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Mapping EU level funding instruments 2021-2027 to Digital Decade targets

2024 update

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Contents

Abstract

This technical report quantifies and analyses the parts of the EU's long-term budget which have the potential to impact the Digital Decade targets and general objectives. In doing so, we first map five key funding instruments — Recovery and Resilience Facility, Cohesion Policy, Horizon Europe, Digital Europe Programme and Connecting Europe Facility-Digital — onto each Digital Decade target. Results of this exercise indicate that, out of the EUR 957 billion planned in total across these funding instruments, EUR 177 billion could potentially impact the domains related to the Digital Decade targets and EUR 27 billion for its general objectives. The digitalisation of businesses and of public services are the main cardinal points of focus, receiving 64% of the total mapped budget with potential to impact Digital Decade targets. The online provision of key public services and the basic digitalisation of small and medium enterprises are the two targets that receive the largest allocations. We also find that the allocation by Digital Decade target is homogeneous across countries with a few, interesting exceptions. From our findings, we conclude that the fund distribution seems balanced, with the exception of some targets that receive little specific attention, like *edge nodes*, *electronic identification* or *quantum computing*.

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Executive summary

Policy context

The European Commission is committed to achieving a strong level of digitalisation by 2030 through the Digital Decade Policy Programme. The programme is specifically designed to promote the integration of digital technologies to enhance economic and social development by creating a favourable environment for innovation and investment in the European Union. The programme sets concrete targets and actions for the four key pillars (named cardinal points): *digital skills, digital infrastructures, digitalisation of businesses,* and *digitalisation of public services.*

In parallel, the EU's long-term budget 2021-2027 sets an unprecedented economic effort to achieve ambitious goals regarding the digital and green transition and social inclusion. The Recovery and Resilience Facility represents the biggest financial effort of the EU to date, including, for the first time, grants in addition to loans. Other funding sources, such as Cohesion Policy, Connecting Europe Facility-Digital, Horizon Europe or Digital Europe Programme allocate funds to digital skills and technological domains that are considered critical. In this context, this study aims to estimate how much investments from these EU funding instruments could potentially support the achievement of the Digital Decade (DD) targets. It also looks at identifying the targets that receive the largest funding and how the Member States are allocating these funds.

Key conclusions

This report quantifies and analyses the mapping of five key funding instruments (Recovery and Resilience Facility, Cohesion Policy, Horizon Europe, Digital Europe Programme and Connecting Europe Facility-Digital) to the Digital Decade targets and general objectives. Our results show that the funding instruments analysed provide large financial support (EUR 177 billion) to the achievement of the Digital Decade targets. The instruments allocate funding in a balanced way, but the targets of o*nline provision of key public services*, *adoption of technologies by businesses*, *basic digitalisation of SMEs*, and *innovative scale-ups (unicorns)* receive the highest amounts. On the other side, advanced technologies such as *quantum computing* or *edge nodes*, or the target of *electronic identification (e-ID)* receive much less funding. However, reaching the targets will depend not only on financial commitments, but also on the depth of the reforms and measures that accompany the investments, their capacity to produce long-run structural changes in Europe, the efforts of the private sector, and the ability to target the right sectors of the economy.

Main findings

We provide interesting insights on the volume and distribution of funds across targets and Member States:

— Of the total financing provided by the five instruments analysed (EUR 957 billion), it is estimated **a Digital Decade-relevant budget of EUR 205 billion**: **EUR 177 billion assist the achievement of the DD targets, and EUR 27 billion contribute to the general objectives of the Digital Decade**. This translates into 21% digital funding (intended as the proportion of total budget targeted to DD targets and objectives), ranging from 12% (Cohesion Policy) to 100% (Digital Europe Programme or Connecting Europe Facility–Digital).

— **The Recovery and Resilience Facility (RRF) is a crucial financial instrument to achieve the Digital Decade targets.** With an estimated EUR 136 billion, it is the largest contributor to the Digital Decade targets and represents 77% of the funds that could potentially impact the Digital Decade targets.

— **Funding instruments contribute mainly to the pillars of digitalisation of businesses and of public services.** Concretely, the *online provision of public services* (EUR 32 billion), the *uptake of digital technologies by businesses* (*cloud computing services, data analytics, artificial intelligence*) (EUR 25 billion), the *basic digitalisation of small and medium enterprises* (EUR 20 billion), and the funding of *innovative scale-ups (unicorns)* (EUR 19 billion) are the targets that receive the largest amounts of EU funding.

