffusion process. The market saturation point is set at 80% for both the Digital Decade and the baseline trajectories²⁰⁷. The saturation point is assumed to be slightly above the 2030 target of 75%, to allow for further increasing of the cloud technology adoption levels after the target is reached. The speed of diffusion parameter of the Digital Decade trajectory is set so that the 75% target is reached by 2030, while the speed of diffusion of the baseline trajectory is based on the interpolation of pre-break-in-series data (2014-2020). As for all the other S-shaped functional forms, the timing of diffusion is computed to make the baseline trajectory start at the last observed data point (the 2021 value for cloud. Figure 448 shows the Digital Decade and baseline trajectories for the share of firms using sophisticate or intermediate cloud services. The estimated 2030 value falls short of approximately ten percentage points from the 2030 target value if no additional investments are implemented (expected value in 2030 = 66%).

²⁰⁷ Digital Decade and baseline trajectories are presented in the “Communication from the Commission establishing Union-level projected trajectories for the digital targets” [C\(2023\) 7500](#).

Figure 448: Share of enterprises using Cloud services in the EU. Historical data, Digital Decade (DD) trajectory and baseline trajectory towards 2030 ²⁰⁸



Actions at EU and national level

Data Act

The Data Act, which was adopted by the College on 23 February 2022, will fundamentally reshape the EU cloud regulatory landscape and enable European businesses to benefit from a more open cloud market. The proposed Regulation 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 stack to remove obstacles to switching, the proposed Data Act tackles vendor lock-in practices, which nowadays constitute a major obstacle to cloud adoption by European businesses. The possibility of free and fast switching will allow customers of data processing services to benefit from the vast opportunities offered by the European cloud market, where providers of all sizes will compete on performance, innovation and price.

Free Flow of Non-Personal Data Regulation

Adopted in 2018, the Free Flow of Non-Personal Data Regulation has led Member States to largely remove data localisation requirements, which have in the past hampered the free flow of data in Europe and impeded the emergence of a true single market for data to the detriment of European businesses. In fact, 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.²⁰⁹ First results of the European Cloud Data Flow Monitoring suggests that the total volume of data flows across the EU has increased over the years bringing along significant economic

²⁰⁸ Eurostat's indicator "Enterprises purchasing at least one of the following 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 series occurred in 2021 when the indicator "Enterprises buying sophisticated or intermediate CC Services" is 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).

²⁰⁹ Wauter, P. et al (2016), Measuring the economic impact of cloud computing in Europe.

opportunities. However, these flows are not equally distributed among Member States despite the applicability of the principle of free movement of data established by this Regulation and the General Data Protection Regulation.

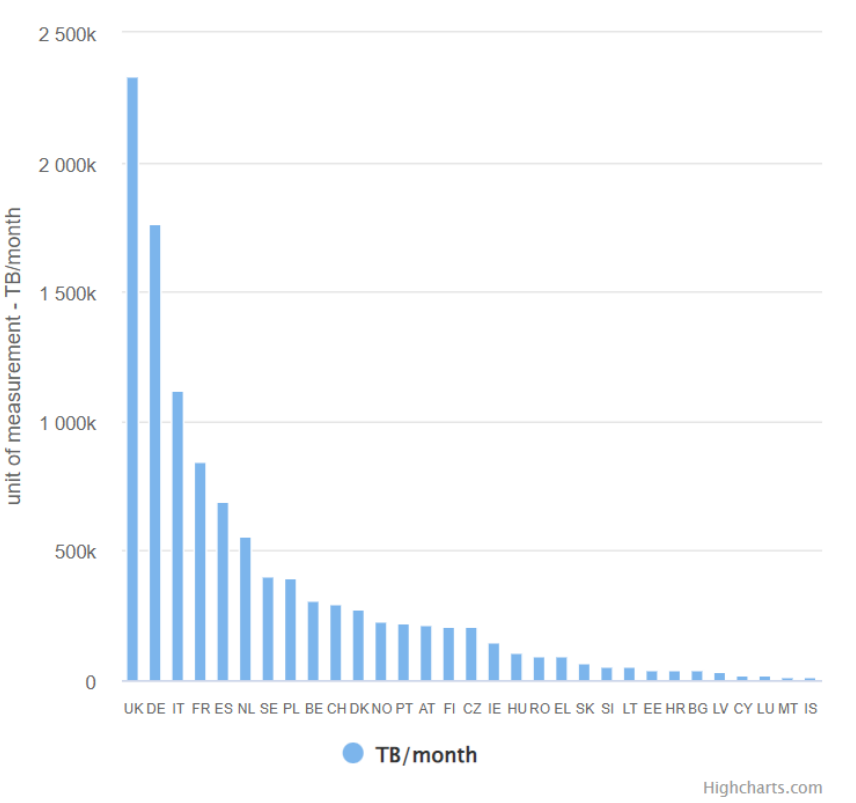
Furthermore, data flows seem to continue to be negatively impacted by the commercial lock-in practices that the Data Act seeks to address. Taken together, the Data Act and the Free Flow of Non-Personal Data Regulation will set the framework conditions for an open and fair EU cloud market for European businesses users to tap into.

A. Cloud Market Monitoring & Oversight Instruments

European Cloud Data Flow Monitoring

The European Cloud Data Flow Monitoring²¹⁰ measures and forecasts the volume and the economic value of cloud data flows within the European Union (EU), the UK and EFTA countries from 2016 to 2030. In 2022, the volume of cloud data flows within the EU was estimated to be 11.2 Exabytes with an associated economic value of EUR 2.05 billion. **The volume of cloud data flows is forecasted to increase 8-fold from the 2022 level to 92.1 Exabytes/year in 2030.** The map and graph below provide comparative country data flow and outflow forecasts for 2030, where data is available.

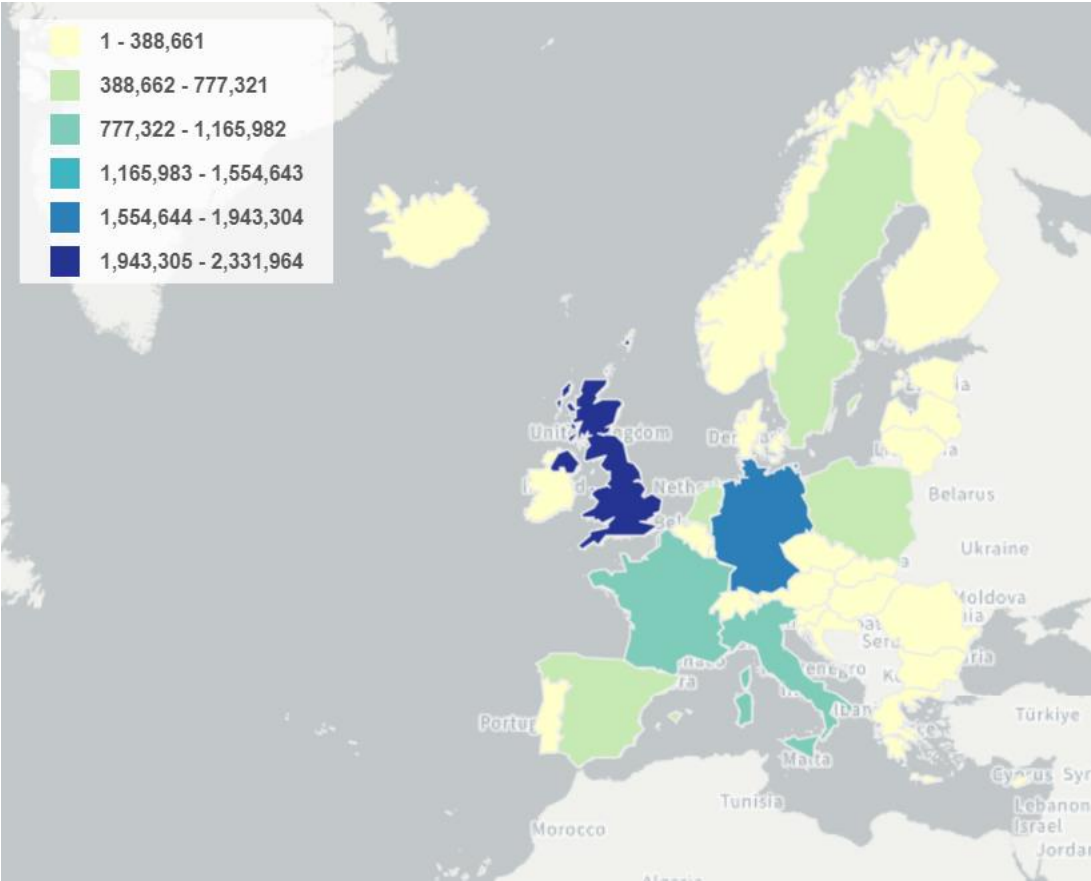
Figure 449: Enterprise data flowing from the selected country to cloud facilities by country, 2030²¹¹



²¹⁰ [Economic value of data flows | Shaping Europe’s digital future \(europa.eu\)](#)

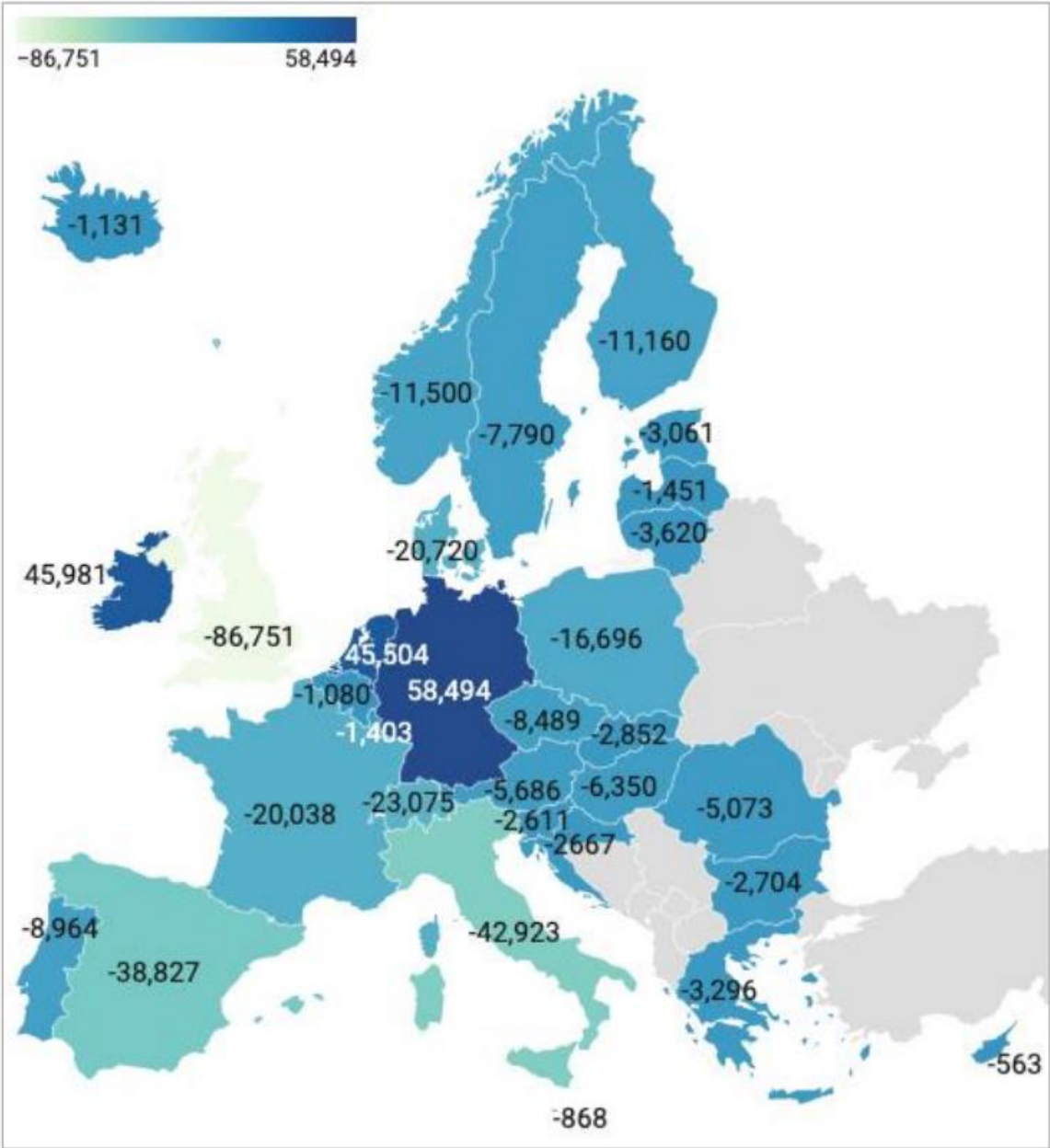
²¹¹ [The European Data Flow Monitoring | Shaping Europe’s digital future \(europa.eu\)](#)

Figure 50: Enterprise data flowing from the selected country to cloud facilities by country, 2030²¹²



²¹² [The European Data Flow Monitoring | Shaping Europe’s digital future \(europa.eu\)](https://european-council.europa.eu/media/en/press-operations/infographic-116236/image001.png)

Figure 51: Data flows geography: Net inflow/outflow map for data flowing to cloud and edge data centres for the 31 countries examined in the study (TB/month) in 2020²¹³



In 2022, enterprises with over 250 employees have higher cloud data flows (6.3 Exabytes/year) than all other sizes of enterprise combined in 2022. Highest growth is predicted for EU27 enterprises with 10 to 49 employees, they are forecasted to have 9.6-fold cloud data flow growth to 16.5 Exabytes/year in 2030. Lowest growth rates are predicted for the largest companies with over 250 employees. These EU27 enterprises are forecasted to have 7.5-fold cloud data flow growth to 46.9 Exabytes/year.

Cloud Rulebook

Over the past decade at EU level, a largely self-regulatory approach to cloud has resulted in a multitude of self-regulatory codes of conducts and standards for the cloud market. This vast landscape is becoming increasingly difficult to navigate for business users. The upcoming EU Cloud

²¹³ [Study on mapping data flows | Shaping Europe’s digital future \(europa.eu\)](https://europa.eu/study-on-mapping-data-flows)

Rulebook will provide a single point of reference for understanding the applicable rules stemming from EU legislation, self-regulatory initiatives, certification mechanisms and standards. By assisting European businesses in understanding the regulatory picture, the Rulebook will strengthen the regulatory expertise and confidence of European businesses as they move to the cloud. A first version will be published in summer 2023 and will be updated regularly thereafter.

Cloud Marketplace

To complement the Rulebook, the Commission has awarded a grant for a cloud marketplace to create a single point of access for trusted data processing services. It will comprise both cloud and edge services and make it easier for European businesses to navigate the multitude of offerings available on the European cloud market and to identify and evaluate their specific features. By helping businesses understand and compare different offers, the marketplace will contribute to reducing the time that businesses have to invest before being able to choose the most viable cloud solution for their needs.

B. Cloud Industrial Initiatives

Pre-Notified IPCEI on Next Generation Cloud Infrastructure and Services

One of the key actions of the European Strategy for Data is the set-up of a High Impact Project on next generation federated cloud infrastructures and services. To realise the ambition of this Strategy, in April 2022, 12 Member States and more than hundreds of European companies, research and technological organisations pre-notified an *Important Project of Common European Interest on Next Generation Cloud Infrastructure and Services* (IPCEI-CIS) which forms part of the Multi-Country Project on a *Common Data Infrastructure and Services* and will benefit from funding under the *Recovery and Resilience Facility*.

The IPCEI-CIS aims at equipping the European Union with the next generation of advanced, distributed, secure, sustainable and innovative cloud-to-edge capabilities that citizens and businesses are in need for. It will thus support the achievement of the Digital Decade's cloud uptake among European enterprises.

European Alliance for Industrial Data, Edge and Cloud

Since 2021, the European Alliance for Industrial Data, Edge and Cloud brings together European 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 contributes to overcoming the fragmentation in the European cloud market and helps forge a common approach to developing and deploying the next generation of cloud and edge capabilities for the benefit of European businesses.

3.4.3 Big data

Overview

Big data are characterised by volume, variety and velocity, i.e., vast amounts of data, which are complex in nature, in different formats and frequently generated. Big data analytics refers to the use of technologies, techniques or software tools such as data or text mining and machine learning, for analysing big data extracted from the enterprise's own data sources or other data sources.

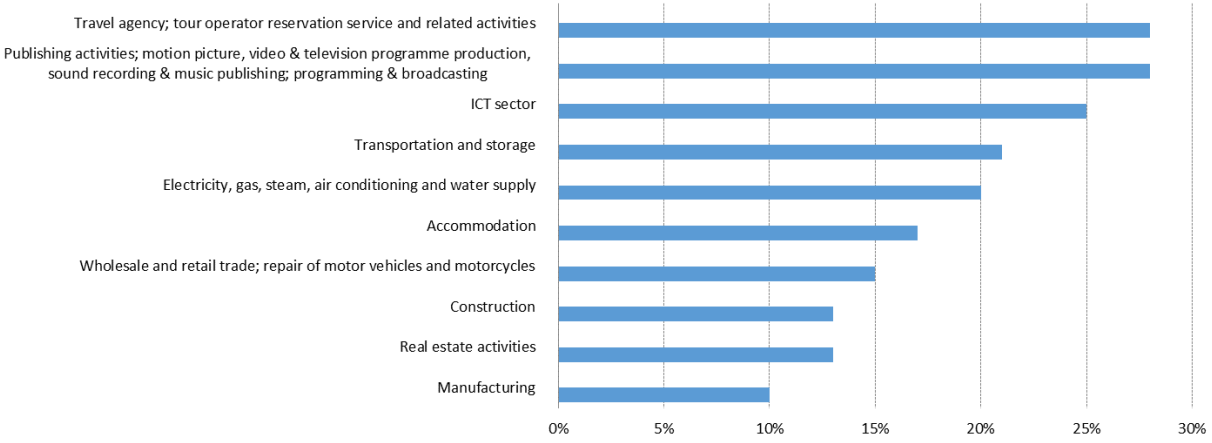
Enterprises all over the EU and across sectors are constantly adapting to new technologies for collecting, storing and analysing data. No recent data is available in this area where technology

uptake is accelerating and many measures already undertaken by Member States are therefore not reflected in available data. As reported in the 2022 DESI exercise, which contains the latest available data, in 2020, 14% of companies carried out big data analytics. This helped them to produce near time or real time results from data that come in different format types. Large companies had the lion’s share in big data processing (with 34% of them using big data), while SMEs had still room for improvement to take advantage of all the benefits of big data (14% use big data).

In Malta, almost a third of enterprises analysed big data. The Netherlands and Denmark followed closely behind, with 27%. At the other end of the spectrum only 5-6% of enterprises in Romania, Slovakia, Cyprus and Bulgaria analysed big data.²¹⁴

When looking at a sectoral breakdown, enterprises were more likely to analyse big data in the travel agency; tour operator reservation service and related activities and in the publishing activities²¹⁵ sectors (both at 28%), followed by the ICT sector at 25%. Only 15% of enterprises carried out big data analytics in the wholesale and retail trade²¹⁶ sector, 13% in construction and in real estate activities, and 10% in the manufacturing sector.

Figure 52: Enterprises analysing big data per sector (% of enterprises), 2020



Trends towards 2030

The technology adoption rationale described by an S-shaped curve applies equally for Big Data. Big Data usage take-up is expected to be slow in the beginning, to accelerate after a while to reach a slower final uptake, probably driven by very small firms, which may have less incentive to adopt big data technologies. Also in this case, the market saturation point is set at 80%, above the target of 75%, to allow for further increase after the target is reached. The speed of diffusion parameter is set so that the 75% target is reached by 2030 in the Digital Decade trajectory²¹⁷. Figure 53 shows the Digital Decade and baseline trajectories for the share of firms using Big Data. The estimated 2030 value in the business-as-usual scenario is far below the 2030 target.

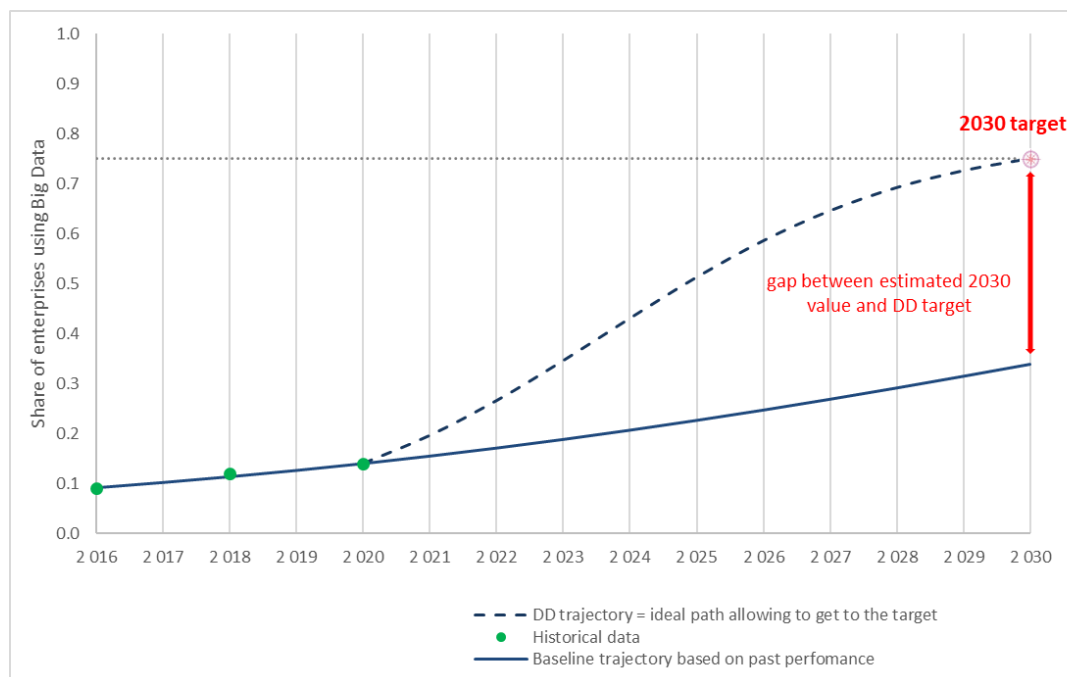
²¹⁴ 2022 data shows substantial progress as 14.3% of enterprises use big data for internal analysis in Spain, the only country for which ESTAT data are available for 2022.

²¹⁵ Publishing activities; motion picture, video & television programme production, sound recording & music publishing; programming & broadcasting

²¹⁶ Wholesale and retail trade; repair of motor vehicles and motorcycles

²¹⁷ Digital Decade and baseline trajectories are presented in the “Communication from the Commission establishing Union-level projected trajectories for the digital targets” [C\(2023\) 7500](#).

Figure 53: Share of enterprises using Big Data in the EU. Historical data, Digital Decade (DD) trajectory and baseline trajectory towards 2030



Actions at EU and national level

The European Data Strategy of February 2020 clearly described the vision of a European single market for data in which data can flow freely across borders and sectors while in full compliance with the respective European rules and values. The strategy also laid down the foundations of common European data spaces in a set of vertical sectors of strategic importance for the European Union at large.

The European Data Strategy also announced two proposals for legislative instruments that are meant to facilitate data sharing to benefit society and economy, with a special focus on businesses across Europe. The first instrument, the Data Governance Act²¹⁸ will increase trust in voluntary data sharing, strengthen mechanisms to increase data availability and overcome technical obstacles to the reuse of data. The Regulation is a key building block for the establishment of common European data spaces in strategic domains, involving both private and public players. The Data Governance Act entered into force on 23 June 2022 and will be applicable from September 2023.

The Data Act, which is the second key proposal announced in the European Data Strategy, will complement the Data Governance Act by clarifying access and use rights on data with the objective of ensuring fairness in the data economy.

National actors will play a key role in making this EU-level regulatory toolbox work on the ground and benefit the largest possible range and number of beneficiaries in the Member States. They will also be instrumental in making the common European data spaces work in each Member State and with the involvement of all key players so that the European single market for data foreseen in the Data Strategy becomes a reality in the medium term.

Policy actions are underpinned – among others - by investments in data research, innovation and data infrastructures, via the Horizon Europe and Digital Europe Programmes. With the launch of Horizon Europe, the European Commission has notably established a partnership with the AI, Data

²¹⁸ <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32022R0868>

and Robotics Association (ADRA), raising 2.6 billion EUR of public and private investments for technological development. The association brings together major industrial stakeholders in the field of AI, data and robotics. Within the programme, the European Union has already provided approximately 200 million EUR. The 25 funded projects focus on data mining, analytics, secure and privacy-compliant data management, as well as technologies supporting the data economy such as models for data marketplaces and data monetisation. These build on the success of several projects funded in the previous programme, Horizon 2020. Other projects address topics as diverse as networks of excellence in Safe AI, AI for the Green Deal, or tackling biases in AI.

Within the Digital Europe Programme, the focus is on the deployment of data spaces and the successful exploitation of High Value Datasets, fostering data sharing and the development of a European Data Infrastructure. Among Digital Europe activities, we can highlight the various coordination and support actions setting the basis for domain-specific data spaces and building stakeholders engagement, and the Data Spaces Support Centre. The latter has an essential coordination role, creating a network of stakeholder, ensuring inter-operability across all data spaces and maximising their industrial and societal impact.

3.5 SMEs

3.5.1 Overview

Digital intensity

The Digital Intensity Index (DII) measures the use of different digital technologies at enterprise level. The DII score of an enterprise is based on counting how many out of 12 selected technologies are used.

Figure 54 shows the composition of the DII in 2022²¹⁹. It also shows the degree of penetration and speed of adoption of the different technologies monitored by the DII. Large companies in the EU are more digitised than SMEs. While some aspects seem to be reaching saturation, at least for large companies, there is still room for improvement for most indicators.

Figure 54: Digital Intensity Index indicators tracking digitisation processes (% enterprises), 2022²²⁰

	Large	SMEs
The maximum contracted download speed of the fastest fixed line internet connection is at least 30 Mb/s	96%	84%
Use at least 3 ICT security measures	97%	73%
Enterprises make persons employed aware of their obligations in ICT security related issues	91%	57%
Any of the persons employed having remote access to any of the following: e-mail, documents, business apps	91%	56%
Enterprises where more than 50% of the persons employed had access to the internet for business purposes	60%	51%
Enterprises which conducted remote meetings (via e.g. Skype, Zoom, MS Teams, WebEx, etc.)	93%	49%
Enterprise with document(s) on measures, practices or procedures on ICT security	80%	36%
Any type of training provided to develop ICT related skills of the persons employed, during 2021	70%	21%
Employ ICT specialists	78%	19%
Enterprises with e-commerce sales of at least 1% turnover	39%	19%
Enterprises where web sales are more than 1% of the total turnover and B2C web sales more than 10% of the web sales	13%	11%
Use industrial or service robots	26%	6%

Source: Eurostat, European Union survey on ICT usage and e-commerce in enterprises.

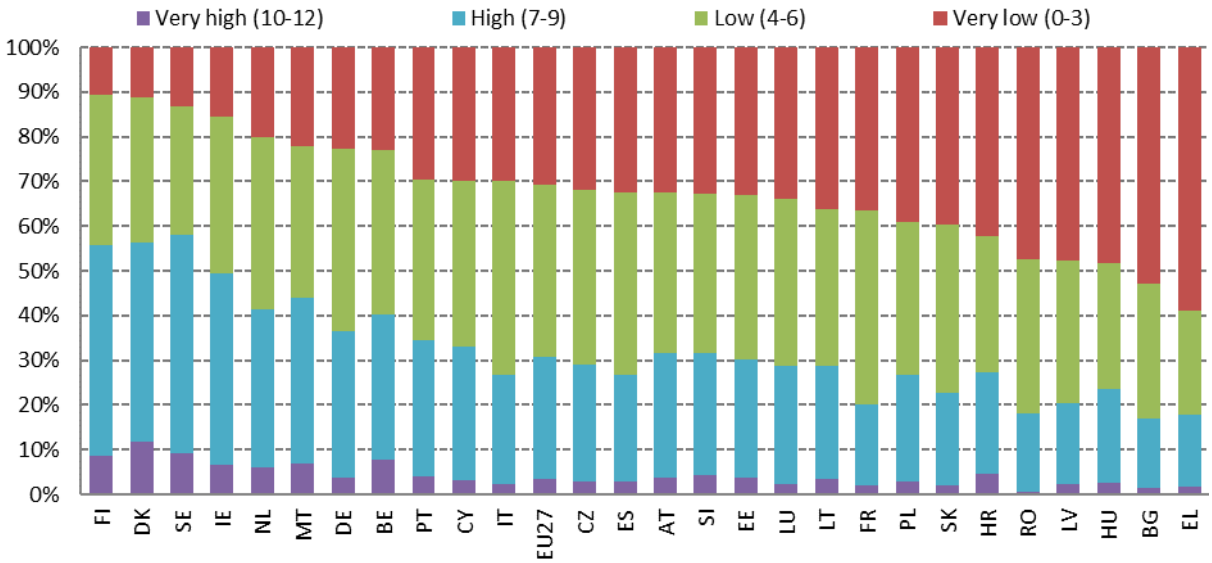
²¹⁹ Please note that DII in 2022 is not comparable with DII in 2021, as different technologies were considered.

²²⁰ ERP stands for enterprise resource planning. CRM stands for customer relationship management. CC stands for cloud computing. IoT stands for Internet of Things.

According to the target of the Path to the Digital Decade proposal, by 2030 more than 90% of SMEs should reach at least a basic level of digital intensity. Basic DII level requires usage of at least four technologies and comprises SMEs with very high, high and low DII.

There are only five countries (Denmark Sweden, Finland, Belgium and Malta) in the EU where the share of SMEs with a very high DII (i.e., possessing at least 10 out of the 12 monitored digital technologies) is above 7%, followed by Ireland, the Netherlands, Croatia, Slovenia and Portugal with above 4%. By contrast, in countries such as Greece, Bulgaria, Hungary, Latvia and Romania, more than 45% of SMEs have made only a small investment in digital technologies (i.e., have a very low DII).

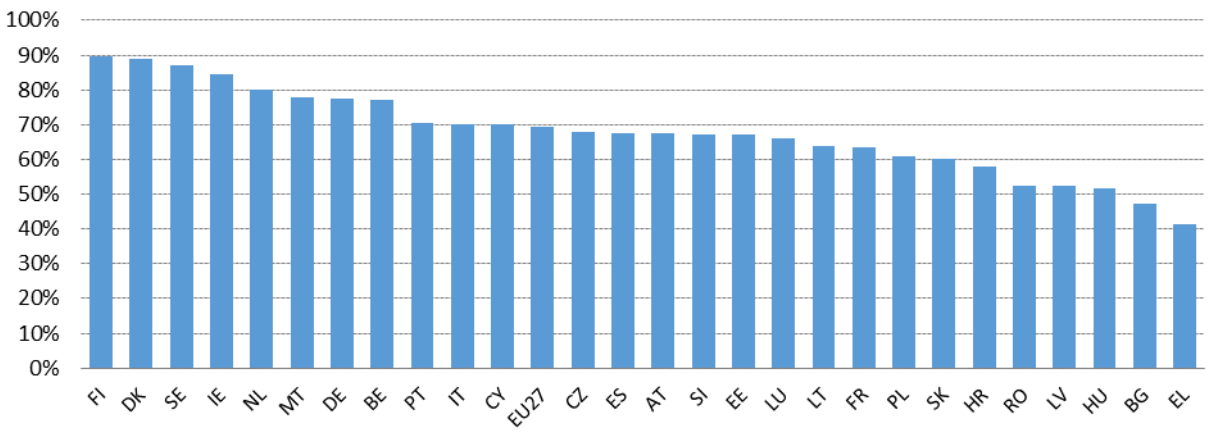
Figure 55: Digital Intensity Index by level (% of SMEs), 2022



Source: Eurostat, European Union survey on ICT usage and e-commerce in enterprises.

Figure 56 shows the share of SMEs with a basic DII score. At least 80% of SMEs in four Nordic countries (Finland, Denmark, Sweden and Ireland) reached at least a basic level of digital intensity, while in Greece and Bulgaria this level is below 50%.

Figure 56: SMEs with at least basic level of digital intensity, 2022



Source: Eurostat, European Union survey on ICT usage and e-commerce in enterprises.

Overall, the level of digitalisation of SMEs remains uneven across MSs and economic sectors. A key barrier to be overcome is the lack of awareness of the potential of digital technologies and the lack of

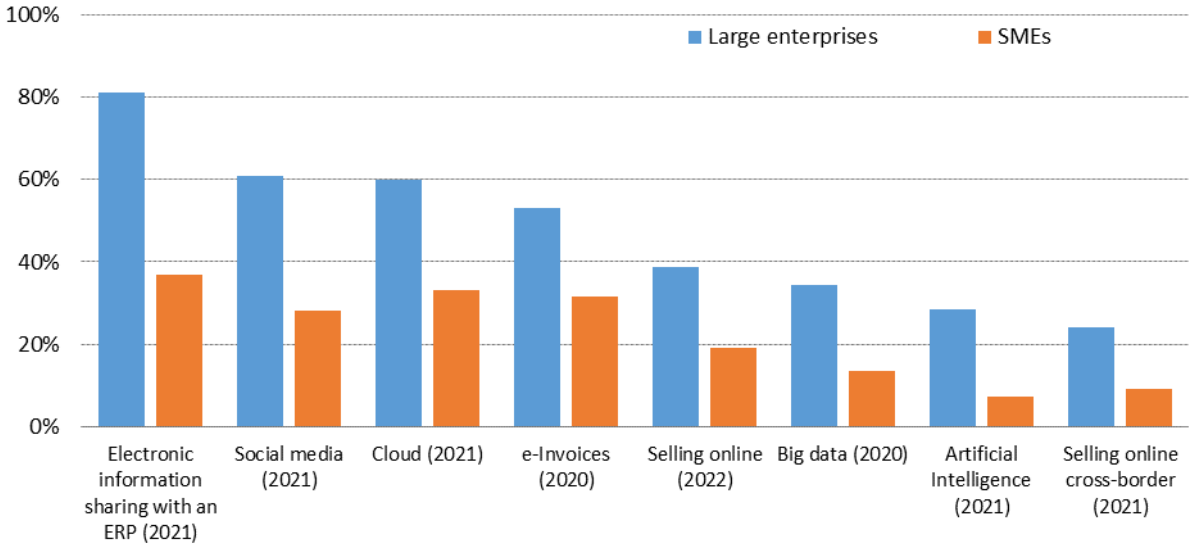
skills and technical expertise among the employees to integrate basic or advanced digital technologies in the business operations.

Adoption of digital technologies by enterprises

Large enterprises are more likely to adopt new technologies. For example, electronic information sharing through enterprise resource planning (ERP) software is much more common in large enterprises (81%) than in SMEs (37%). On social media²²¹, more than twice as many large enterprises (61%) make use of it if compared to SMEs (28%). SMEs exploit e-commerce opportunities only to a limited extent, with only 19% selling online (versus 39% of large enterprises) and only 9% selling cross border online (versus 24% of large enterprises). There are many other technological opportunities yet to be exploited by SMEs such as cloud services²²², AI and big data. The possibility of extracting information from data through advanced data analytics techniques will be essential for the competitiveness of the EU's economy. Reaching 75% adoption of advanced big data analytics by businesses across sectors will enable European companies to match the growth in data uptake at global level and fully exploit the rich new ways to explore and interpret data using AI, natural language processing and extended reality technologies.

There are common factors that play a critical role in enabling and boosting the uptake of cloud services, big data and AI, such as the availability of staff with advanced digital skills. Additionally, ensuring legal certainty and addressing data protection and liability issues is very important to enable the use of data and minimise the risks of breaches in security and data protection.

Figure 57: Adoption of digital technologies (% enterprises), 2020, 2021, 2022²²³



Source: Eurostat, European Union survey on ICT usage and e-commerce in enterprises.

• **e-Commerce**

²²¹ For social media the Eurostat indicator 'Use two or more social media' (code: E_SM1_GE2) is used. See DESI methodological note.

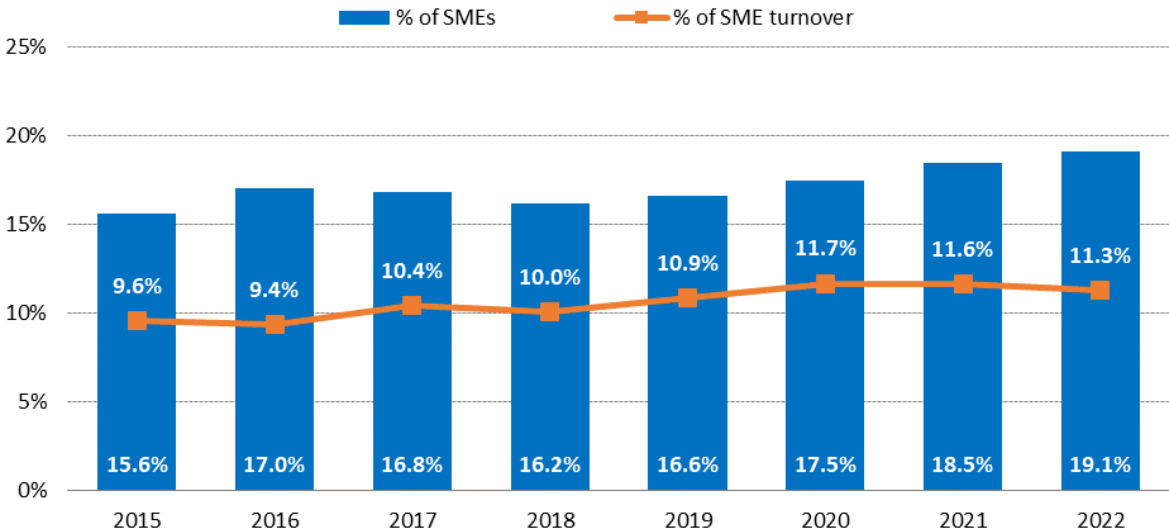
²²² For cloud the Eurostat indicator 'Enterprises buying sophisticated or intermediate cloud computing services' (code: E_CC1_SI) is used. See SWD(2023) 574 'Digital Decade Digital Economy and Society Index (DESI) 2023 Methodological Note'

²²³ These are the DESI 2022 indicators under the sub-dimension 3b and 3c of the Integration of digital technology dimension. For exact definitions, please see the DESI methodological note.

The European Commission put forward two legislative proposals to upgrade rules governing digital services in the EU: the Digital Services Act (DSA) and the Digital Markets Act (DMA). They form a single set of new rules applicable across the whole EU to create a safer and more open digital space. The DSA and DMA have two main goals: (i) to create a safer digital space in which the fundamental rights of all users of digital services are protected; and (ii) to establish a level playing field to foster innovation, growth and competitiveness, both in the single market and globally.²²⁴

According to the 2022 survey, around one in five EU small and medium sized enterprises (SMEs) made online sales, amounting to 11% of total turnover. Between 2015 and 2022, the percentage of SMEs selling online increased by 3.5 percentage points and the turnover of these companies achieved from online sales increased by 1.7 percentage points.

Figure 58: Trends in e-commerce (% of SMEs, % of SME turnover), 2015-2022²²⁵ -



Source: Eurostat, European Union survey on ICT usage and e-commerce in enterprises.

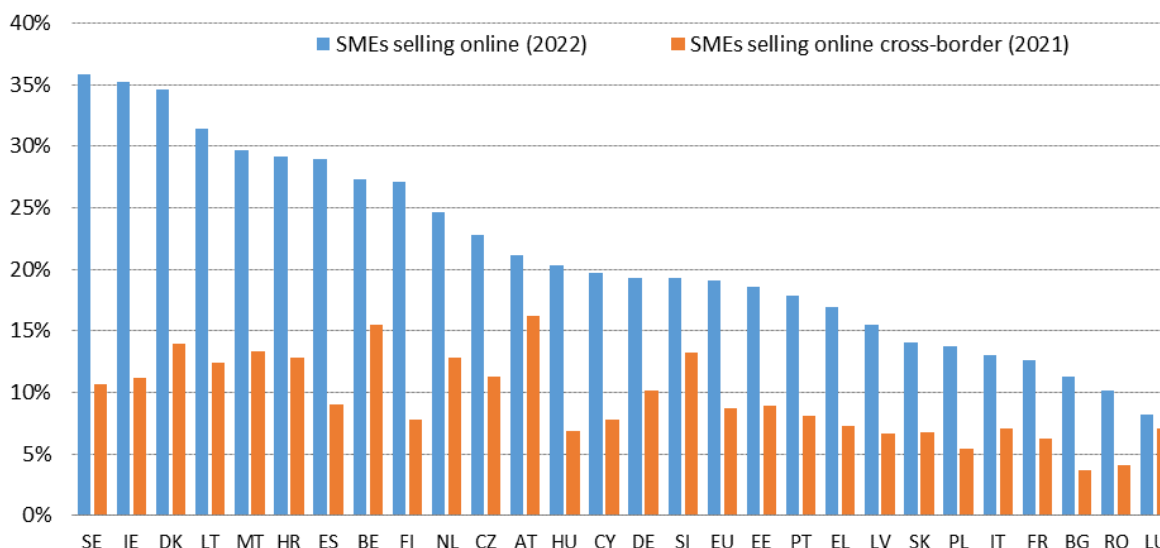
Enterprises benefit from cross-border e-commerce by exploiting economies of scale. This helps to reduce costs, increase efficiency, promote competitiveness and improve productivity. Cross-border e-commerce is even more important for enterprises and especially SMEs that are confined to a small home market. However, only 9% of SMEs made web sales to customers in other EU countries in 2020. SMEs in Sweden, Ireland, Denmark and Lithuania have the largest proportion of online sales (30% or more). Austria leads in cross-border online sales²²⁶ (16% of Austrian enterprises have online sales across borders to other EU countries), followed by Belgium, Denmark, Malta and Slovenia (all above 13%).