— **Despite its relevance for economic growth and sovereignty, *artificial intelligence* only receives an average amount of funds compared to the other targets** (EUR 9 billion). A large part of funding is allocated to the uptake of advanced technologies by firms (*cloud computing services, data analytics, artificial intelligence*), but no particular emphasis is placed on any of them individually.

— **Italy and Spain are the Member States that receive the largest RRF and Cohesion Policy funds in absolute terms. Italy** receives EUR 45 billion (EUR 768 per capita), while **Spain** receives EUR 44 billion that could potentially impact Digital Decade targets (and leads when considering the country's population, with EUR 906 per capita). Relative to population size, some Mediterranean, Balkan and Eastern Europe countries benefit the most from the funding instruments, for example **Greece** (EUR 8.5 billion, EUR 821 per capita), **Portugal** (EUR 6 billion, EUR 582 per capita), **Latvia** (EUR 747 million, EUR 397 per capita) or **Croatia** (EUR 1.4 billion, EUR 355 per capita). **Although the allocations by target are overall homogenous across Member States, there are interesting specialisation patterns in some countries**. **Spain** invests heavily via the EU funds in *semiconductors* (EUR 12 billion out of EUR 15 billion invested in the whole EU), especially in chip design; the **Netherlands** in *quantum computing* (EUR 264 million out of EUR 866 million for the whole EU) and **Italy** in digital skills, both *basic* and *ICT specialists* (EUR 7.5 billion out of EUR 25 billion for the whole EU).

Related and future JRC work

This report continues a series of JRC technical reports that support the monitoring of the Digital Decade Policy Programme. They include a line of work related to the projection and aggregation of trajectories, and another related to investments that assist the achievement of the Digital Decade targets and general objectives. Future work will involve the update of the mapping of EU funding instruments to Digital Decade targets including revisions and newly adopted work programmes.

Quick guide

Section 1 of the report provides an introduction.

Section 2 offers a description of the funding instruments analysed and a methodological note to support the interpretation of the results of the mapping exercise.

Section 3 presents the main results of the report, analysing how much each funding instrument contributes to the Digital Decade, how much budget is allocated to each cardinal point and target, how the funding is distributed across Member States and some specialisation patterns by country.

Section 4 provides some concluding remarks.

The annexes present additional information on data sources and the limitations of the mapping, an example of application of the methodology, and supplementary tables and figures.

The report is accompanied by the dataset of the mapped funding instruments and is available at the following link: https://data.jrc.ec.europa.eu/collection/id-00396

1 Introduction

The 2021-2027 multiannual financial framework (MFF) ([1]) represents the European Commission's most substantial financial commitment to date, targeting challenging objectives in the areas of digitalisation, climate change and social inclusion among others. The European Union's (EU's) long-term budget is equipped with more than EUR 1,800 billion to meet the EU's economic, social and environmental priorities. To highlight its commitment to achieving these goals, and amid the COVID-19 pandemic, the MFF exceptionally included the NextGenerationEU ([2]) recovery package, which provides up to EUR 750 billion in addition to the initially planned EUR 1,100 billion and, notably, includes non-reimbursable grants for the first time.

Within this framework, the digital transition has become one of the top political priorities of the European Commission ('A Europe fit for the digital age' is one of the six von der Leyen's priorities set for 2019-2024). Technological and digital sovereignty are key components of the European Economic Security Strategy (European Commission, 2023). The growing relevance of the data economy, potential dependencies in key technologies and the fragility of supply chains amid external shocks (Acemoglu and Tahbaz-Salezi, 2024) have prompted the EU to pursue a more autonomous position, where it can defend its interests, make its own choices and protect its economy while still cooperating with key partners (European Commission, 2021). Additionally, digitalisation has the potential to impact economies and societies in other ways as well. For example, recent evidence has highlighted its role in increasing productivity in companies that are lagging behind (Borowiecki et al., 2021), shaping demand and market response to shocks (Nagaraj and Reimers, 2023) and profoundly impacting labour markets (Chen et al., 2019; Acemoglu and Restrepo, 2022).