²²⁴ [The Digital Services Act package | Shaping Europe’s digital future \(europa.eu\)](https://european-council.europa.eu/media/en/press-operations/infographic-117336.png)

²²⁵ Data for e-commerce refer to the calendar year prior to the survey, e.g. 2022 data refer to 2021 e-commerce.

²²⁶ Cross-border refers to other EU countries only.

Figure 59: SMEs selling online (2022) and selling online cross-border (2021) (% of SMEs)



Source: Eurostat, European Union survey on ICT usage and e-commerce in enterprises.

A majority (56%) of SMEs with web sales to other EU countries have no difficulties when selling to customers in other EU countries. On the other hand, 43% report at least one obstacle that is mainly related to economic factors (e.g., high costs of delivering or returning products, a problem reported by 28% of SMEs). The problems related to resolving complaints and disputes (13%) and the lack of knowledge of foreign languages (10%) are also highlighted as difficulties by the SMEs selling online to other EU countries.

3.5.2 Trends towards 2030

The digital intensity²²⁷ target implies a wide uptake of digital technologies by EU small and medium enterprises (SMEs) - those having between 10 and 249 employees and self-employed persons - in the EU. In 2022, 97% of the 1.47 million enterprises in the EU were SMEs.

²²⁷ Methodology: Digital Intensity is measured via the Digital Intensity Index (DII) that counts how many of twelve selected technologies are used by the enterprise. Every year, the DII covers a broad range of technologies, from basic to more sophisticated ones, and aims at measuring the level of digitalisation of EU SMEs. The 2022 survey includes the twelve following technologies and/or criteria:

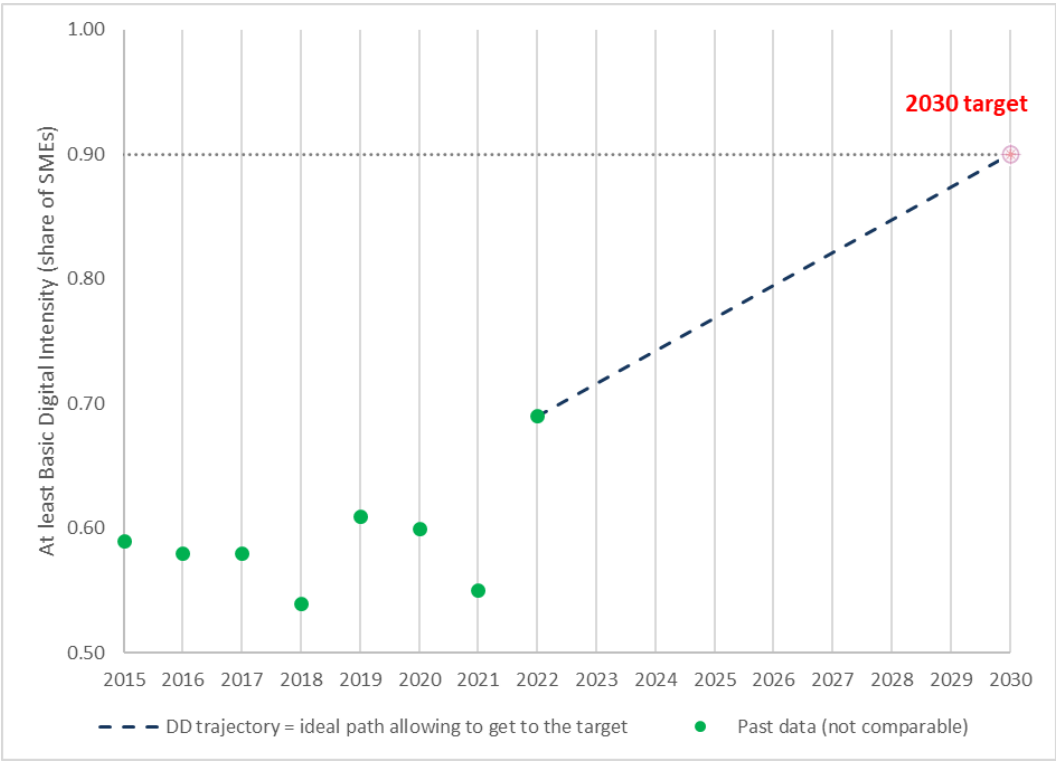
1. Enterprises where more than 50% of the persons employed had access to the internet for business purposes;
2. Employ ICT specialists;
3. The maximum contracted download speed of the fastest fixed line internet connection is at least 30 Mb/s;
4. Enterprises which conducted remote meetings;
5. Enterprises make persons employed aware of their obligations in ICT security related issues;
6. Any type of training provided to develop ICT related skills of the persons employed, during 2021;
7. Use at least three ICT security measures;
8. Enterprise with document(s) on measures, practices or procedures on ICT security;
9. Any of the persons employed having remote access to any of the following: e-mail, documents, business apps;
10. Use industrial or service robots;
11. Used any computer networks for sales (at least 1%);
12. Enterprises where web sales are more than 1% of the total turnover and Business-to-Customer (B2C) web sales more than 10% of the web sales.

The Enterprise survey questions used for the definition of the Digital Intensity Index vary every year. The list used by year is provided by Eurostat at this [link](#).

A basic level of digital intensity means that an enterprise uses at least four of the twelve selected digital technologies.

The Digital Decade trajectory²²⁸ is based on a linear functional form as the assumption is that the KPI will follow an increasing trend, although with fluctuations year on year, reaching the target in 2030.

Figure 60: Digital Intensity Index. Historical data and the Digital Decade (DD) trajectory towards 2030



Due to the change in the composition of the indicator to include more recent technologies, over the last years the indicator has shown little progress and even dropped in some years. Having a moving target enables adapting the indicator to technological change and progress, as skills or technologies that are considered advanced today might become basic in the future. The limitation is the unavailability of comparable historical data at present. To enable better monitoring, the Commission has worked to establish a consistent definition every two years starting from 2021. As a result, the 2021 figures will be comparable with those of 2023, 2025, 2027, and 2029, while the 2022 figures will be comparable with those of 2024, 2026, 2028, and 2030.

3.5.3 Actions at EU and national level

The adoption and integration of digital technologies into European SMEs’ daily life is of fundamental importance for these companies’ chances to stay competitive and to reach a state of stable long term sustainable growth. The importance of digital skills, the uptake of digital solutions that is the integration of a digital perspective in all different parts of SMEs’ life is therefore also clearly pointed out as one of the main priorities in the European Commission’s Communication on the SME Relief Package²²⁹.

Together with Member States, the Commission is investing one and a half billion euros, over a period of 7 years, in a network of [European Digital Innovation Hubs \(EDIHs\)](#) to provide tailor-made

²²⁸ Digital Decade and baseline trajectories are presented in the “Communication from the Commission establishing Union-level projected trajectories for the digital targets” [C\(2023\) 7500](#).

²²⁹ https://ec.europa.eu/commission/presscorner/detail/en/ip_23_4409

digitalisation support to SMEs and public sector organisations (PSOs) in all regions and sectors of the EU. Digital Innovation Hubs are one-stop-shops where SMEs and PSOs can get advice and support to digitalise their organisations. The funding received by the hubs will be fully passed on in the form of digitalisation services to their customers, who will either receive those services for free or at a reduced rate. Services include “test before investing”, expert advice, training, support with access to finance, Digital Maturity Assessment and ecosystem building. Hubs often have a specific technological and/or sectoral focus, fitting to the needs of their region. Indeed, each Member State has at least one hub specialised in AI. However, through their networking it is hoped that the digitalisation needs of any businesses, in any sector and region can get the support they need.

The selection procedures for the setup of the initial network of hubs was completed at the beginning of the year and 151 hubs were selected to receive the first three years of funding from the Digital Europe Programme (DIGITAL). These hubs have now started their work. The network shows a good coverage of sectors and technologies. The most important technologies covered are Artificial Intelligence, Cybersecurity, High-powered computing, Audio-visual, Internet of things and big data. The most important sectors are Manufacturing, Health care, Public Administration, Agri-food, Energy and Transport. The funding from DIGITAL covers 50% of eligible costs and Member States have committed to fund the other 50% through national funds, EU synergy funds (ERDF or RRF) and/or contributions from the private sector.

As a result of the selection procedure for the hubs, an additional 89 hubs were awarded a “Seal of Excellence”; as they were of good quality, even though they could not be funded under DIGITAL. Most of these hubs will also be funded, as Member States have taken up the opportunity to fund the “Seal of Excellence” hubs either through national funding sources or through synergy funding opportunities which allow them to make use of Recovery and Resilience Facility (RRF) or European Regional Development Funds (ERDF). “Seal of Excellence” hubs will be able to join the network as equal participants. So that, by the end of the year, the network will comprise around 230 hubs and cover all EU regions, Iceland, Lichtenstein and Norway.

In addition to supporting Digital Innovation Hubs, Member States are also making use of the Recovery and Resilience Facility for implementing a number of other types of actions to support the digitalisation of businesses of different types (e.g., SMEs, start-ups and large enterprises) in their countries. Indeed, 26% of RRF investments are targeted towards digital, and out of this 19% is dedicated to digitalisation of businesses. An analysis of the National Recovery and Resilience Plans shows that they contain 101 measures (10 reforms and 91 investments) specifically aimed at digitalising businesses.²³⁰ Some investments offer grants or vouchers to companies to support their digitalisation projects (e.g., Portugal and Croatia). Others target the creation of testing facilities (e.g., Czechia, Finland and Slovakia) and digital infrastructures (e.g., Sweden). Some also have a specific sectoral focus (e.g., manufacturing, tourism, cultural and creative industry etc.) or are specific to certain types of businesses. As already mentioned, several investments are directed at reinforcing existing or creating new digital innovation hubs or providing advice and training support for businesses, in particular SMEs.

Reforms propose the introduction of specific laws to foster the thriving of start-ups in their countries, others take the form of tax incentives to facilitate the uptake of technologies (e.g. Denmark and Italy). Several reforms aim at introducing the right governance structure, environment, or strategy for the digitalisation of the economy and society. Finally, some reforms address the gap in digital

²³⁰ Number of measures from 27 Recovery and Resilience Plans. Note that some plans are currently undergoing revisions, and that the figures may change.

business skills (e.g. Luxemburg and Ireland), propose regulatory sandboxes (e.g. Czechia), and the creation of funds (e.g. Croatia).

These actions provide an important boost to the support for the digitalisation of businesses, including SMEs, across Europe and should make a substantial contribution to achieving the 2030 targets. However, the targets are ambitious (i.e. that 90% of SMEs reach a basic level of digital intensity) and a sustained effort will be needed to enable their achievement. It will be important going forward, that the level of ambition is not eroded, that the actions are fully implemented and that new actions are launched replicating and building on existing success stories and good practices for the benefit of SMEs everywhere.

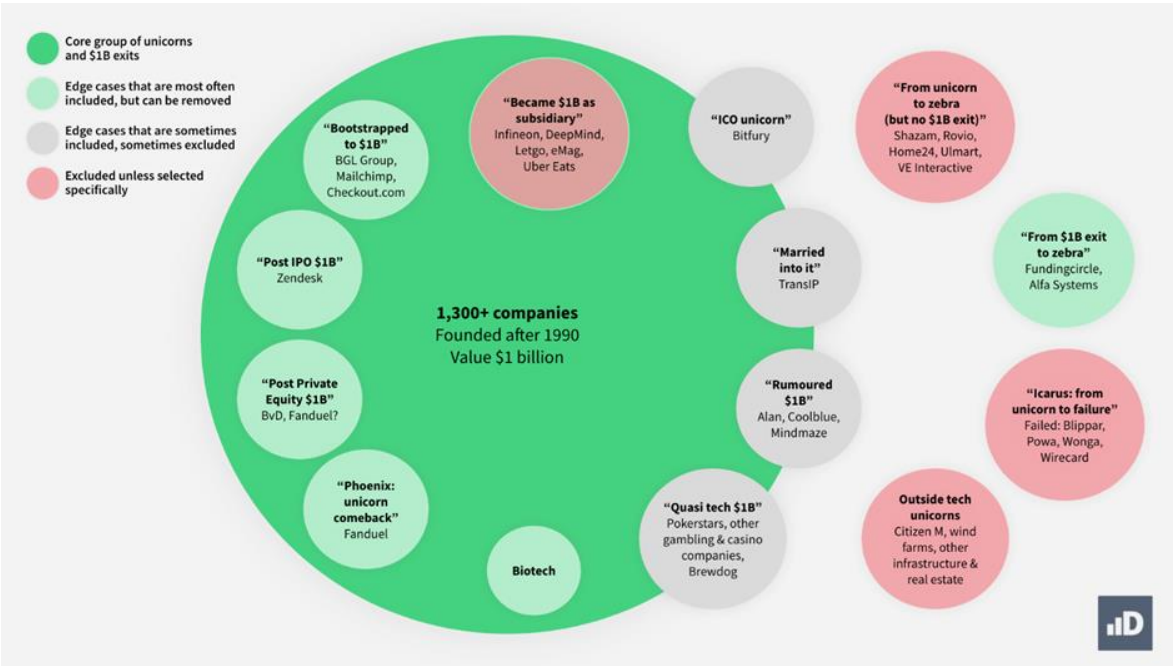
3.6 Unicorns

3.6.1 Overview

A unicorn is defined in the KPI Implementing Act²³¹ as a privately held start-up company valued at over USD 1 billion. This is a stage of the start-up financial development which proves its maturity and success on the global market. For the current analysis, we include tech companies founded since 1990 that are currently valued at over USD 1 billion, while companies that passed USD 1 billion as a subsidiary are excluded. Companies that may now be worth less than USD 1 billion but exited at more than USD 1 billion are also included.

The proposed Digital Decade sets the target of doubling the current number of EU27 unicorns by 2030.

Figure 61: The definition of unicorns included in the analysis



Source: Dealroom

In 2023, the EU need to make further progress with regard to the Digital Decade target to double the number of unicorns. At the start of 2023 249²³² unicorns are based in the EU²³³ as compared to

²³¹ https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=uriserv%3AOJ.L_.2023.168.01.0048.01.ENG&toc=OJ%3AL%3A2023%3A168%3ATOC

²³² Data downloaded from Dealroom on 9 January 2023.

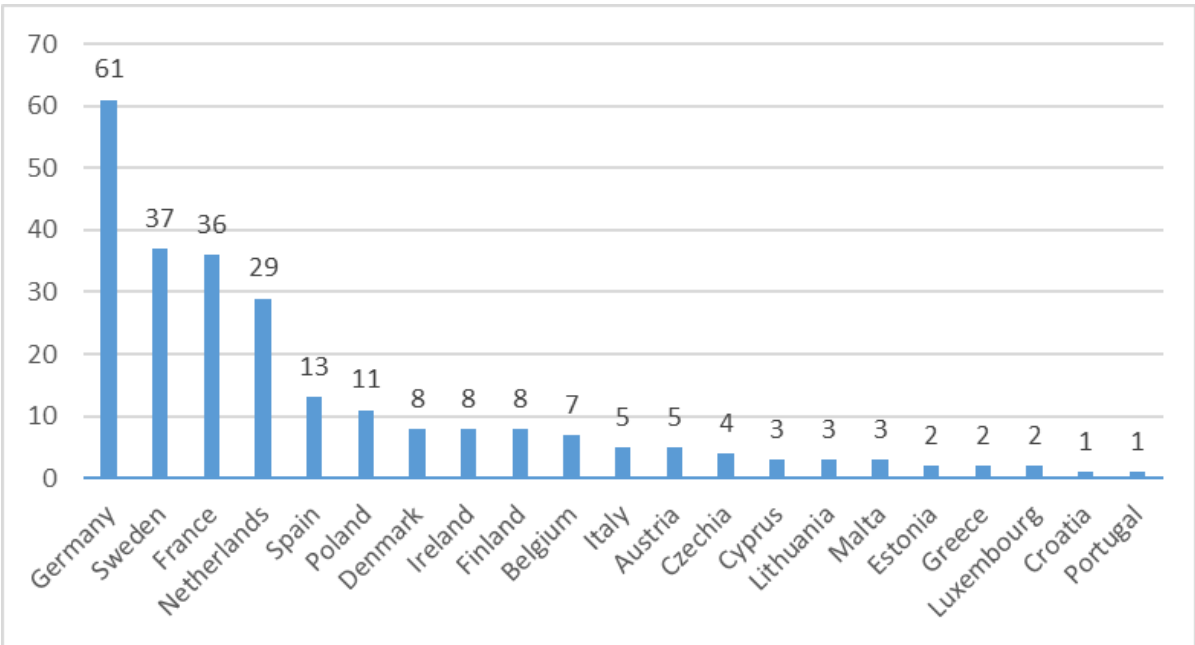
²³³ EU unicorn numbers stated are for EU-founded companies that continue to have their HQ in the EU.

1 444 in the US and 330 in China. According to Dealroom, as of January 2023 there were 2609 unicorns in the world. The numbers for key regions are:

- EU: 249 unicorns (increase from 222 in March 2022)
- USA: 1 444 (increase from 1 243)
- Asia 585 (increase from 530)
- China: 330 (increase from 306)
- UK: 149 (increase from 119)

There remains substantial room for improvement. Leading EU countries at the start of 2023 are Germany 62 (up from 56 end of 2021), Sweden 38 (31), France 36 (29) and the Netherlands 29 (24). There are six EU Member States without a single unicorn (although three countries of these – Romania, Latvia and Bulgaria – were the founding location for a unicorn that is now headquartered outside of the EU). A few countries made significant progress: Ireland increased its unicorn from 2022 to 9, from 5 in 2021; Croatia now has now two unicorns having had zero in 2021.

Figure 62: Number of unicorns per EU Member State



Source: Dealroom, total per country, Jan 2023

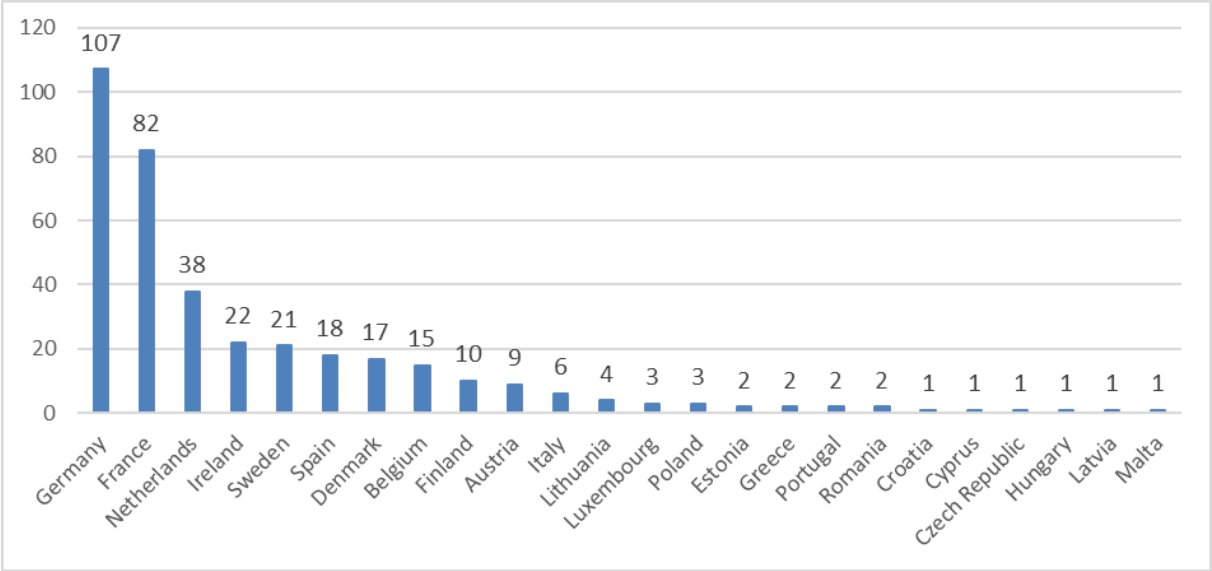
The current level of performance has a strong link to relatively immature start-up ecosystems. In order to be considered a unicorn, a company has to steadily and dynamically grow through all the development phases supported by the start-up ecosystem. According to Startup Genome, the best global start-up ecosystems in 2022 were Silicon Valley (1st), followed by New York City and London (tied at 2nd), Los Angeles (4th), and Tel Aviv (5th). There are no EU start-up ecosystems in the top 10 globally. The best EU ecosystem – Berlin – was ranked 13th worldwide followed by Amsterdam (14th) and Paris (18th). While nine of the best 20 ecosystems are located in North America, only 3 of them are in the EU. Asia is catching up with 7 ecosystems in the top 20. ²³⁴

In the EU there are 369 start-ups that are already showing potential of reaching unicorn status, they have already secured a valuation of between EUR 100m and EUR 1 000m. The distribution of the

²³⁴ The Global Startup Ecosystem Report 2023 (<https://startupgenome.com/report/gser2023>)

potential unicorns across EU Member States is outlined in Figure 63: Distribution of the ‘potential future unicorns’ by EU member state (two EU member states (Slovenia and Slovakia) did not have any start-up falling into this category). These numbers show an imbalance in the distribution of the ‘potential future unicorns’ with over half of them located (189) in two EU Member States (France and Germany).

Figure 63: Distribution of the ‘potential future unicorns’ by EU member state



Source: Dealroom, March 2023

3.6.2 Trends towards 2030

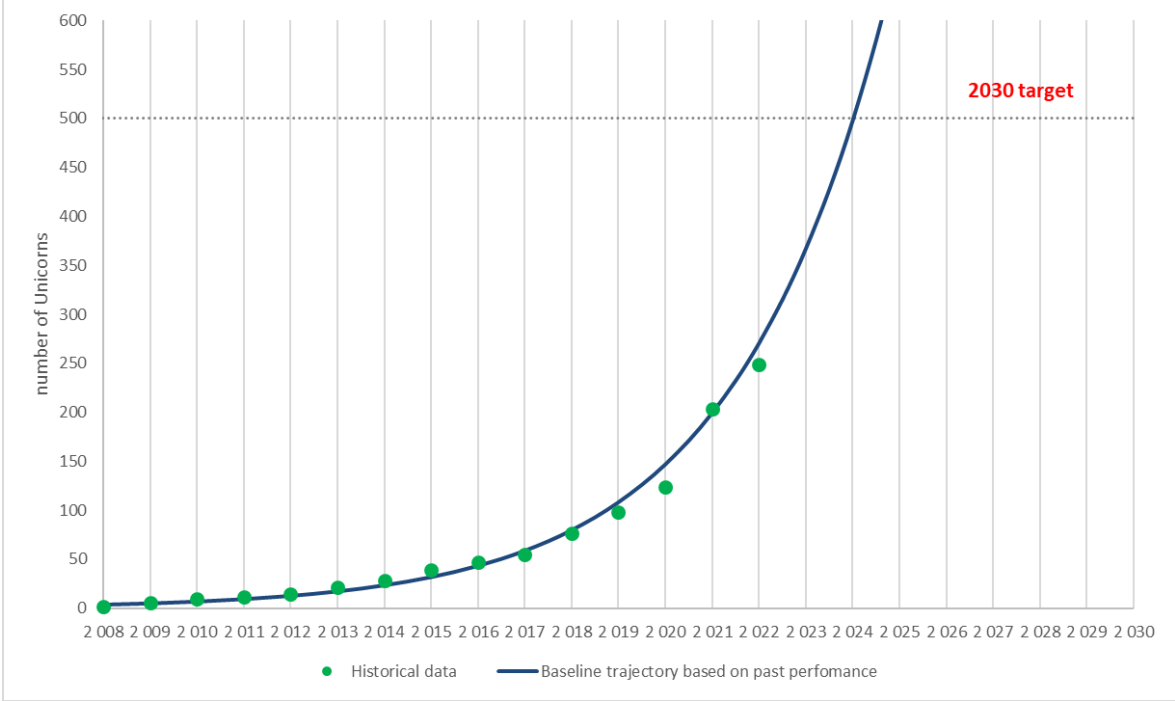
The 2030 target for this KPI requires the definition of the reference data point. This document takes the number of unicorns recorded in 2022 in the EU (249) as reference point and considers 500 as the 2030 target. As noted by the experts (source: [CBINSIGHTS’ Research Brief](#) & the [2022 Atomico State of the EU Tech report](#)) unstable macro-economic trends of the last year suggest that growth levels of recent years are not likely to be sustained in the near term, and possibly longer. This new reality was already evident in the last two quarters of 2022 that saw investments in start-ups go down and most leading tech companies (large caps and unicorns) lay off staff. High inflation, rising interest rates, and geopolitical crises, such as the war in Ukraine, all contributed to the recent decline in unicorn births. This suggests that the high growth levels observed in the EU in recent years may not be replicable in the medium term.

Newly released data from Dealroom indicates that the number of newly established unicorns in the EU was relatively low in the first quarter of 2023, with only three recorded, compared to around 20 in the corresponding period in 2021 and 2022 (22 and 20, respectively). Four new unicorns were established in Q1 2020. The 'births rate' of unicorns in the EU seems to have gone back to the pre-covid situation.

Even with its recent upward trend, the EU remains behind other regions, such as the US, China and the UK, where most of these companies are concentrated, either because they are founded there or are moved to after their foundation. Creating strong and supportive ecosystems, exploiting the full potential of the EU internal market and overcoming the persisting legal and economic barriers between EU Member States are all important factors to foster unicorns’ creation or attract them from all over the world.

The baseline trajectory²³⁵ relies on the historical data of unicorns covering the period from 2008 to 2022. The functional form chosen in this case is the exponential one (linear in the logarithms) that fits well the historical data (see figure below). No Digital Decade trajectory is shown due to the recent/current instability of trends.

Figure 64: Number of Unicorns in the EU. Historical data and baseline trajectory



3.6.3 Actions at EU and national level

EU Startup Nations Standard, mobilising action under national competencies:

- In March 2021 the European Commission launched the [EU Startup Nations Standard](#) (EU SNS) to mobilise and support Member States to deliver optimised framework conditions and regulatory environment for start-ups.
- The EU SNS political declaration outlined best practices in 8 policy areas that fall under national competencies (areas such including: Fiscal Treatment of Stock Options; Tech Transfer policy; Attraction and Retention of Talent; and Access to Growth Finance). Ministers from 27 countries (26 EU Member States and Iceland from the EEA) confirmed their commitment to the EU SNS and its goals.
- EU SNS is now actively progressing beyond the “aspirations” of the political declaration to real world “operations” following launch in December 2021 of the ‘[Europe Startup Nations Alliance](#)’ (ESNA), implementation body of the EU SNS.
- ESNA is supporting signatory countries by identifying and implementing best practices in the 8 policy areas, providing technical support and measuring progress of countries in reaching the ‘EU Startup Nations Standard’.

²³⁵ Digital Decade and baseline trajectories are presented in the “Communication from the Commission establishing Union-level projected trajectories for the digital targets” [C\(2023\) 7500](#).

Digital Markets Act:

- The Digital Markets Act, which entered into force in May 2023, introduces new obligations for large platforms (“Gatekeepers”) in the digital world.
- Not only are start-ups and SMEs exempt from new obligations in the DMA, but it is also they who are expected to mostly benefit from the DMA - be they SMEs that already compete with the gatekeepers, or new entrants.
- For example, new data portability obligations introduced by the DMA for gatekeepers will open up unprecedented possibilities for smaller players in the EU.
- These data portability obligations – which gatekeepers will need to comply with by March 2024 – will facilitate user switching and multi-homing and thereby increase potential user base. This new reality can empower innovative and nimble start-ups to bring innovative solutions to the market. It provides competitors and new entrants a real chance to grow by capturing a new stream of demand and / or proposing competitive offers. This in turn can facilitate start-ups to attract more growth capital from investors for them to scale-up.

4 Digital Public Services

4.1 Overall context: why are digital public services critical and where is Europe in this regard in 2023 at the outset of the Digital Decade

Every citizen and business should be able to interact digitally with public administrations. Recent data shows that being able to interact with public authorities online, matters to the citizens in Europe. Improving online access to public services is among the top four actions that Europeans think their country should prioritise by 2030 ²³⁶.

Providing digital public services has become an important tool for public authorities to increase their efficiency and to improve their relationship with the public. The term e-Government refers to the use of technology to improve and facilitate government services. It allows citizens, for example, to request birth certificates or submit tax declarations online. Wider and easier access to public services ultimately increases transparency and accountability and reduces administrative burden and corruption. It also supports access to public services in rural areas and remote regions like the outermost regions. The Digital Decade policy programme²³⁷ sets clear targets for the digitalisation of public services to be achieved by 2030 in order to boost the Member States' efforts to overcome these barriers and to make public services accessible online:

- i. there is 100 % online accessible provision of key public services and, where relevant, it is possible for citizens and businesses in the Union to interact online with public administrations;
- ii. 100% of citizens have access to medical records online; and
- iii. 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.

Overall, the online availability of public services has been growing steadily over the last decade and the EU's performance is strong for this cardinal point of the Digital Decade. The COVID-19 pandemic accelerated the digitalisation of public services. However, progress is uneven across and within Member States. As a general principle, services for citizens are less likely to be available online than services for businesses. A lack of interoperability, trust and digital skills have been identified as barriers to digitalisation.

Human-centricity and transparency are key principles when designing and implementing digital solutions for public services. Digital tools to be used for accessing public services online should be easy-to-use, efficient, trustworthy, and allow for personalised services. They should comply with high security, privacy and data protection requirements and standards. Digital provision of public services can be linked to life events e.g., losing or finding a job, studying, owning or driving a car, or starting an own business. Offline accessibility of services shall be maintained while transitioning to digital tools.

²³⁶ Special Eurobarometer survey 532

²³⁷ Proposal for a DECISION OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL establishing the 2030 Policy Programme "Path to the Digital Decade" COM/2021/574 final

The digital transformation has the potential to contribute to achieving broader societal outcomes²³⁸. It should therefore go hand-in-hand with fostering democracy, good governance, social inclusion, and increasing the efficiency of public services.

The European Declaration on Digital Rights and Principles²³⁹ signed in December 2022 provides that everyone should have online access to key public services in the EU, building on the Berlin declaration on Digital Society and Value-based Digital Government (2020). Specifically, the EU and Member States committed to facilitating and supporting seamless, secure and interoperable access across the EU to digital public services designed to meet people's needs in an effective manner. This includes, in particular, digital health and care services, and notably access to electronic health records. Importantly, the EU and Member States also agreed as part of the Declaration to ensure that people living in the EU are offered the possibility to use an accessible, voluntary, secure and trusted digital identity that gives access to a broad range of online services. This Report also provides first indications on the progress made in the implementation of the Declaration. More insights on how Member States' public administrations are considering fundamental rights in their digital transformation can be found in the Berlin declaration progress report.

The importance of digitalising public services and introducing or improving e-government solutions is also reflected in the allocation of funds under the Recovery and Resilience Facility (RRF). 26% of the funds under the RRF, i.e., EUR 130 billion, are targeted towards the digital transformation in general. EUR 48 billion of these funds are allocated to digitalising public services, which is the policy area with the highest investment within the digital envelope and therefore with an important potential for advancement.

Access to digital identification

The Digital Decade target requires that 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.

Cross-border recognition of national electronic identification schemes

[Regulation \(EU\) No 910/2014 on electronic identification and trust services](#) for electronic transactions in the internal market (eIDAS Regulation) created a basis for cross-border electronic identification within the EU. Based on the eIDAS Regulation, EU Member States may notify and recognise, on a voluntary basis, national electronic identification schemes. The cross-border recognition of notified electronic identification schemes became mandatory in 2018.

Data collected as part of an [evaluation pursuant to Art. 49 of the eIDAS Regulation](#) shows that, in early 2021, about 60% of the EU population in 14 Member States were able to use their national eID cross-border. 14% of key public service providers across all Member States allowed cross-border authentication with an e-ID system. In addition, the number of successful cross-border authentications per year, though on the rise, was very small. As there is no requirement for Member States to issue and notify a national electronic identification scheme and to make it interoperable with those in other Member States, there are discrepancies between countries. Moreover, the landscape for Digital Identity has changed substantially over the last years. Today our digital identity includes a variety of attributes and credentials like age, gender, or professional or personal interests.

European Digital Identity Wallet

²³⁸ See for example Millard, J., Impact of digital transformation on public governance, Manzoni, M. and Schade, S. editor(s), Publications Office of the European Union, Luxembourg, 2023, doi:10.2760/204686, <https://publications.jrc.ec.europa.eu/repository/handle/JRC133975>.

²³⁹ European Declaration on Digital Rights and Principles for the Digital Decade COM/2022/28 final

To address these shortcomings, in June 2021, the European Commission [proposed a framework for a European Digital Identity](#), available for all EU citizens, residents and businesses via a European Digital Identity Wallet. The key aspect of the proposed framework, which would amend the eIDAS Regulation, is a personal digital wallet to allow citizens to prove their identity, and to share identity-related attributes and electronic documents in a secure and convenient way. This proposed European Digital Identity wallet is intended to enable people to choose which aspects of their identity and which part of their data and certificates they want to share with third parties. The proposed solution would also keep track of any data sharing activities. The proposal includes an obligation for Member States to issue a digital wallet under a notified eID scheme, built on common technical standards (as laid out in the Architecture and Reference Framework (ARF)), and following compulsory certification. To set up the necessary technical architecture, speed up the [implementation](#), and to provide guidelines to Member States to avoid fragmentation, the proposal was accompanied by a Recommendation for the development of a Union toolbox defining harmonized technical specifications for the wallet. A prototype wallet is currently being developed under a [Framework Contract](#) under the Digital Europe Programme. Following a call for [large-scale pilot projects](#) launched in 2022, four pilot projects co-funded under the Digital Europe Programme and launched in April 2023, have started to test the wallet in a number of everyday use cases and to test its integration in national eID system in 26 Member States and Norway, Iceland, and Ukraine.

Digital Travel Documents

In its Communication of 24 July 2020 on an EU Security Union Strategy, the Commission made a pledge to continue and to extend the scope of its ongoing work on EU travel and residence documents, including through further digitalisation in order to improve the tools for combating document fraud, as well as promoting seamless cross-border travel and passenger clearance.

In the Communication 'A strategy towards a fully functioning and resilient Schengen area' of June 2023, the Commission announced that, following an in-depth impact assessment and the necessary consultations, it would present legislative proposals on digitalisation of travel documents and facilitation of travel. The digitalisation of travel documents (passports and identity cards) aims to achieve a safer Schengen Area and facilitate the exercise of the right to free movement within the EU. The Commission's preparatory work is currently ongoing.

Access to medical records online

The Digital Decade target that 100% of citizens shall have access to their medical records online builds on the following initiatives and legislative acts.

Enabling citizens to access to their health data online empowers them to be actively involved in their own health journey. Access to health data is essential to be able to seek a second opinion or to receive treatment from a different healthcare provider.

Citizens' access to health data still varies greatly between EU Member States. However, the Member States and private institutions are increasing their efforts to accelerate and advance secure and interoperable electronic health data infrastructures that enable health data access and use.

The concept of access to electronic health data is complex and multi-dimensional. National readiness to enable citizen access to health data can be measured along three broad lines of progress: (1) nationwide availability of secure and easy to use data access service, (2) the scope of health data that is accessible to citizens (3) equity of access and availability of support.

In 2018, the European Commission published a Communication on the digital transformation of health and care²⁴⁰. With the aim of empowering citizens and improving health across the society, the Commission proposed to take action in the following three areas: – (1) secure access to health data for citizens and sharing of health data across borders, (2) better data to advance research, disease prevention, and personalised health and care, (3) digital tools to empower citizens to be actively involved in their own health journey and to allow for person-centred care.

In 2019, the Commission published interoperability recommendations for common technical specifications for exchange format of Electronic Health Records (EEHRxF)²⁴¹ in order to facilitate secure data sharing across the EU.

On 3 May 2022, a legislative proposal for a Regulation on the European Health Data Space (EHDS)²⁴² was published. The proposed EHDS is one of nine data spaces announced in the 2020 EU Data Strategy. The EHDS is intended to promote better exchange and access to different types of health data (including electronic health records), to empower citizens to control their health data, to support healthcare delivery (so-called primary use of data), and to improve the quality and accessibility of health data for research, innovation and policymaking.

The Commission is exploring the potential of using the digital identity wallet in the health sector, building on the recent experience with the EU Digital COVID Certificate which provided secure health data access via smartphones.

Online accessibility of key public services

The Digital Decade target that 100% of citizens shall have access to key public services online is strongly related to the following initiatives and legislative acts.

Online setting up of companies and branches

A major step in providing digital public services for companies was taken in 2019, when the Company Law Digitalisation Directive²⁴³ ensured that company law procedures, such as the setup of a company or branch, can be performed fully online; and the Company Law Mobility Directive²⁴⁴ allowed public administrations to exchange information, including pre-operation certificates, on mergers, conversions and divisions of companies taking place in different Member States.

As a second step in the digitalisation of company law procedures, the Commission recently adopted a proposal to further expand the use of digital tools and processes in EU company law²⁴⁵. The proposal aims at contributing to the further digitalisation of the single market and helping companies, and especially small and medium-sized ones, to do business in the EU, increasing the availability of

²⁴⁰ COMMUNICATION FROM THE COMMISSION TO THE EUROPEAN PARLIAMENT, THE COUNCIL, THE EUROPEAN ECONOMIC AND SOCIAL COMMITTEE AND THE COMMITTEE OF THE REGIONS on enabling the digital transformation of health and care in the Digital Single Market; empowering citizens and building a healthier society COM(2018) 233 final

²⁴¹ Commission Recommendation (EU) 2019/243 of 6 February 2019 on a European Electronic Health Record exchange format

²⁴² Proposal for a REGULATION OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL on the European Health Data Space COM/2022/197 final

²⁴³ 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

²⁴⁴ 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.

²⁴⁵ Proposal for a Directive of the European Parliament and of the Council amending Directives 2009/102/EC and (EU) 2017/1132 as regards further expanding and upgrading the use of digital tools and processes in company law.

company information at EU level and removing administrative barriers when companies and authorities use company information in cross-border situations. Companies are estimated to benefit from savings of EUR 437 million of administrative burden per year, thanks to measures like the EU Company Certificate or the application of the “once-only principle” while registering a subsidiary or a branch. Overall, the proposal promotes “digital by default” solutions. The proposal is also emphasizing the importance of trust services use and aims at ensuring that such solutions such as the EU Company Certificate are compatible with the forthcoming European Digital Identity Wallet.

Similarly to the 2019 Digitalisation Directive and Mobility Directive, the proposal builds on the use of the system of interconnection of business registers (BRIS)²⁴⁶. BRIS interconnects all Member States’ and EEA countries’ business registers and provides the public with access to information about 20 million companies and their cross-border branches, and information about mergers, conversions and divisions of EU companies. BRIS is operational since 2017 and relies on the use of a European Unique Identification Number for companies – EUID – which makes it possible to unequivocally identify companies in the internal market.

Single Digital Gateway

The Single Digital Gateway²⁴⁷ (SDG) is one of the most ambitious EU eGovernment initiatives to digitalise public administration. It is key to enhance the EU’s competitiveness and achieve a level-playing field in the Single Market.

Through the Your Europe²⁴⁸ web portal, the SDG is setting up a cross-sectoral one-stop shop that provides businesses and citizens with:

- Reliable and up-to-date **information** about rules and procedures in the Single Market, at all levels of government;
- Direct, centralised, and guided **access to assistance and problem-solving services**;
- Direct access to a wide range of **fully digitised administrative procedures**, for which the Once-Only Technical System (OOTS) allows an **automated exchange of evidence** between authorities across the EU, except for those procedures concerning the on-line setting up of companies and branches and or any subsequent filing by companies, which are covered instead by the rules of the Company Law Digitalisation Directive including the BRIS system;
- **Feedback tools** to report on the quality of services and single market obstacles.