In this context, the Digital Decade Policy Programme 2030 ([3]) becomes the vision and governance framework guiding EU's digitalisation objectives. The programme establishes general objectives supported by a series of digital targets grouped around four thematic pillars, also named cardinal points (*digital skills, digital infrastructures, digitalisation of businesses* and *digitalisation of public services*), complemented by new cooperation mechanisms and a monitoring process to keep track of the progress and ensure the collective effort to achieve the targets at EU level. The MFF allocates funds to various programmes that directly support digital objectives. For example, the Recovery and Resilience Facility (RRF) funding requires Member States to allocate at least 20% of their national recovery and resilience plans to digital priorities. The Digital Europe Programme (DIGITAL) aims to drive the digital transformation by targeting investments in advanced technologies. Horizon Europe (HE) also focuses on digital technologies across its pillars. Understanding the extent and intensity of this monetary support to the Digital Decade (DD) is a policy-relevant exercise that can provide insights on how the present MFF may potentially influence the achievement of Digital Decade general objectives and targets and contribute to a successful digital transition.

This report aims to quantify and analyse the main digital EU-level public investments under the MFF 2021-2027 that are related to the different Digital Decade targets. Specifically, we ask how much budget from five key funding instruments under the long-term budget can potentially contribute to

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1 https://commission.europa.eu/strategy-and-policy/eu-budget/long-term-eu-budget/2021-2027_en

2 https://next-generation-eu.europa.eu/index_en

3 Decision (EU) 2022/2481 of the European Parliament and of the Council of 14 December 2022 establishing the Digital Decade Policy Programme 2030 (OJ L 323, 19.12.2022, pp. 426). https://eur-lex.europa.eu/eli/dec/2022/2481/oj

achieving the DD targets and how much is directed towards each of the specific targets. The five instruments analysed are: Recovery and Resilience Facility (RRF), Cohesion Policy (CP), Digital Europe Programme (DIGITAL), Horizon Europe (HE) and Connecting Europe Facility-Digital (CEF-Digital) ([4]). As a residual measure, we also quantify digital investments that are not related to any particular target, but rather to the general objectives of the Digital Decade Policy Programme, such as greater resilience to cyberattacks or achieving an inclusive, transparent and open digital environment. To this end, we collect and process detailed information on the instruments' work programmes (WP) and map each planned investment with a digital component to a Digital Decade target. The granularity of our data allows us to examine also the geographical allocation of planned DD investments and the specialisation pattern of each funding instrument and Member State. Finally, this work represents an update of the mapping methodology and dataset developed in Papazoglou et al. (2023).

Our analysis presents, in short, five main findings. First, out of EUR 957 billion budgeted in the five analysed instruments, we identify EUR 177 billion to have a potential impact on the DD targets, which represent almost 18% of total budget of the five funds and 10% of the total EU long-term budget for 2021-2027. An additional EUR 27 billion is estimated to fund the general DD objectives. Second, DD-targets relevant investments are directed mainly towards the digitalisation of businesses and public services, which jointly receive almost two thirds of the total DD-targets relevant budget. Third, we identify a specialisation pattern of funds: while RRF is the largest contributor to all DD related investments, CEF-Digital investments are focused on the connectivity targets, Cohesion Policy on digitalisation of businesses, and HE on investments in advanced technologies. Moreover, Germany and Ireland are the countries with the highest share of RRF funding allocated to DD relevant investments (around 40% and 35% of their respective national recovery and resilience plans). Finally, there are interesting national specialisation patterns across digital technologies: for example, Spain stands out with strong investments in semiconductors that account for 81% of the total in the EU.

The contribution of this report is twofold. First, we construct a unique dataset that maps the most relevant funds with a digital component from the MFF to a Digital Decade target at a very detailed level. This dataset can be of interest to both researchers and policymakers studying the digital transition and European funds. Second, we provide descriptive evidence on the extent and intensity of digital investments from the MFF 2021-2027, showing that a sizable amount of the budget is expected to contribute to achieving the Digital Decade targets, although with some national differences with respect to the volume of investments and the targets distribution. The impact of investments is not only driven by their absolute level, it is also influenced by several factors not studied in this paper. For example, reform depth, the capacity of investments to support long-term structural changes or the suitability of milestones to set the basis for sustainable growth are key factors that will determine the success or failure of the ambitious reforms planned by the EU. However, sizable investments are a necessary condition for achieving profound changes in the economic structure of Europe, and their quantification is the focus of this report.