The SDG is **improving the European business environment** by cutting red tape and helping companies, notably SMEs, to better understand and use their rights and the opportunities offered by the Single Market. It also simplifies the daily **life of citizens**. Therefore, the SDG is a major lever for a better Single Market.

The SDG is implemented in stages as a joint effort from both the Member States and the Commission. It was launched in 2020, making information on rights and procedures at EU and national levels available on Your Europe together with seven assistance services, data compilation systems and user feedback mechanisms. In December 2022, the same information was made available on Your Europe for the municipal level (where applicable).

Finally, by December 2023, the **Member States should**:

- a. Ensure that **where a procedure²⁴⁹ can be accessed and completed online by national users it can also be so by cross-border users** in a non-discriminatory way.

²⁴⁶ https://e-justice.europa.eu/489/EN/business_registers_search_for_a_company_in_the_eu

²⁴⁷ Regulation (EU) 2018/1724 establishing a single digital gateway to provide access to information, to procedures and to assistance and problem-solving services and amending Regulation (EU) No 1024/2012.

²⁴⁸ <https://europa.eu/youreurope/>

- b. Provide **online access, for national and cross-border users, to procedures in 21 areas**²⁵⁰ that are crucial to the business cycle and citizens' formalities.

These procedures are to be offered fully online. This means that users will be able to identify themselves and to authenticate, to complete and sign applications online. They will subsequently be notified electronically when the relevant process is completed. By December 2023, the Commission and the Member States shall deploy a so-called **Once-Only Technical System** which will enable the automated and secure exchange of evidence between EU public authorities – in the form of documents or structured data - without having to request the same data or documents from the applicant twice.

Many of these procedures defined in the SDG Regulation correspond to administrative steps in life events for which the provision of online public services is monitored via the eGovernment Benchmark, which feeds into the Digital Economy and Society Index.

Interoperability

While working towards the digital transformation of public services and their availability online, the Union needs to ensure that these services are also accessible to citizens of any Member State without discrimination. These services should also be fully aligned with EU values and principles, such as the once-only principle and human-centricity²⁵¹, striving for personalised and eventually pro-active public services that work seamlessly across borders²⁵². **Interoperability is a key enabler** in this endeavour. Interoperability facilitates **legal, organisational, semantic, and technical alignment**, as recommended by the **European Interoperability Framework (EIF)**²⁵³ **to facilitate cross-border data exchange**. **Interoperability** is also essential **to remove barriers to the Single Market** and to deliver human-centric, interconnected digital public services. The Commission therefore proposed the **Interoperable Europe Act**²⁵⁴ in November 2022.

The Interoperable Europe Act is intended to help the EU and its Member States to deliver better public services online. It provides for a structured cooperation framework on interoperability between the Member States' public administrations and European Institutions, bodies and agencies and to create common reusable interoperability solutions that will enable administrations at all levels to provide cross-border public services. Importantly, the proposed Act paves the way towards an interoperable-by-design approach to policy making and implementation in the Union, by introducing 'interoperability assessments'²⁵⁵. It should help public administrations and sectoral initiatives to explore, and where appropriate address, cross-border and cross-domain interoperability aspects, as well as help increase the reuse of common interoperability solutions 'interoperability assessments' when designing online tools to access digital public services. It is expected that cross-border interoperability can lead to cost-savings of between EUR 5.5 and EUR 6.3 million per year for citizens

²⁴⁹ Annex I of the SDGR list the procedure types covered by the SDG. See also Article 2(2)(b) SDGR.

²⁵⁰ Annex II of the SDGR list the procedure types covered by the SDG.

²⁵¹ [Ministerial Declaration on eGovernment - Tallinn declaration](#).

²⁵² The [Berlin Declaration on Digital Society and Value-based Digital Government](#).

²⁵³ The [European Interoperability Framework](#).

²⁵⁴ The [proposal](#) was adopted by the Commission on 18 November 2022 and is currently under inter-institutional negotiations.

²⁵⁵ Article 3 of the [proposed Act](#).

and between EUR 5.7 and EUR 19.2 billion per year for businesses dealing with public administrations²⁵⁶.

The uptake of interoperability in Europe is monitored through the National Interoperability Framework Observatory (NIFO)²⁵⁷, and more specifically via the EIF monitoring mechanism²⁵⁸ and the Digital Public Administration factsheets²⁵⁹.

4.2 Overall outlook based on DESI digital public services indicators

Table 8 Digital public services indicators grouped in two classes

	DESI 2021	#N/A DESI 2022	DESI 2023	EU DESI 2023	EU 2030 target
4a1 e-Government users % internet users	NA	NA	74% 2022	74% 2022	
4a2 Digital public services for citizens Score (0 to 100)	NA	75 2021	77 2022	77 2022	100
4a3 Digital public services for businesses Score (0 to 100)	NA	82 2021	84 2022	84 2022	100
4a4 Pre-filled forms Score (0 to 100)	NA	64 2021	68 2022	68 2022	
4a5 Transparency of service delivery, design and personal data Score (0 to 100)	NA	63 2021	65 2022	65 2022	
4a6 User support Score (0 to 100)	NA	82 2021	84 2022	84 2022	
4a7 Mobile friendliness Score (0 to 100)	NA	92 2021	93 2022	93 2022	
4b1 Access to e-health records Score (0 to 100)	NA	NA	72 2023	72 2023	100

Source: DESI 2023, European Commission. Indicators' description and details in 2023 DESI methodological note. Key Performance Indicators for the Digital Decade targets for 2030 of the Digital Decade Policy Programme are highlighted in green.

4.3 Overview on digitalisation of public services

4.3.1 e-Government users

This indicator measures the share of all internet users (aged 16-74) that interacted via a website or an app with public authorities in the last 12 months.²⁶⁰

In Denmark, Cyprus, Finland, the Netherlands, Sweden, Estonia and Luxembourg more than 90% of internet users interacted with the public authorities via websites and apps in the last 12 months. On average, 3 out of 4 internet users within the EU interacted online via websites and apps with public

²⁵⁶ [COMMISSION STAFF WORKING DOCUMENT IMPACT ASSESSMENT REPORT Accompanying the document Proposal for a REGULATION OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL laying down measures for a high level of public sector interoperability across the Union \(Interoperable Europe Act\) - SWD\(2022\)721](#), pg. 54.

²⁵⁷ More information on the [National Interoperability Framework Observatory \(NIFO\)](#).

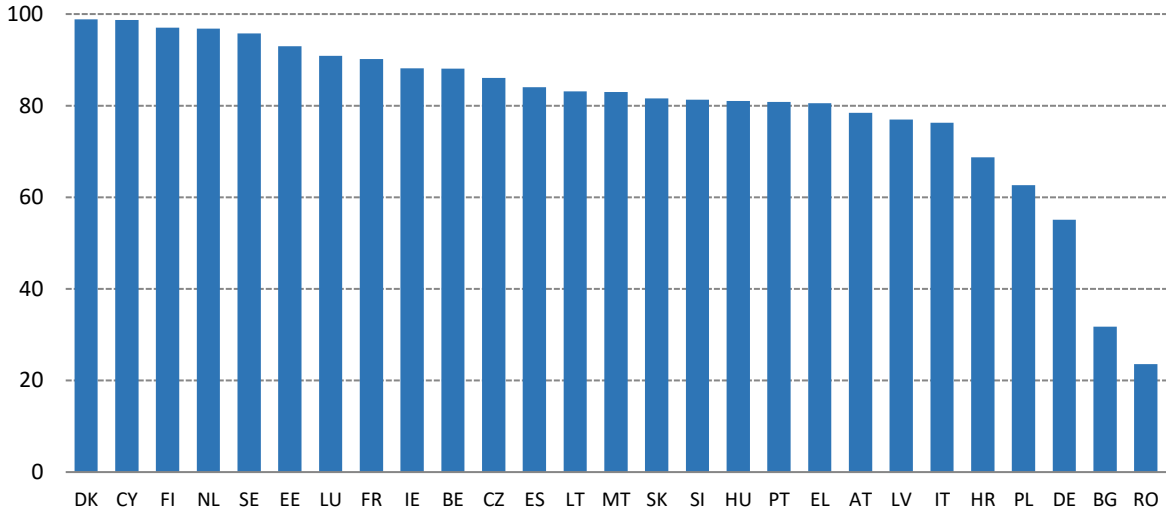
²⁵⁸ More information on the [EIF monitoring mechanism](#).

²⁵⁹ More information on the [Digital Public Administration factsheets](#).

²⁶⁰ Due to a change in the survey methodology, the indicator I_IGOV12 collected via the EU survey on the use of ICT in households and by individuals until 2021 was discontinued. I_IGOVANYS is collected via the same survey since 2022, but represents a wider range of e-government activities, with online interactions via websites and apps.

authorities. In Bulgaria, however, only 32% of internet users interacted online with public authorities in the last 12 months, in Romania only 24%.

Figure 64: e-Government users interacting with public authorities via websites or apps in the last 12 months (% of internet users), 2022



Source: Eurostat, Community survey on ICT usage in Households and by Individuals.

4.3.2 Digital public services for citizens

The target under the Digital Decade Policy Programme is **full online availability of key public services for citizens by 2030**²⁶¹. The Implementing Act on the Key Performance Indicator defines the **indicator on online availability of public services for citizens** as the key performance indicator for measuring the progress on the Digital Decade target.

This key performance indicator²⁶² measures **the extent to which a service or information on a service for citizens is provided online, and/or via a government portal**. Services can be offered fully online, partially online, or offline only, and are classified accordingly. The indicator measures the share of administrative steps in a life event that can be done online for major life events for citizens. A life event is a package of governmental or public services, usually provided by multiple agencies, that support citizens through key points of their lives, such as the birth of a child. The indicator considers 7 major life events, *Career, Studying and Family, Health, Moving, Transport, Starting a*

²⁶¹ Art 4 of the Decision on the Digital Decade Policy Programme sets amongst others the following target: 1. (4) the digitalisation of public services, where: (a) there is 100 % online accessible provision of key public services and, where relevant, it is possible for citizens and businesses in the Union to interact online with public administrations;

²⁶² In 2020, the indicator replaced the Online service completion indicator that measured the online availability of all (business and citizen) national services, of which some were already covered by the Digital public services for businesses indicator. The input for this indicator is the national online availability indicator and the cross-border online availability indicator of the citizen-related life events from the e-Government Benchmark study. The number of services assessed in 2020,2021 and 2022 was 69. Out of these 69 services, 66 were measured at national level and 35 at cross border level. Of course, some services were measured for both the national and the cross-border dimensions. The data for this indicator is gathered biannually.

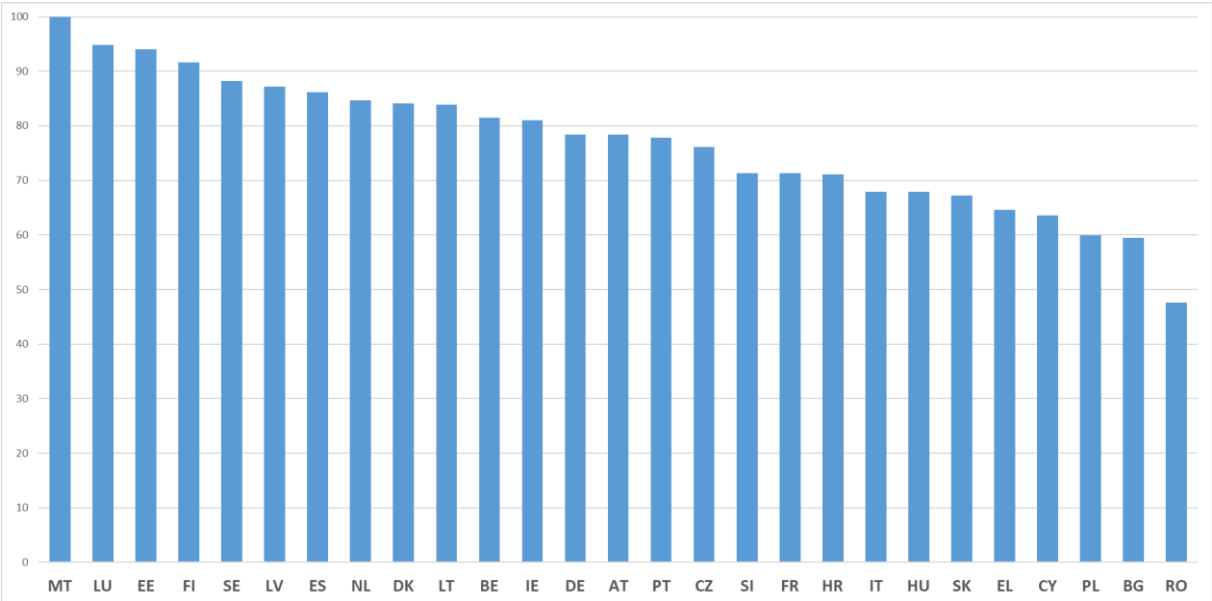
Small Claims Procedure. The indicator is calculated as the average of the national and cross-border online availability for informational and transactional services²⁶³.

Malta, Luxembourg, Estonia and Finland performed the best on this measure, scoring more than 90. Malta as the top-scoring country achieved the Digital Decade target for 2030 already. Finland reached the milestone of a score of at least 90 for the first time in 2022. 12 countries in total (Malta, Luxembourg, Estonia, Finland, Sweden, Latvia, Spain, the Netherlands, Denmark, Lithuania, Belgium and Ireland) scored above 80. Belgium joined this group for the first time.

While in 2021 still 5 countries (Romania, Greece, Cyprus, Poland and Bulgaria) scored less than 60, in 2022 only Romania is performing below a score of 60 with a score of 48.

Despite this narrowing in the gap in the performance of frontrunners and laggards and also the EU average increased from 75 in 2021 to 77 in 2022, overall distance to the **Digital Decade target is significant**. This shows that there remains **ample room for improvement**. Based on the actual data, 15 countries score below 80 and are therefore still far from the Digital Decade target to be achieved by 2030. In these countries **major steps are necessary to be able to achieve the digital decade target in 2030**.

Figure 65: Digital public services for citizens (score 0 to 100), 2022



Source: eGovernment Benchmark, Capgemini.

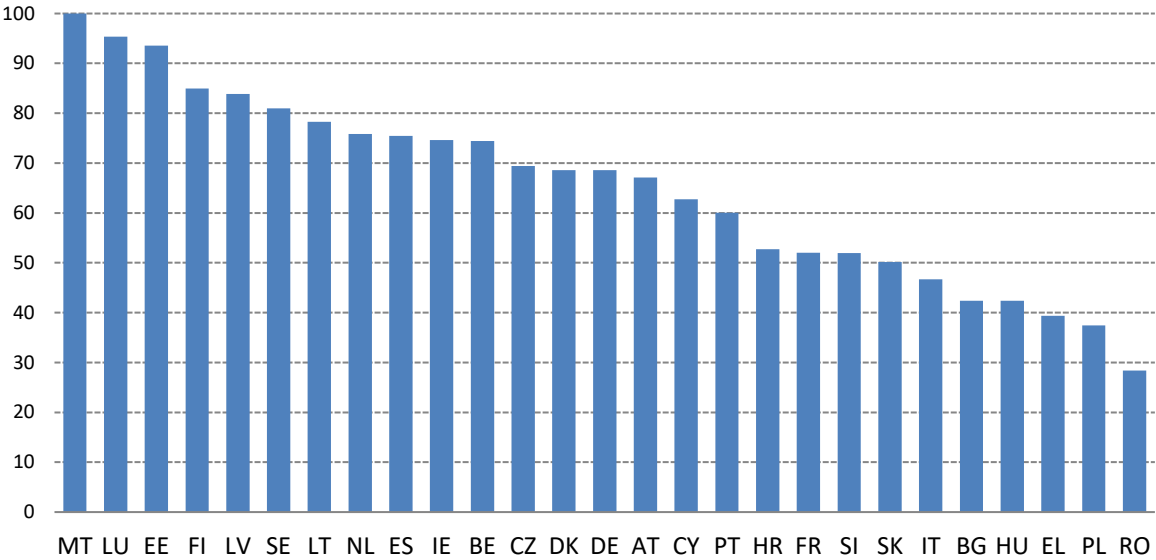
The indicator for online accessibility of public services has two components: national and cross-border²⁶⁴ online availability of public services for citizens., The cross-border element appears to be the main driver for low performance as it is the weak point in many Member States. Targeted action to improve cross-border online availability is therefore most needed to improve the overall performance. In particular, this holds true for the lowest **performing countries with scores below 50** (Romania, Poland, Greece, Hungary, Bulgaria, Italy and Slovakia). Countries with **scores between 50 and 70**, namely Slovenia, France, Croatia, Portugal, Cyprus, Austria, Germany, Denmark, and Czechia,

²⁶³ Informational services: services and procedures that provide users with adequate and personalised insight into his/her situation. Transactional services: services and procedures needed to fulfil the essential requirements of a life event through online interaction.

²⁶⁴ Cross-border online availability is the extent to which informational and transactional services and information concerning these services are provided online for users from other European countries.

should also take adequate steps to improve the cross-border online availability of public services for citizens.

Figure 66: Cross-border online availability of public services for citizens (score 0 to 100), 2022



4.3.3 Digital public services for businesses

The Digital Decade Policy Programme sets the **target of full online availability of key public services for businesses in 2030**. The Implementing Act on the Key Performance Indicator defines the indicator on online availability of public services for businesses as the key performance indicator for measuring the progress on the Digital Decade target.

This key performance indicator²⁶⁵ measures **the extent to which a service or information on a service for businesses is provided online, and/or via a government portal**. Services may be offered fully, partially online or offline only. The indicator measures the share of administrative steps in a life event that can be done online for the two major life events for businesses, namely when 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 services²⁶⁴. 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. Therefore, this indicator also measures the degree to which **public services for businesses are interoperable and work cross-border**.²⁶⁶

Based on the 2022 data, Ireland, Finland, Estonia, Malta, Luxembourg, Lithuania and Spain have a score above 90 (out of 100). Ireland and Finland already reached the score of 100 in 2022, i.e., achieved the 2030 Digital Decade target.

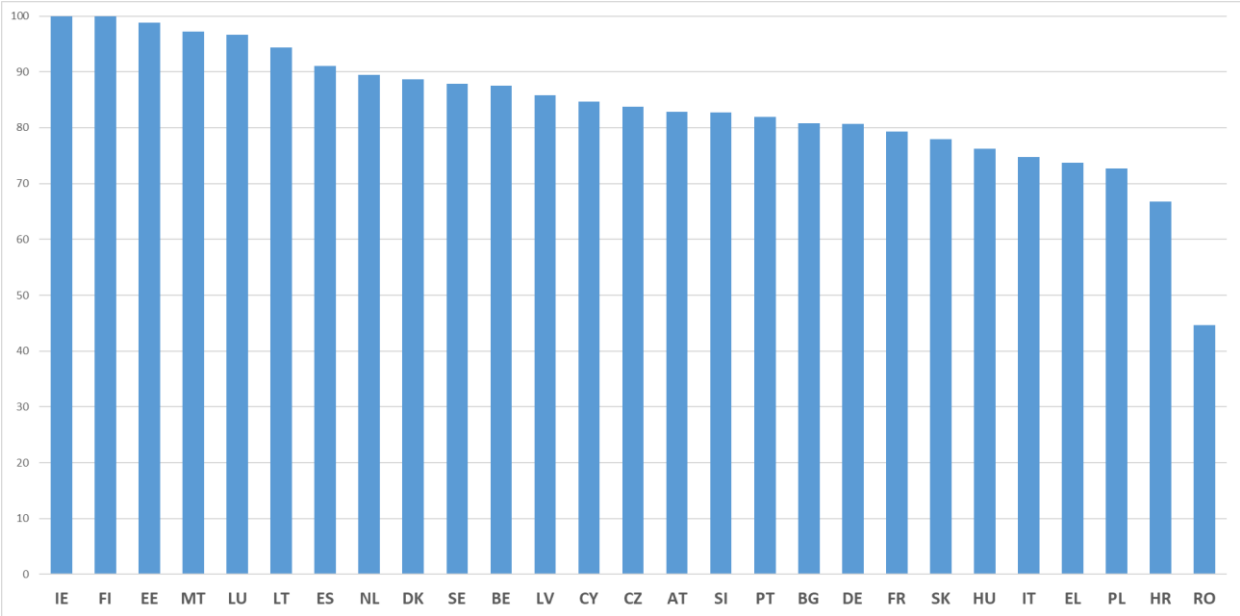
²⁶⁵ The input for this indicator is the national online availability indicator and the cross-border online availability indicator of the business-related life events from the e-Government Benchmark.