The remainder of the report is organised as follows. Section 2 provides some background on the funding instruments analysed and presents a brief description of the methodology to map the investments to each DD target. Section 3 discusses the main results of the analysis. Section 4 outlines some concluding remarks and describes possible future steps.

[4] The Connecting Europe Facility instrument covers three sectors: energy, transport and digital. In this analysis we focus only on the digital sector.

2 Data and methodology

This section contains the basic information about the funding instruments that were considered in our study, as well as some details about the methodology followed.

2.1 Background on the funding instruments

The funding instruments included in this study are:

- Recovery and Resilience Facility (RRF) 2020-2026;
- Cohesion Policy (CP) 2021-2027;
- Horizon Europe (HE) 2021-2024;
- Digital Europe Programme (DIGITAL) 2021-2027;
- Connecting Europe Facility – Digital (CEF-Digital) 2021-2027.

For each of the funds we present a subsection with a short description of the instrument, the amount of budget involved and some details on the data sources used for the analysis. For the complete list of references to the official documents consulted, please refer to Annex 1. Table 1 summarises the five funding instruments considered and their specific components and associated budget.

Table 1. Total budget of the five funding instruments (*million EUR)* and their components

Funding Instrument and single components	Total budget	Budget by component
Total	**957,422**	
Recovery and Resilience Facility (RRF) 2020-2026	**651,670**	
Cohesion Policy (CP) 2021-2027	**260,896**	
Horizon Europe (HE) 2021-2024	**35,199**	
HE Main Work Programme		29,419
European Innovation Council (EIC) calls		2,070
Chips and Key Digital Technologies (KDT) Joint Undertakings		2,045
European High-Performance Computing (EuroHPC) Joint Undertaking		551
Innovative Health Initiative (IHI) Joint Undertaking		613
Smart Networks and Services (SNS) Joint Undertaking		501
Digital Europe Programme (DIGITAL) 2021-2027	**7,948**	
DIGITAL Main Work Programme		3,638
Cybersecurity		1,006
European Digital Innovation Hubs (EDIHs)		329
Chips Joint Undertaking		1,281
European High-Performance Computing (EuroHPC) Joint Undertaking		1,694
Connecting Europe Facility – Digital (CEF-Digital) 2021-2027	**1,709**	
CEF-Digital Main Work Programme		1,568
European High-Performance Computing (EuroHPC) Joint Undertaking		141

Note: The total budget in this table refers only to the parts of the funding instrument and reference periods considered in the mapping exercise. In particular, CP only includes the European Regional Development Fund (ERDF), the Cohesion Fund (CF), and the European Territorial Cooperation Fund (Interreg), while HE includes the main work programmes, four Joint Undertakings and the European Innovation Council (EIC) calls. This explains why the amounts displayed in the table do not match with the amounts included in subsections 2.1.2 and 2.1.3.

Source: JRC calculations

2.1.1 Recovery and Resilience Facility

The **Recovery and Resilience Facility ([5])** is the key instrument of NextGenerationEU ([6]), the economic recovery package of the European Union, which has been explicitly designed to support Member States impacted by the COVID-19 pandemic. The RRF consists of around EUR 650 billion ([7]) in loans and grants available to support reforms and investments undertaken by Member States. In response to the hardships and global energy market disruption caused by Russia's invasion of Ukraine, the European Commission has implemented its REPowerEU Plan ([8]), a new component of RRF, and the current mapping exercise addresses also this new instrument. The data come from Directorate-General for Economic and Financial Affairs (ECFIN) and cover RRF measures and milestones for the period 2020-2026.

2.1.2 Cohesion Policy

Cohesion Policy ([9]) is the EU's main investment policy aimed at reducing regional disparities and promoting economic and social cohesion among its Member States, and delivers on the Union's political priorities, especially the green and digital transition. EUR 392 billion – almost a third of the total EU budget – have been set aside for this funding instrument ([10]). In agreement with Directorate-General for Regional and Urban Policy (REGIO), only the following funds are included in the mapping and subsequent estimation: the European Regional Development Fund (ERDF), the Cohesion Fund (CF), and the European Territorial Cooperation Fund (Interreg), all of them totalling to EUR 261 billion. The remaining funds from CP are not included into the analysis. The data come from the Cohesion Open data platform ([11]) and cover the period 2021-2027.