²⁶⁶ In 2020, the indicator was updated to align with policy advancements and goals in the field (e.g. alignment with the [Single Digital Gateway Regulation](#)). The eGovernment Benchmark method was updated, and the total number of services assessed was reduced. The number of services assessed in 2020, 2021 and 2022 was 26. All 26 were measured at national level and 18 at cross-border level. Of course, some services were measured for both the national and the cross-border dimensions.

Two countries have a score below 70, only half of the number of countries that scored below 70 in 2021. In 2022 it is only Croatia with a score of 67 and Romania with a score of 45 who are significantly lagging behind.

The EU average score is 84 in 2022 compared to 82 in 2021. Only 8 countries have a score below 80. This shows that most of the Member States are relatively on track to achieve the digital decade target of a score of 100 by 2030. However, in countries with a score below 80, in particular, in Romania and Croatia, significant improvements are necessary to be able to achieve the 2030 Digital Decade target for online availability of public services for businesses.

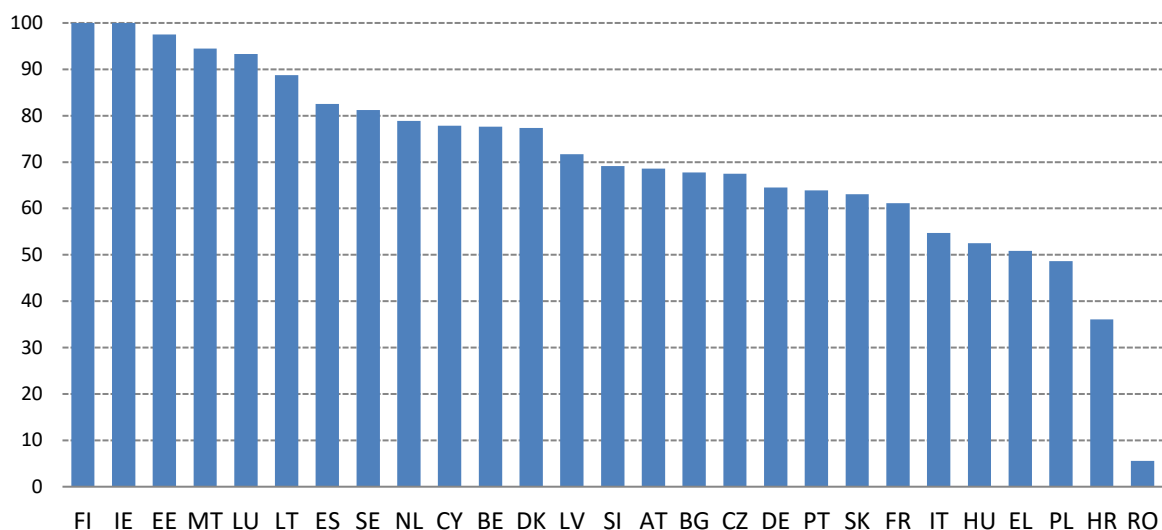
Figure 67: Digital public services for businesses (Score 0 to 100), 2022



Source: eGovernment Benchmark, Capgemini.

As the graph below shows, there is a **wider gap between Member States** if looking at the subcomponent on **cross-border online availability of public services for businesses. The majority of Member States scores lower on this subcomponent** in comparison to their overall score (if looking at both national and cross-border users). Romania reaches a score of only 6 for this sub-indicator. This means that basically almost no public services for businesses are available online for cross-border users. **14 Member States in total reach scores below 70 on this sub-indicator and therefore need to improve significantly in order to achieve the 2030 Digital Decade targets.**

Figure 69: Cross-border availability of public services for businesses (Score 0 to 100), 2022



Source: eGovernment Benchmark, Capgemini.

4.3.4 Pre-filled forms

This indicator²⁶⁷ measures **the extent to which data that is already known to public administrations is pre-filled in forms presented to the user**. The maximum overall score is 100. The use of interconnected registers is key to ensure that users do not have to resubmit the same data to the public administration (Once Only Principle).²⁶⁸ In the context of the Single Digital Gateway, direct access to a wide range of **fully digitised administrative procedures** is envisaged. The **Once-Only Technical System (OOTS) allows an automated exchange of evidence between authorities across the EU**.

The best performing countries in 2022 were The Netherlands, Lithuania, Finland, Malta, Estonia Denmark, and Sweden, all of which attained scores above 85. Compared to 2021, the top performers remained the same countries.

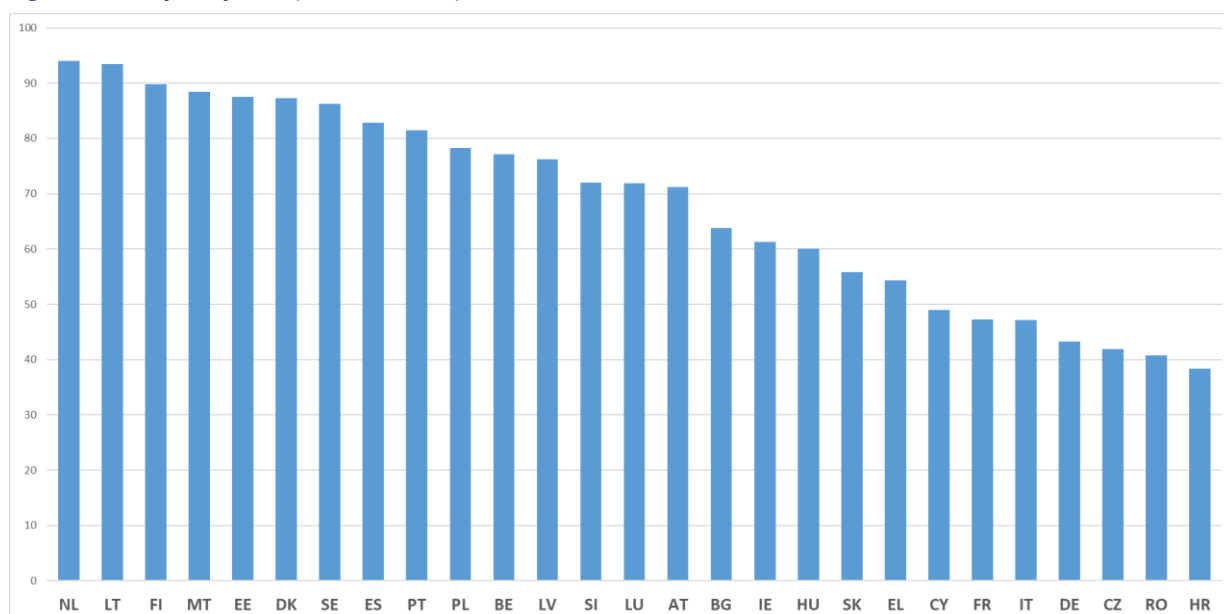
On the other hand, some of the worst performers made significant improvements compared to 2021. Notably, Romania more than doubled its score to 41, and Cyprus jumped from 36 to 49. The countries with scores below 50 are Cyprus, France, Italy, Germany, Czechia, Romania, and Croatia (lowest score of 38).

Despite the progress some countries have made, the **gap between the best and worst performing countries remains significant**. Also, the EU average increased from 64 in 2021 to 68 in 2022, but **with an EU average score of 68 overall this is an area where substantial room for improvement persists**.

²⁶⁷ The input for this indicator is the authentic sources indicator of the eGovernment benchmark. The indicator has been recently renamed to pre-filled forms in the eGovernment Benchmark study 2023, in order to ensure better consistency between the eGovernment Benchmark study collecting this data and the reporting under DESI. The number of services assessed in 2020, 2021 and 2022 was 95 (69 for citizens and 26 for businesses). The data for this indicator is gathered biannually.

²⁶⁸ In 2020, the methodology for the indicator was updated to align with policy advancements and goals in the field (e.g., by updating the set of national services).

Figure 68: Pre-filled forms (Score 0 to 100), 2022



Source: eGovernment Benchmark, Capgemini.

4.3.5 Transparency

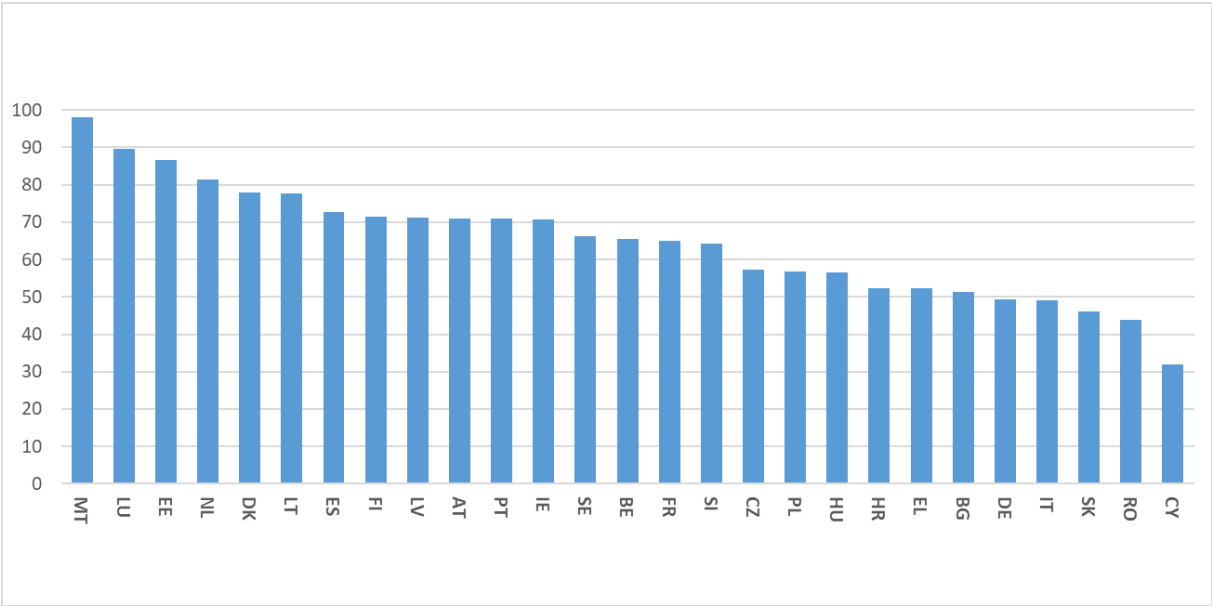
Transparency assesses the **extent to which service processes are transparent, services are designed with user involvement and users can manage their personal data.**²⁶⁹ This aggregate indicator includes the following three key elements:

1. Transparency of service delivery: the extent to which the service process and expectations are clear.
2. Transparency of personal data²⁷⁰: 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 on and involved in policy and service design processes.

²⁶⁹ Similarly, to the other indicators for which data is gathered with the eGovernment Benchmark study, in 2020, these indicators were updated to align with policy advancements and goals in the field by reducing the total number of services assessed.

²⁷⁰ The Transparency of personal data indicator analyses the availability and degree of digitalisation regarding online modalities of exercising data subject rights. Importantly, it does not provide a GDPR compliance review (reserved to competent data protection authorities) and does not form any restriction that could be provided by Member State law.

Figure 69: Transparency status in Member States (Score 0 to 100), 2022



Source: eGovernment Benchmark, Capgemini.

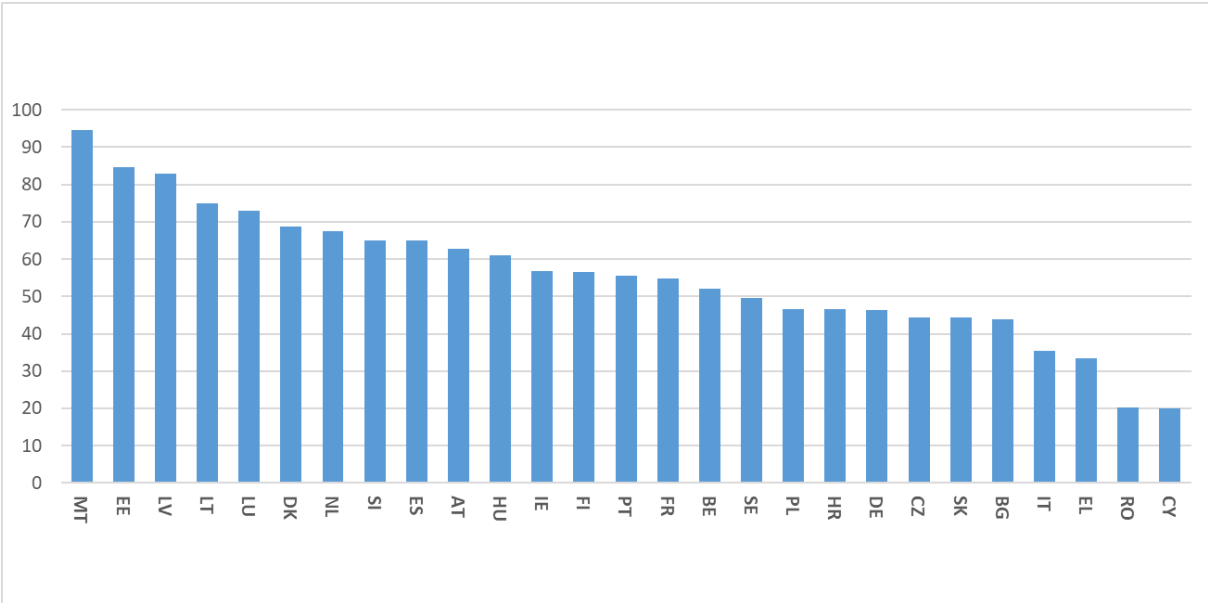
For the aggregated indicator on transparency, Member States’ scores range from 32 (Cyprus) to 98 (Malta). Overall, 12 countries are performing well with scores above 70 (Malta, Luxemburg, Estonia, The Netherlands, Denmark, Lithuania, Spain, Finland, Latvia, Austria, Portugal, and Ireland) **The EU average score is 65 in 2022.**

5 countries, namely Germany, Italy, Slovakia, Romania, and Cyprus, score below 50.

In relation to transparency, given the wide range in performance, **Member States could learn from each other and adopt best practises, in order to narrow the gap in performance and to overall achieve better transparency of digital public services in Europe.**

It is worthwhile to explore how the Member States perform in relation to the different sub-indicators, to better understand where the weaknesses and strengths of the different Member States are in terms transparency of digital public services.

Figure 70: Transparency of service delivery (Score 0 to 100), 2022

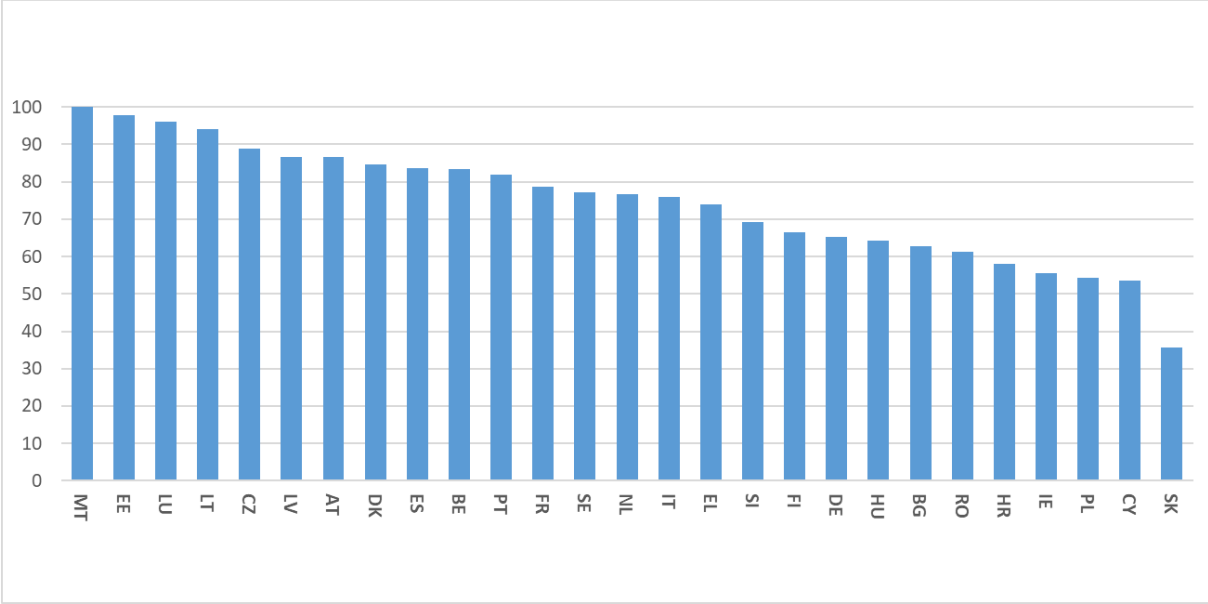


Source: eGovernment Benchmark, Capgemini.

Next to Malta and Estonia, Latvia is a frontrunner on the performance on the sub-indicator **transparency of service delivery**, with a score of above 80. In these countries service process and expectations are relatively clear.

Romania and Cyprus are the laggards (with a score of 20). 11 Member States (Sweden, Poland, Croatia, Germany, Czechia, Slovakia, Bulgaria, Italy, Greece, Romania and Cyprus) score below 50. **The average score is 56. This represents the weakest performance among the 3 sub-components. It is therefore recommended that the Member States take action towards improving the transparency of the service delivery for public services online.**

Figure 71: Transparency of personal data (Score 0 to 100), 2022

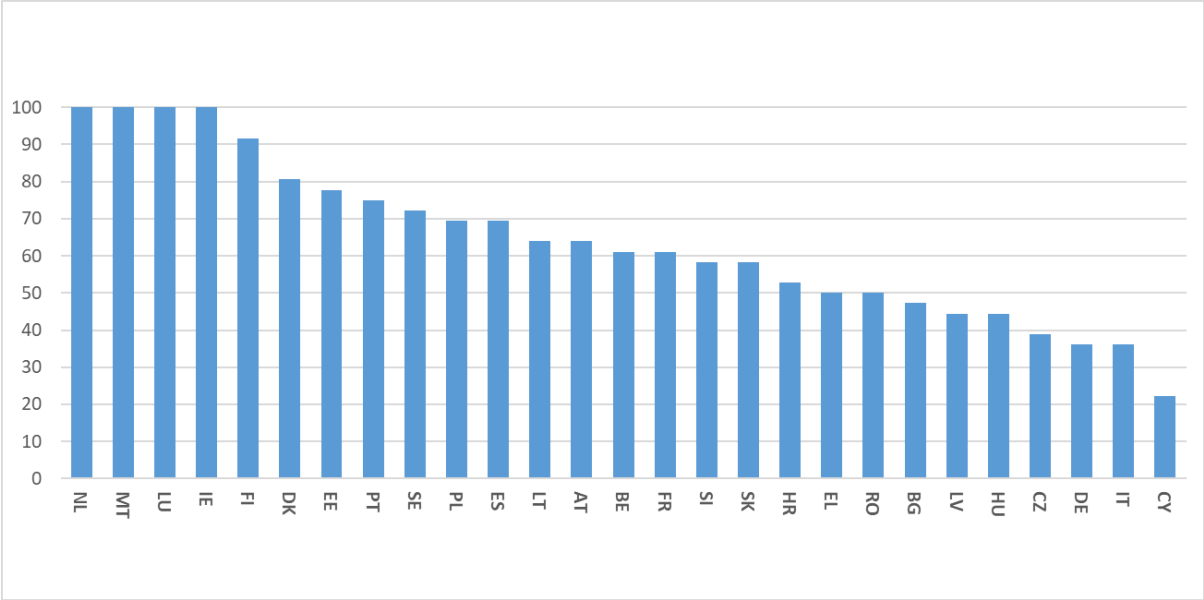


Source: eGovernment Benchmark, Capgemini.

On **transparency of personal data**, 11 Member States reach scores above 80; with Malta, Estonia, Luxembourg and Latvia in the lead with a score above 90. This means that in these Member States users can manage their personal data held by government organisations rather well.

On the other hand, 5 Member States perform below a score of 60 (Croatia, Ireland, Poland, Cyprus and Slovakia). Slovakia scores 36, which is less than half of the **EU average score of 75**. Especially in Slovakia, but also in other **less performing Member States with a score below of 60**, there is a **pressing need to improve the possibility for users to manage their personal data held by government organisations**.

Figure 72: Transparency of service design (Score 0 to 100), 2022



Source: eGovernment Benchmark, Capgemini.

The difference in performance between the highest- and lowest-scoring countries is particularly large in the **transparency of design delivery**. The **EU average score is 64**.