2.1.3 Horizon Europe

Horizon Europe (HE) ([12]) is the European Union's key funding programme for research and innovation with a budget of EUR 95.5 billion for the period 2021-2027. It aims to tackle policy priorities, including green and digital transitions, helping to achieve the United Nation's Sustainable Development Goals and boosting the EU's competitiveness and growth. The study considers the HE main work programme, four Joint Undertakings (see Box 1 in this subsection for more details) and the European Innovation Council (EIC) calls. HE formally includes the European Research Council (ERC) calls as well as the

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5 https://ec.europa.eu/info/business-economy-euro/recovery-coronavirus/recovery-and-resilience-facility_en

6 https://europa.eu/next-generation-eu/index_en

7 This figure is at 2022 prices and refers to the total amount requested by Member States in their national plans.

8 https://commission.europa.eu/strategy-and-policy/priorities-2019-2024/european-green-deal/repowereu-affordable-secure-and-sustainable-energy-europe_en

9 https://ec.europa.eu/regional_policy/2021-2027_en#:~:text=EU%20Cohesion%20Policy%20contributes%20to,the%20green%20and%20digital%20transition

10 https://ec.europa.eu/regional_policy/policy/what/investment-policy_en

11 https://cohesiondata.ec.europa.eu/2021-2027-Finances/2021-2027-EU-cohesion-policy-JTF-budget-initial-al/v7xe-nn2c/about_data

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

European Institute of Innovation and Technology (EIT) calls, which provide funding for excellent frontier research, but that are not included in our study due to data availability.

For Horizon Europe the available data are planned budget allocations for the period 2021-2024: HE 2021-2022 and HE 2023-2024 main work programmes. Data are provided by Directorate-General for Communications Networks, Content and Technology (CNECT) (WP 2021-22) and Directorate-General for Research and Innovation (RTD) (WP 2023-24).

Box 1. Deep dive on Joint Undertakings (JUs)

Joint Undertakings (JUs) are public-private partnerships that bring together industry, academia, and other stakeholders that address specific research and innovation challenges. By fostering collaboration between different stakeholders, JUs aim to maximise the impact of research and innovation and ensure that new discoveries are translated into real-world solutions ([13]). They are formally included under the umbrella of Horizon Europe ([14]) but they may be financed by different instruments. Our exercise maps the following four JUs:

- **Chips Joint Undertaking** (**Chips**) ([15]) JU, whose work programme is composed by a Non-Initiative part (former Key Digital Technologies (KDT) JU) and by an Initiative part, jointly covering years 2021-2027. The aim of this JU is to reinforce the European semiconductor ecosystem and Europe's technological leadership ([16]);
- **European High-Performance Computing** (**EuroHPC**) ([17]) JU, for years 2022-2027, that allows the European Union and the EuroHPC JU participating countries to coordinate their efforts and pool their resources to make Europe a world leader in supercomputing ([18]);
- **Smart Networks and Services** (**SNS**) ([19]) JU, for the period 2022-2024, that aims to facilitate and develop industrial leadership in Europe in 5G and 6G networks and services;
- **Innovative Health Initiative** (**IHI**) ([20]) JU, for years 2022-2024, that aims to translate health research and innovation into tangible benefits for patients and society, and to ensure that Europe remains at the cutting edge of interdisciplinary, sustainable, patient-centric health research.

For all JUs, data are taken from their respective work programmes. Only SNS and IHI JUs are totally implemented through the HE budget, while Chips is implemented through DIGITAL and HE, and EuroHPC is implemented through DIGITAL, HE and CEF-Digital.

13 https://research-and-innovation.ec.europa.eu/funding/funding-opportunities/funding-programmes-and-open-calls/horizon-europe/european-partnerships-horizon-europe_en

14 Council Regulations (EU) 2021/2085 and (EU) 2023/1782 establishing the Joint Undertakings under Horizon Europe

15 https://www.chips-ju.europa.eu/

16 Only for the part of the JU financed by DIGITAL the data includes years 2025 to 2027 (taken from the strategic orientations for Digital Europe Programme). For HE the budget of the JU limits to years 2021 to 2024.

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

18 Only for the part of the JU financed by DIGITAL the data includes years 2025 to 2027 (taken from the strategic orientations for Digital Europe Programme). For CEF-Digital and HE the budget of the JU limits to years 2022 to 2024.

19 https://smart-networks.europa.eu/

20 https://www.ihi.europa.eu/

For the mapping exercise, we consider under HE both **Joint Undertakings** (JUs) IHI and SNS in their total amount (as they are implemented only through HE), while for Chips and EuroHPC we consider under the current funding instrument only the part of those JUs financed by it. For the complete list of data sources for the JUs, please refer to Annex 1.

The **European Innovation Council** (EIC) ([21]), with a budget of EUR 10.1 billion (for years 2021-2027), supports different stages of innovation from early-stage research to proof of concept, technology transfer, and the financing and scale up of start-ups and small and medium-sized enterprises (SMEs). The data cover years 2021 and 2022 and have been provided by the European Innovation Council and SMEs Executive Agency (EISMEA).

2.1.4 Digital Europe Programme

Digital Europe Programme ([22]) is a key European Union funding programme focused on bringing digital technologies to EU businesses, citizens, and public administrations. DIGITAL provides funding to support projects in five areas, namely: (i) supercomputing, (ii) artificial intelligence, (iii) cybersecurity, (iv) advanced digital skills, and (v) ensuring wide use of digital technologies across the economy and society. DIGITAL is implemented through different work programmes: the main one, the cybersecurity one and the one dedicated to European Digital Innovation Hubs (EDIHs), plus two work programmes managed by the Chips JU and the EuroHPC JU (see Box 1 in subsection 2.1.3 for more information). These JUs are not fully implemented through DIGITAL budget, as Chips is implemented through DIGITAL and HE, while EuroHPC is implemented through DIGITAL, HE and CEF-Digital. Therefore, we consider under DIGITAL only the part of those JUs financed by it.

The planned overall budget of DIGITAL is EUR 8.1 billion. The available data cover the 2021-2027 period. For the complete list of data sources for DIGITAL, please refer to Annex 1.

2.1.5 Connecting Europe Facility – Digital

The **Connecting Europe Facility** is a financial instrument aiming to promote growth, jobs and competitiveness at European level targeting three pillars: Transport, Energy and Digital ([23]). The part of the funding instrument dedicated to this last pillar (CEF-Digital ([24])) allocates EUR 1.6 billion in European connectivity infrastructures. CEF-Digital includes also a small amount of budget implemented through the EuroHPC Joint Undertaking (see the Box 1 in subsection 2.1.3 for more info on JUs). The available data cover years from 2021 to 2027; for the complete list of data sources for CEF Digital, please refer to Annex 1.

2.2 Methodological approach

To estimate the contributions of different funding instruments to DD targets we follow the same approach that was implemented through the 2023 mapping exercise and explained in the related report (Papazoglou et al., 2023). This section touches upon the main features of this approach, while

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21 https://eic.ec.europa.eu/index_en