In 2022, The Netherlands, Malta, Luxembourg, and Ireland reached the maximum score of 100. Finland is also a top performer with a score above 90. In these countries, users are fully informed on and are involved in policy and service design processes.

At the lower end of the range, there are 9 countries (Greece, Romania, Bulgaria, Latvia, Hungary, Czechia, Germany Italy and Cyprus) with scores below 50. The lowest-scoring country is Cyprus with a score of 22, which is 14 points below the second-lowest score of 36 (Germany and Italy). The low scores indicate that, in these countries, users are little informed on or scarcely involved in policy and service design processes.

Except for the top performers, there is ample room for improvement in informing users on policy and service design processes and in involving users in these processes.

4.3.6 User support

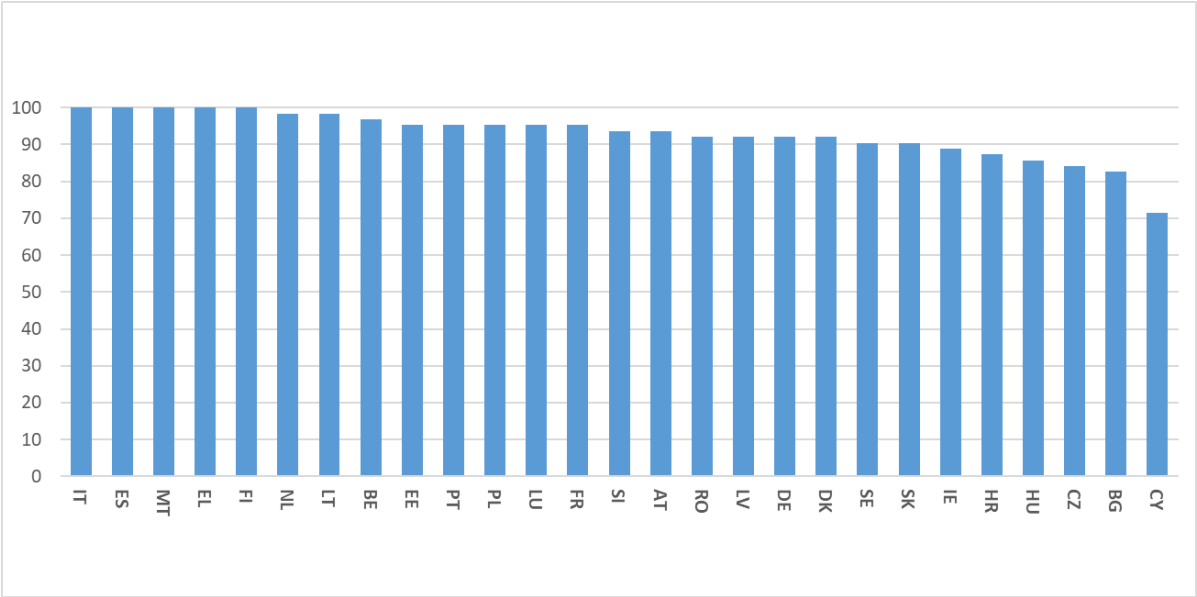
The indicator on user support is the aggregate indicator measuring the **extent to which online support, help features, and feedback mechanisms are available for users from within the country and from other European countries**. User support is an essential element of **user centricity**.

On average, the Member States score **82**. The lowest-scoring countries are Hungary (score of 67), the Czech Republic (64), Bulgaria (63), and Cyprus (score of 58). The top performer Malta reaches the full score.

The indicator consists of 2 sub-indicators measuring the user support to national users and cross-border users. The figures below show a significant difference in performance between the 2 sub-indicators.

border users. The figures below show a significant difference in performance in the 2 sub-indicators.

Figure 73: User support (national) (Score 0 to 100), 2022

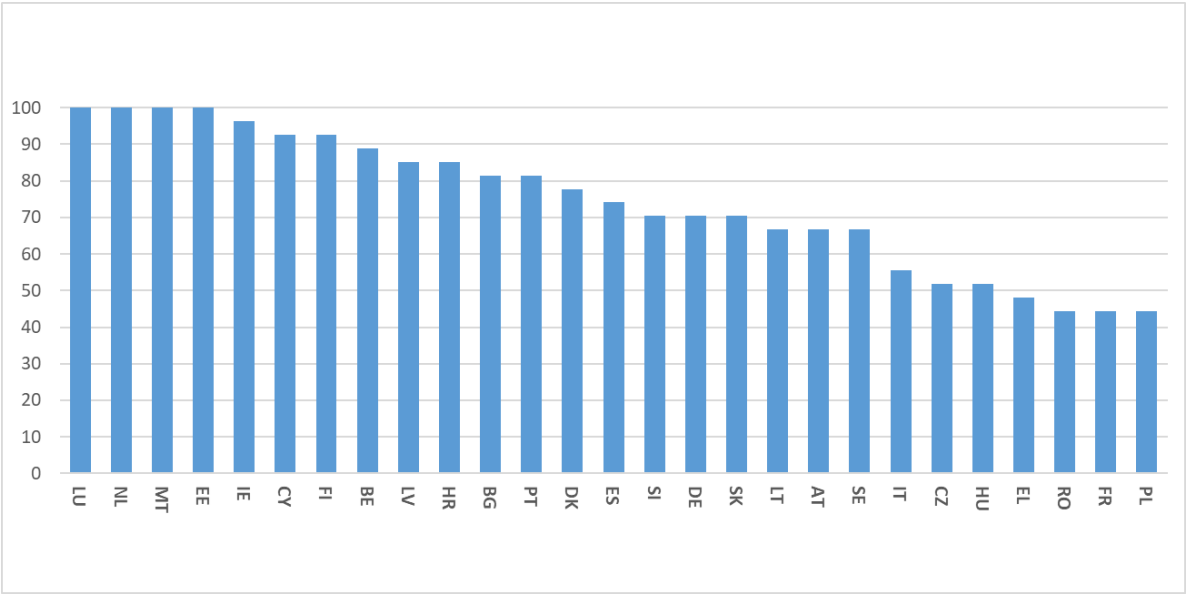


Source: eGovernment Benchmark, Capgemini.

Italy, Spain, Malta, Greece and Finland provide full user support to users based within their country. the EU average score is with 93 also very high. The lowest performing country is Cyprus with a score of 71.

The sub-indicator cross-border user support measures the extent to which online support, help features, and feedback mechanisms are available for users accessing public services from other European countries.

Figure 74: User support (cross-border) (Score 0 to 100), 2022



Source: eGovernment Benchmark, Capgemini.

In relation to cross-border user support, there is a very wide range in performance within the EU. The average score is 74. 4 countries, namely Luxembourg, the Netherlands, Malta, and Estonia, attain the maximum scores. 4 countries do not even reach a score of 50, with Greece scoring 48, Romania, France and Poland scoring 44.

Moreover, Cyprus is the only country that performs far better for cross-border user support than for national user support. This is against the trend in other Member States.

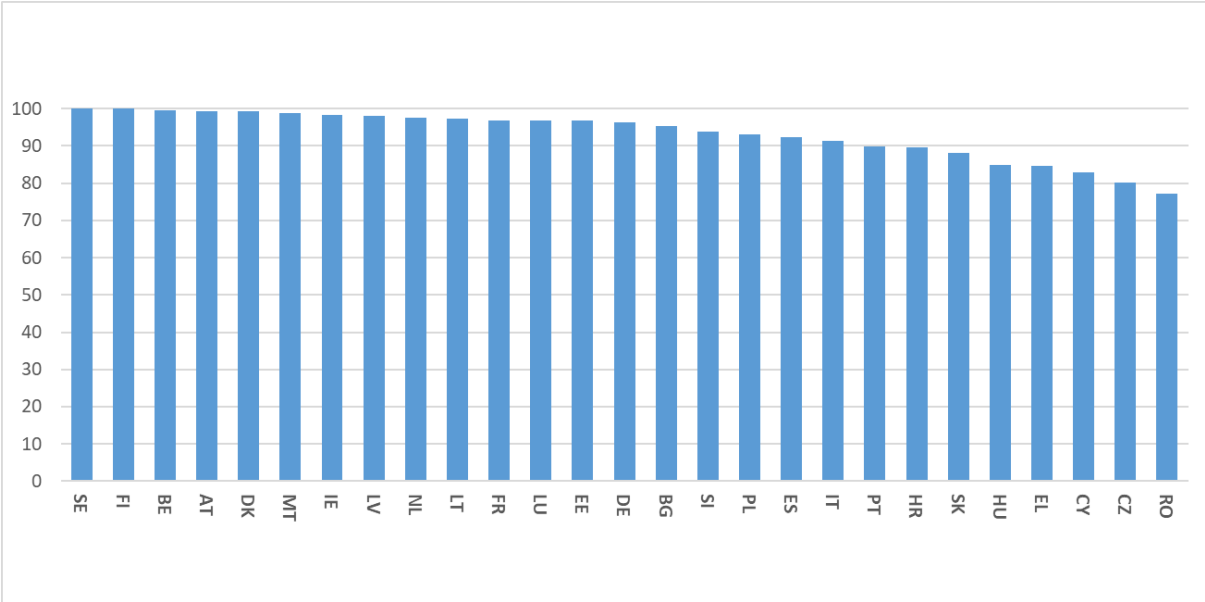
The most **significant gap in performance between national and cross-border user support** exists in Poland, France, Romania, Greece, Hungary and Italy, where scores for cross-border user support are only approximately half of the scores for national user support.

In many Member States closing this substantial gap and providing user support to cross-border users would require substantial efforts.

4.3.7 *Mobile friendliness*

The newly added indicator on mobile friendliness assesses **the extent to which services are provided through a mobile-friendly interface, i.e., an interface that is responsive to the mobile device**. The compatibility with mobile devices is an aspect of **user-centricity**, which becomes more and more important.

Figure 75: Mobile friendliness (Score 0 to 100), 2022



Source: eGovernment Benchmark, Capgemini.

Overall, the Member States perform well on this indicator, with an **EU average score of 93**. Only Romania scores with 77 below 80. The highest-scoring countries with scores above 99 are Sweden, Finland, Belgium, and Austria. 15 countries in total have a score above 95. Nonetheless, **strongly linked to the target on online availability for digital public services for citizens and businesses, digital public services should ideally become fully available to users regardless of which interface they use.**

4.4 Trends towards 2030 for digitalisation of public services

The Digital Decade target aims at ensuring wide and easy access to public services online, measured through the online availability of key public services be it for citizens, for example to fix and reschedule an appointment at the hospital or appeal against court decision, or for businesses, for example when starting a business or conducting regular business operations.

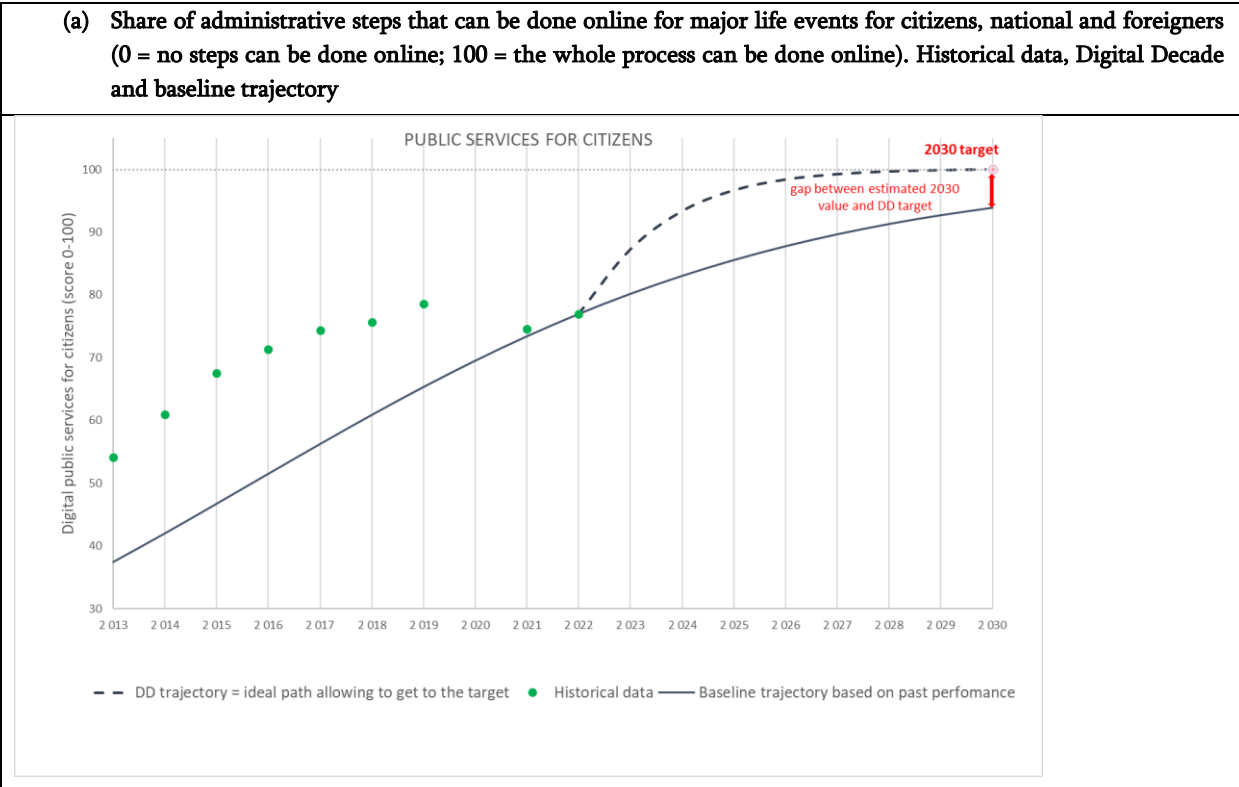
The evolution of the provision of digital public services is generally assumed to follow an S-shaped curve. There are two main reasons why the growth rate becomes smaller once a certain level of digitisation has been reached. First, some services will be more costly to digitalise. Therefore, they

will be left for the end of the digitalisation process. Second, services in rural or remote areas where the digital infrastructure is less advanced will be more difficult to digitalise.

The methodology used by the eGovernment benchmark was revised in 2020, leading to a break-in-series for both key performance indicators. The methodology used to estimate the eGovernment KPIs trajectories and adapt them to the break in series is explained in the Communication from the Commission establishing Union-level projected trajectories for the digital targets²⁷¹.

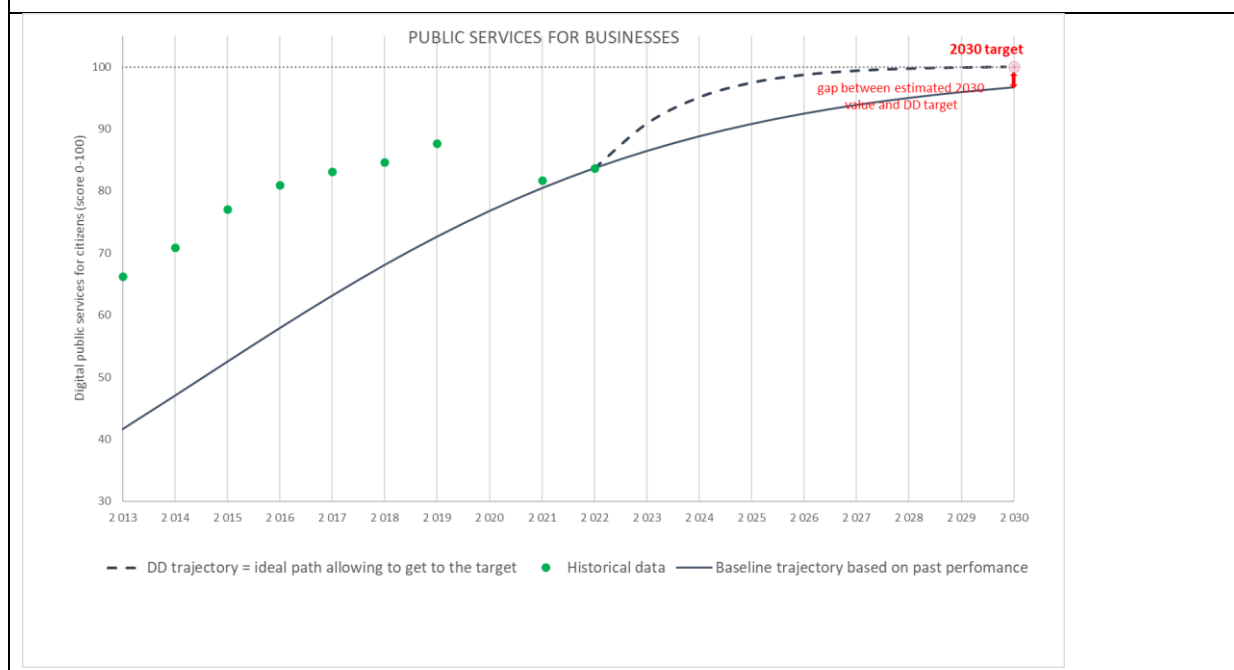
Historical data, the Digital Decade trajectory and the baseline trajectory are shown in Figure 76 (a) for the citizens’ KPI and Figure 76 (b) for the businesses’ KPI. The 2030 expected value with no further investments is 94% for the citizens’ indicator and 97% for the businesses’ indicator.

Figure 76: Online service provision for citizens (top chart) and businesses (bottom chart). Historical data, Digital Decade (DD) trajectory and baseline trajectory towards 2030



²⁷¹ Digital Decade and baseline trajectories are presented in the “Communication from the Commission establishing Union-level projected trajectories for the digital targets” [C\(2023\) 7500](#).

(b) Share of public services needed for starting a business and for conducting regular business operations that are available online for domestics as well as for foreign users (0 = no steps can be done online; 1 = the whole process can be done online). Historical data, Digital Decade and baseline trajectory



In 2022, the availability of digital public services for citizens and businesses achieved, respectively, the score 77 and 84 out of the maximum value of 100. Some Member States are already close to or have achieved the 100 points target. Nevertheless, progress is uneven across and within Member States. In particular, there is ample room of improvement as regards the availability of cross-border services.

4.5 Overview on Electronic identification (eID)

The Digital Decade target on electronic identification requires that, by 2030, 100 % of Union citizens have access to secure electronic identification (eID) means that are recognised throughout the Union, enabling them to have full control over identity transactions and shared personal data. Access to eID is measured by two KPIs:

- (1) as the number of Member States that have notified at least one national eID scheme in accordance with Regulation (EU) No 910/2014¹⁰ and
- (2) as the number of Member States that have provided access to secure privacy-enhancing and data protection compliant eID via the European Digital Identity Wallet in accordance with the Proposal for a Regulation of the European Parliament and of the Council amending Regulation (EU) No 910/2014 as regards establishing a framework for a European Digital Identity.¹¹

By the time of the publication of this document, a **total of 21 EU countries are expected to have notified at least one eID scheme**. Four of the remaining countries are currently involved in at least one large-scale pilot project funded by the Digital Europe Programme. The goal of these pilot projects is to test the wallet around a diverse range of every-day use-cases such as identification/authentication, signing documents electronically, making payments and storing mobile driving licenses, ePrescriptions, digital travel credentials, diplomas, and social security documents. The feedback from these pilots will allow improving and completing the wallet architecture.

4.6 Trends towards 2030 on eID

The legislative discussions of the European Digital Identity proposal are still in progress. In parallel with the legislative discussions, several steps are being undertaken to facilitate the deployment of the European Digital Identity Wallet among the wallet ecosystem once the legal obligation for Member States to provide wallets will become binding.

- The proposal is planned to be adopted in the course of 2023.
- The Commission proposed for Member States to issue digital wallets within 12 months from the entry into force, but this deadline is still subject to discussion among the co-legislators.
- The indicative timeframe for availability of the digital wallets currently is within the course of 2025 (subject to agreement by the co-legislators).
- 100 % of EU citizens would thus have access to the digital wallet as of that timeframe.

4.7 Overview on e-health

The digitalization of health has the **potential to deeply transform the healthcare landscape, improving access to care, enhancing patient engagement, and ultimately leading to better health outcomes for individuals and communities**. Facilitating and supporting seamless, secure and interoperable access across the EU to digital public services designed to meet people's needs in an effective manner, including in particular digital health and care services, notably access to electronic health records, has been explicitly included in the European Declaration on Digital Rights and Principles for the Digital Decade.