22 https://digital-strategy.ec.europa.eu/en/activities/digital-programme

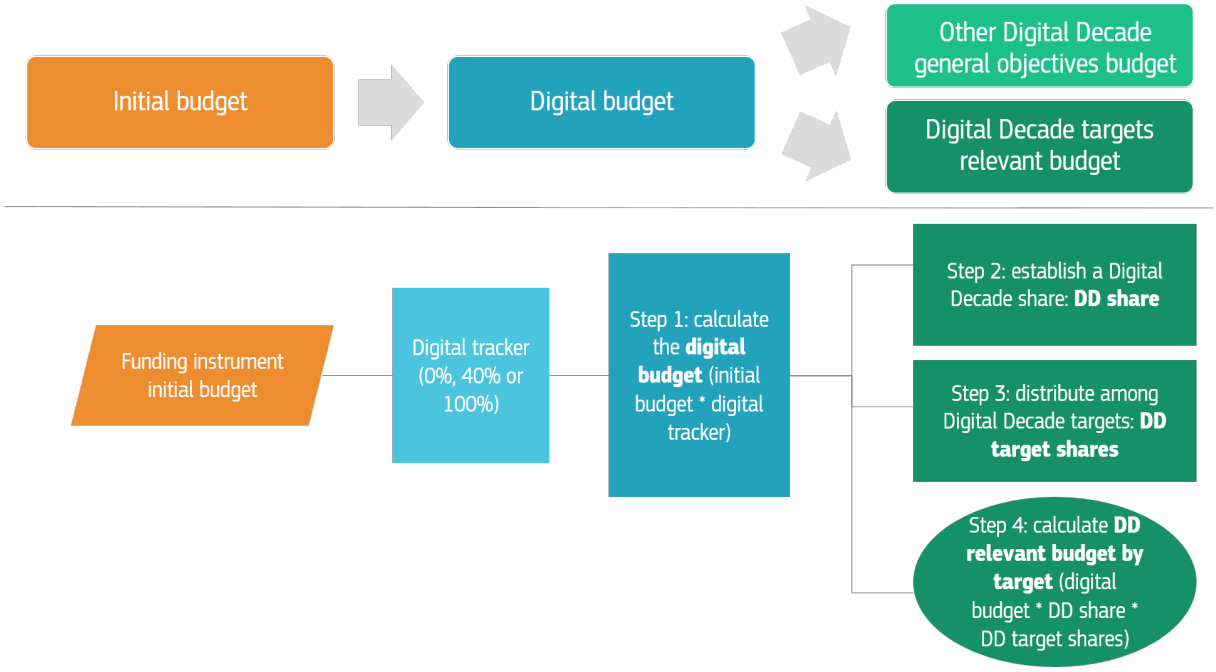
23 https://cinea.ec.europa.eu/programmes/connecting-europe-facility_en

24 https://digital-strategy.ec.europa.eu/en/activities/cef-digital

a practical example as well as some caveats of the methodology are available in Annex 1; to have all the methodological details of the study, please refer to the 2023 mapping report.

The starting point is the **initial budget** of each funding instrument, from which we first identify the **digital budget** and then split it into the **Digital Decade-targets relevant budget** and the budget related to **Digital Decade general objectives**. The DD-targets relevant budget is then broken down into single DD targets. The whole process is summarised in Figure 1.

Figure 1. Flowchart of the methodology to map the funds to Digital Decade targets



Source: Authors' elaboration

The **initial budget** is taken from the individual funding instruments data sources listed under subsection 2.1, and it relates to planned investments. For each fund, we scan the related work programmes and identify the planned amount of budget for each thematic objective, intervention field, call or specific objective (that we will call as 'category' from now on for simplicity).

Each funding instrument comes with a **digital tracker** (sometimes called **digital tag**), a coefficient that quantifies the digital intensity of each category. It may take percentages of 0% (in case the category does not relate to digital), 40% (in case it only partially contains a digital component) or 100% (in case the category is fully related to digital) ([25]). For some funding instruments the digital tracker is constant throughout the whole fund (for example, Digital Europe Programme and Connecting Europe Facility – Digital have a digital tracker set to 100% for all categories, while for the

[25] Expenditure tracking is performed to estimate the financing of horizontal priorities in the EU budget such as climate, biodiversity, gender equality, sustainable development goals and digital transition. In the case of RRF, Annex VII to the regulation (Regulation (EU) 2021/241 of the European Parliament and of the Council of 12 February 2021 establishing the Recovery and Resilience Facility) provides a list of intervention fields, each with its associated EU digital coefficient. According to the Digital tracking stocktaking exercise performed by Directorate-General for Budget (BUDG), the list of RRF's intervention fields "is derived from the list in the common provisions regulation and, to date, 11 EU spending programmes are already able to track their digital-relevant expenditure based on this methodology".

Innovative Health Initiative is set to 40%), while for other funds it has been defined by domain experts in different European Commission DGs at a higher level of granularity (e.g., intervention field). The **digital budget** is then obtained by multiplying the initial budget by the corresponding digital tracker (*Step 1*).

Step 2 consists of the estimation of the amount of budgetary provisions that may have a direct impact on the Digital Decade targets. To do so, it is necessary to examine available information on each category of the funding instruments and to assign a coefficient that we call Digital Decade share (**DD share**). Like for the digital tracker, DD share is assigned manually to take values of 0% (in case the category does not contribute at all to any DD target), 40% (when it contributes partially or indirectly to at least one DD target) or 100% (in case the content is strongly related to at least one DD target) ([26]). By multiplying the identified DD share by the digital budget computed in *Step 1*, we obtain the Digital Decade targets related budget (**DD-targets relevant budget**), that represents the amount of budget from that specific funding instrument that contributes to DD targets.