The key performance indicator for monitoring the progress towards the target which is defined as the digitalisation of public services where 100 % of Union citizens have access to their electronic health records is set as follows:

The access to e-health records is measured as: (i) the nationwide availability of online access services for citizens to their electronic health records data (via a patient portal, or a patient mobile app) with additional measures in place that enable certain categories of people (e.g. guardians for children, people with disabilities, elderly) to also access their data, and (ii) the percentage of individuals that have ability to obtain or make use of their own minimum set of health-related data currently stored in public and private electronic health-record (EHR) systems.

The indicator is an aggregate indicator with 12 sub-indicators measuring key aspects of the availability of online access to electronic health record data, at the country level:

1. the nationwide availability of online access to electronic health data;
2. the categories of accessible health data;
3. the availability of authentication schemes, type of front-end solutions and coverage and
4. the accessibility for certain categories of people (like vulnerable groups).

Overall, the **EU performs reasonably well** on this indicator, with an **EU average score of 72** and 12 countries above it, with the **countries in the lead** such as: Denmark (96), Lithuania (92), Finland (90), Estonia (89), Austria (88), Poland (86), Croatia (86), Belgium (85) and Spain (83). In these countries, **sufficiently comprehensive electronic health records are accessible by a large proportion of the national population, with secure means of authentication and measures to facilitate equitable access opportunities for citizens**.

On the other hand, the **6 countries currently lagging behind in their degree of citizens' access to electronic health records** are Portugal (63), Greece (61), Romania (57), Czechia (47), Slovakia (45). In Ireland with score 0, such an access is not enabled for citizens.

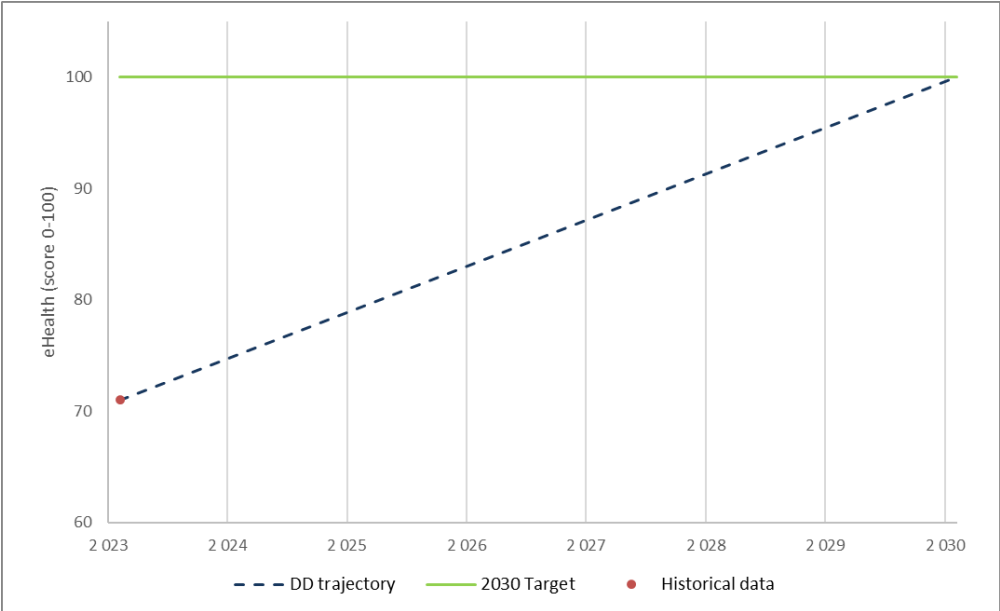
As all Member States except Ireland reported to have implemented electronic access services for citizens through national or regional level or through systems offered by healthcare providers, the gaps to be addressed remain in other components of the indicator: There is notably a need to improve the range of data that is accessible, increase the population coverage to at least 80%, ensure eIDAS compliant identification, have at least 60% of potential providers being technically connected and consistently supplying health data, and enable access opportunities for informal carers and facilitate web accessibility²⁷².

4.8 Trends towards 2030 on e-health, electronic health record

Given that the target is defined as the digitalisation of public services where 100 % of Union citizens have access to their electronic health records, the e-Health indicator measures the availability of electronic medical data for the European citizens and does not measure citizens’ actual usage of online health services.

In absence of historical data, it is assumed that the ideal path towards 100% of Union citizens having online access to health data will follow a linear trajectory²⁷³ from the value of 72 in 2023 to 100 at the end of the decade (Figure 77: eHealth composite indicator. Historical data and DD trajectory).

Figure 77: eHealth composite indicator. Historical data and DD trajectory



4.9 Actions at Member States and EU level

Many important initiatives and policies exist in the Member States as well as at EU level contributing to achieving the common goals of the Digital Decade.

Measures aimed at **digitalising public services and at introducing or improving e-government solutions figure prominently across the Recovery and Resilience Plans**. 26%, i.e., EUR 130 billion of Recovery and Resilience Facility (RRF) funds are targeted towards digital. EUR 48 billion of the RRF funds allocated to the digital transformation is dedicated to digital public services. Furthermore, out

²⁷² Current assessment of maturity of Member States concerning citizens’ access to their electronic health records data was informed by recent studies published by the Commission: Interoperability of Electronic Health Records (EHR) in the EU study and study for Digital Decade eHealth Indicators Development

²⁷³ Digital Decade and baseline trajectories are presented in the “Communication from the Commission establishing Union-level projected trajectories for the digital targets” [C\(2023\) 7500](#).

of the EUR 117 billion expected to contribute to the Digital Decade targets, EUR 23.8 billion is considered relevant for the availability of digital public services, EUR 13.1 billion for e-health and EUR 0.4 billion for eID.²⁷⁴ Some Member States are devoting more than half of their digital budget for the digitalisation of public services (e.g., Malta, Lithuania, Finland and Croatia). Overall, Member States seek to modernise and improve public administration processes to make them more user-friendly, citizen-oriented and interoperable. The aim is to boost access to and uptake of digital public services by individuals and businesses. Key reforms supported under the RRF include the integration of eID solutions in all government processes and the implementation of the 'Once Only Principle'. The implementation of the RRF is ongoing and in many Member States milestones and targets are being achieved, thereby triggering payments from the Facility.

In several Member States the programmes under the European Regional Development Fund for 2021-27 also include significant EU funding for digitalisation of public services, for example in Poland and Hungary. Cohesion policy plays a key role in tackling social and territorial inequalities by supporting the modernisation of public services, digital skills and infrastructure, digitisation of public services and the digital transformation of businesses. Across all policy objectives, EUR 36.6 billion²⁷⁵ will support the digital transition in the period 2021-27 (in addition to the EUR 16 billion already invested in the digital economy in 2014-2020²⁷⁶). More than EUR 11 billion of that amount will be used to improve digital services and digitalise businesses and 22 500 public administrations.

The Digital Europe Programme is also providing funding related to eID in the Work Programme 2021-2022:

- Via procurement: 15 MEUR for a framework contract for support in developing a reference implementation (RI) of the European Digital Identity Wallet based on the technical architecture (ARF) under development by member states and input by the Large-Scale Pilots
- Via grants (50% co-funding): Initially, 37 MEUR for testing the wallet and contributing to enhancing the ARF/RI, topped up to 46 MEUR with leftover budget from other DEP calls to fund also the reserve-listed project.

Public procurement is the main tool that the public sector has at its disposal to adopt new solutions. However, benchmarking conducted in a study in 2020²⁷⁷ suggests that on average across Europe investments in public **procurement of innovative digital solutions** still need to almost triple in order to reach full speed adoption of innovative digital solutions in public services. According to this study there is a need for significant increased investment in all domains of public sector activity (e.g. public administration, health, transport, security, education and culture, construction, energy, environment, water etc). The study also reveals that differences between EU countries are large.

²⁷⁴ Each Recovery and Resilience Plan has to dedicate at least 20% of the plan's total allocation to digital objectives. To this end, the plans had to specify and justify to what extent each measure contributes fully (100%), partly (40%) or has no impact (0%) on digital objectives, using Annex VII of the RRF Regulation. Combining the coefficients with the cost estimates of each measure allows assessing to what degree the plan contributes to digital objectives and whether it meets the 20% target. Furthermore, a further qualitative assessment of the data took place to allow for an estimation of the possible contribution of RRF measures to the Digital Decade targets.

²⁷⁵ According to the Staff Working Document on Cohesion Policy 2021-27: forging an even stronger Union, Report on the outcome of 2021-27 cohesion policy programming: Under the ERDF and Cohesion Fund EUR 30.3 billion of EU financing is planned linked to the digital transition while under ESF+ EUR 6.3 billion is planned linked to developing digital skills and jobs. Explore the planned investments in the digital transition in [this cohesion open data story](#).

²⁷⁶ See DG REGIO's Annual Activity Report 2021, page 20.

²⁷⁷ <https://digital-strategy.ec.europa.eu/en/library/benchmarking-innovation-procurement-investments-and-policy-frameworks-across-europe>

Member States that are leading in the digital transformation of public services are already well on the way to invest 10% of the country's total public procurement expenditure in deploying innovative digital solutions. However, Member States that are lagging in the digital transformation of public services are still investing less than 1% of the country's total public procurement expenditure in deploying innovative digital solutions. The conducted benchmarking also suggests synergies with green investments: typically, countries that lead in procuring innovative digital solutions also lead in green procurement. In those countries, more than 60% of all innovation procurements relied on ICT based solutions to achieve the desired public services transformation. ICTs are thus a key driver for realising the digital, green twin modernisation of public services. As innovation procurement is not only improving the quality and sustainability of public services but also strengthening the competitiveness of Europe's ICT industry, innovation procurement is also key to strengthen EU strategic autonomy. The study therefore concludes that it is important to boost public procurement investments in the development, testing and adoption of innovative digital solutions.

The Digital Decade country reports highlight the following good practise cases on actions at Member States level:

Table 9 Good practices mentioned in Digital Decade Country reports

Country	Short description of good practice	Target or indicator covered
AT	<p>Doing business abroad simplified between Austria and Germany following the once-only principle - The Austrian Federal Ministry of Finance is cooperating with the German public administration in the Doing Business Abroad (DBA) use case that lays important basis for implementing the Single Digital Gateway Regulation (SDG), specifically the cross-border exchange of evidence according to the once-only principle (SDG OO).</p>	<p>Cross-border online availability of digital public services for businesses</p>
BE	<p>Connectoo is a free online training course that is accessible to anyone working in a federal, regional or municipal administration, regardless of their job. The aim of the programme is to train and certify 10,000 public employees in Belgium by 2030. The main targets of such training are public service employees in direct contact with citizens and also public service employees involved in the design of digital public services.</p>	<p>Digital skills of public administrations, User support and online availability of digital public services for citizens</p>
BG	<p>A first metaverse Ministry - In April 2022, Bulgaria has established a meta-Ministry of Climate Transition and Green Transformation. The ministry resembles a private project organised by a local social tech start-up in the form of a think tank platform for innovative solutions and participatory leadership. The motivation is to help the creation of separate departments at local ministries and to establish an actual official ministry that will be energy-efficient by working almost entirely in the Metaverse.</p>	<p>Applying cloud services in public administrations</p>
CY	<p>The Childbirth Grant service allows mothers of new-borns to apply electronically for a grant in a simple, fast and easy way. The service was released in June 2022.</p> <p>The eligibility requirement for a mother to receive the grant is to have given</p>	<p>Online availability of digital public services for</p>

Country	Short description of good practice	Target or indicator covered
	<p>birth within 12 months prior to her request and have paid social insurance contributions. The service has a high transactional volume (around 10.000 applications annually) and applies the Once-Only principle.</p> <p>The Childbirth Grant service was developed by the DSF following an agile approach to understand the users' needs, to rapidly test assumptions and to react to changing requirements in order to meet these needs. For the design and development of the service, a multidisciplinary service team was created having members participating in different roles. The User-centred design (UCD) approach was followed aiming to release a service that would meet citizens' needs and expectations. Clear, concise, simple and accessible content was used to ensure that users could understand how to use the service. A number of prototypes of how the service could look were also created to ensure that the service delivered was accessible and intuitive.</p>	<p>citizen, Transparency, Pre-filled forms</p>
CZ	<p>Incentives to adopt eID</p> <p>From the beginning of 2023, data mailboxes are being set up automatically for natural persons doing business, since their use is now mandatory. This legislative change will contribute to a rapid growth of a number of the eID users. To attract more users, in November 2022, a digital voter's card application for the presidential election was made available on the Citizen's Portal. The logged-in user only needs his data mailbox to make the submission and then to choose how he wants to receive his voter's card. All other information is being pre-filled for him. Almost 70,000 citizens set up a data mailbox in order to apply for a voter's card, which significantly increased the number of newly established data mailboxes for natural persons.</p>	<p>eID, online availability of digital public services for businesses, pre-filled forms</p>
DE	<p>The digitalization of two online services in particular, namely, the "State Blindness Benefit" and "State Fund for the Blind" focused specifically on accessibility for citizens with impairments of their vision. These services, piloted as a Minimal Viable Product in September 2021 in the state of Lower Saxony, centered on user-friendliness, ease of operation and application, and relied heavily on user testing with the target group</p>	<p>Online availability of digital public services for citizens, Transparency</p>
DK	<p>Denmark participates in the Nordic-Baltic eID Project (NOBID). NOBID monitors and facilitates the regional implementation of the eIDAS interoperability network, which enables citizens in the Nordic and Baltic countries to have access to secure electronic identification (eID) means that are recognised throughout the Union. Together with the Nordic and Baltic countries (Iceland, Norway, Latvia, Germany, Italy), Denmark participates in the NOBID-consortium, which focuses on payments. The focus is on authentication, enrolment with eID and identity matching.</p>	<p>eID</p>
EL	<p>MITOS: National Register of Administrative Procedures</p> <p>The launch of the National Register of Procedures MITOS in 2022 represents a good practice in online accessible provision of key public services which allow citizens and businesses to interact with public administrations.</p> <p>For the first time, every procedure of the Greek State has been gradually</p>	

Country	Short description of good practice	Target or indicator covered
	recorded in the National Register, providing people and end users with all the necessary information about the applicable administrative procedures and legislation, as well as the competent services and processing time. Up today: 2.524 services have been published in the Greek language, and 337 in English. This project will improve the interaction between the citizens and the state, as they will know in advance what exactly is required to be served.	
HR	Artificial Intelligence for Smart Healthcare and Medicine (AI4Health.Cro) project was rated excellent by the European Commission as part of the Digital Europe program. AI4Health.Cro is a non-profit public-private consortium that sees artificial intelligence as key to the advancement of healthcare and as a catalyst for leading Europe to a healthier future. AI4Health.Cro will offer a comprehensive support to businesses and public entities with advanced AI-based services and technologies, addressing the current needs of the healthcare and public health systems for digital transformation.	e-health
HU	<p>Automated issuance of driving licenses - In case all legal conditions are met, driving licenses (such as the first driving license and the exchange of a driving license due to expiry or category expansion) are immediately registered in the road traffic registry, and the new licenses are issued and sent to citizens automatically.</p> <p>During the process, citizens only have to make a declaration for the issuance of documents online via the Magyarország.hu national single point of contact portal, and take the required tests (first aid, category test and medical aptitude test). Further on, the issuing bodies send the certificates of the necessary tests electronically to the specific sectoral information system that manages the driving license register, after which the process is fully automatic.</p> <p>In addition, since January 2023 data on driving licenses can be accessed by the controlling authorities via a standard interface directly from the Hungarian registry real-time online, therefore the drivers do not have to have the documents with them anymore when driving within the country.</p>	Online availability of digital public services for citizens, Pre-filled forms
IE	<p>gov.ie The single public service portal, gov.ie, is designed to create a much better user experience by thematically presenting and simplifying information about public services to ensure that they are not only easy to find, but also easy to follow and navigate. User centricity, inclusivity and accessibility are of key importance. Design principles for government in Ireland (published in October 2022) and digital user experience (UX) checklist support the provision of a quality service. Most government departments are on gov.ie with the final two in the process of transitioning shortly. The gov.ie service continues to be the trusted platform for the government communications, handling over 70 m page views during 2022.</p>	Online availability of digital public services for citizens and businesses
LT	<p>GovTech sandbox The GovTech sandbox focuses on finding digital solutions for better policy making. During 2022, a structured experimentation program designed to solve public sector challenges and foster the creation</p>	Online availability of digital public

Country	Short description of good practice	Target or indicator covered
	of digital solutions in cooperation with SMEs and start-ups was launched. Already 29 successful prototypes responded to the challenges of public sector: e.g., using satellite images and AI to measure damage done to farmers by cows, mobile app for people with mental disability assisting in purchasing goods, using the AI to model policing of road, virtual reality solution visualizing spaces of industrial enterprises and factories.	services for citizens and businesses
MT	Using ICT tools to diagnose diseases more efficiently - As part of the ITAMA project , partly funded by ERDF, public and private project partners from Malta and Italy collected data, built a database, and fed it to a Decision Support System using AI to help medical professionals diagnose Coeliac Disease. In this way, the project aimed to show that data collected through medical tests, blood samples and questionnaires can be sufficient to formulate a diagnosis without the need for invasive endoscopies, enabling the screening of larger populations for the disease. The project concluded in 2022 but investments into the follow-up project ITAMA CAP have started in 2023. This is a good example of using AI to identify more efficient diagnostic methods, benefitting individual patients and the health of the population at large.	e-health
PT	MOSAICO is a common model for designing and development of digital public services. It consists of essential principles for the evolution of public services, promoting coherence and consistency of citizens' and businesses' relationship with the state. The dedicated web portal offers information and documentation of technical architectures of the public administration platforms e.g. digital identity (authentication, signature, certification of attributes), open data portal, interoperability platform, catalogue of entities and services, electronic notifications system, ePortugal (single digital gateway for public services), etc.	Transparency, eID, Online availability of digital public services for citizens and businesses
RO	Several ongoing projects are gaining traction and are illustrating the benefits of e-government services to citizens and businesses in terms of simplification and limiting administrative burden. "Ghiseul.ro" is a nationwide payment platform, as well as an online app, implemented by the ADR and the Romanian Electronic Payments Association, allowing citizens to view and pay fees, taxes, fines, etc. online. 400 types of payments can be done using it, and so far, 1.8 million citizens and businesses used the platform. In the first 3 months of 2023, 75 public institutions have become started using the platform to receive payments, and 250.000 end users have registered, indicating an increasing success of the platform.	Online availability of digital public services for citizens and businesses
SE	Mina ombud - handling of digital powers of attorneys - Sweden has implemented a national infrastructure for a standardized and secure handling of digital powers of attorneys called Mina ombud. This provides for the option to give representation via powers of attorney, and in Sweden there are different juridical ways to represent via for example, roles of caregivers or trustees. Mina ombud gives the option of representation of juridical and natural persons by digital powers of attorney. The value-proposition here is that Mina ombud makes it possible for someone to	Online availability of digital public services for citizens and businesses, e-justice

Country	Short description of good practice	Target or indicator covered
	represent companies and natural persons in digital services. This includes a national webservice for digital powers of attorneys where you can manage via e.g., creating new powers (via signatories), show all parties on a power of attorney, as well as the option to revoke all parties on a power of attorney. Mina ombud also stores powers of attorneys, as well as offering services for third parties to administrate templates and permissions for powers of attorneys.	

Further good practises are collected in the Background report of eGovernment Benchmark study for 2023.²⁷⁸ Moreover, studies from 2022 investigated dynamics and practices of the emerging GovTech scene in the EU in the context of the current state of public procurement for innovation^{279, 280}. Here the term GovTech refers to the use of emerging technologies and digital products and services by government from start-ups and SMEs - instead of relying on large system integrators. The studies provide an overview of GovTech programmes at national level. They also share lessons learnt for setting up government-run GovTech programmes, which can be applied to all levels of government. The findings are now informing EU-wide initiatives, such as the GovTech Incubator²⁸¹ and GovTech Connect²⁸².

²⁷⁸ The study is published together with this report.

²⁷⁹ Kuziemski, M., Mergel, I., Ulrich, P. and Martinez, A., GovTech Practices in the EU, EUR 30985 EN, Publications Office of the European Union, Luxembourg, 2022, ISBN 978-92-76-47234-6, doi:10.2760/74735, JRC128247.

²⁸⁰ Mergel, I., Ulrich, P., Kuziemski, M. and Martinez, A., Scoping GovTech dynamics in the EU, EUR 30979 EN, Publications Office of the European Union, Luxembourg, 2022, ISBN 978-92-76-47059-5, doi:10.2760/700544, JRC128093.

²⁸¹ <https://joinup.ec.europa.eu/interoperable-europe/news/govtech-incubator-launched-2023-digital-government-summit>

²⁸² <https://joinup.ec.europa.eu/collection/govtechconnect/about>