Once we get the DD-targets relevant budget, the next step (*Step 3*) is the distribution of this budget among the DD targets; this is made possible through the manual attribution of shares to the individual DD targets (**DD target shares**). The coefficients may go from 0% (in case there is no direct or clear link with the DD target) to 100% (when the DD relevant budget of that specific category shows a direct and full correspondence with that DD target). The sum of the shares to the individual DD targets for a specific category must sum up to 100% (in order to avoid double counting of budget).

The Digital Decade Policy Programme proposes 12 targets to be achieved by 2030 (some of them including sub-targets, as defined in Article 4 of the policy programme): two for digital skills, four for digital infrastructures, three for digitalisation of businesses and three for digitalisation of public services. As some sub-targets receive specific funding in some of the funds, we consider them as individual targets in this study. Specifically, the target *connectivity* is split into *5G coverage* and *gigabit network coverage*, while the target *uptake of digital technologies by businesses* is split into *cloud computing services*, *data analytics* and *artificial intelligence*. The mapping is therefore performed for 15 targets.

The allocation of the shares contributing to DD targets and across them is based on a qualitative assessment, and as such, it has a degree of subjectivity. To compensate for this subjectivity and to ensure the accuracy and relevance of the analysis, *Steps 2* and *3* are closely followed, validated and corrected (if needed) by experts from different policy DGs of the European Commission that manage the funding instruments and have deep knowledge on how each of them contributes to the DD targets.

Finally, through *Step 4* we translate the shares to the individual DD targets into **DD relevant budget by target**, by simply multiplying the DD-targets relevant budget (from *Step 2*) by the DD target shares (from *Step 3*). The amount of digital budget that is not attributed to any of the DD targets (obtained as the difference between digital budget and DD-targets relevant budget) is meant to contribute to the **DD general objectives**. We propose an example of the full process in Annex 1 to illustrate how the methodology works in practice.

[26] The use of a DD share resembles the digital tracker used to identify how much funding is contributing to the digital objective, but defined in a more narrow way as it is meant to identify the funding of Digital Decade targets. The choice of 0%, 40% and 100% is made to align with the digital tagging methodology.

3 Main results

This section presents the results of the study, starting from a broader view of the initial budget of the funding instruments and the share of it devoted to digital measures, and it then deeps dive into how each fund contributes to the four Digital Decade cardinal points and to the specific DD targets. The section ends with a focus on Member States, but limited to the Recovery and Resilience Facility and Cohesion Policy funds, as they are the only funds for which data are available at country level. Supplementary tables on the funding instruments and on how they contribute to DD targets are available in Annex 2, and a dataset published by the authors is available from the JRC Data Catalogue ([27]).

3.1 From initial budget to Digital Decade relevant budget

As noted in subsection 2.2, our analysis starts from the initial budget allocated to each of the selected funding instruments, which is first narrowed down to the digital budget, and ultimately to the final budget relevant to support the Digital Decade targets (highlighting at the same time also the DD general objectives budget, obtained as a residual measure).

Before showing in detail how the funding instruments contribute to the DD targets, we provide an overview of the total, digital and DD-relevant budgets. Table 2 highlights how the initial EUR 957 million of the five funds become a digital budget of EUR 205 million (21% of the initial one), to arrive at a DD-targets relevant budget of nearly EUR 177 billion, representing 87% of the digital budget. The DD general objectives budget refers to the digital budget that can potentially impact Digital Decade general objectives and is calculated as the difference between the digital budget and the DD-targets relevant one.

Table 2. Initial, digital and DD-targets relevant budget (*million EUR*) by funding instrument

Fund	Total funding (€ million)	Digital funding					
		Total Digital funding (€ million)	% over Total funding	Funding Digital Decade general objectives		Funding Digital Decade targets	
				(€ million)	% over Total funding	(€ million)	% over Total funding
Total	**957,422**	**204,583**	**21%**	**27,488**	**3%**	**177,096**	**18%**
Recovery and Resilience Facility (RRF)	651,670	150,037	23%	14,129	2%	135,909	21%
Cohesion Policy (CP)	260,896	31,063	12%	4,392	2%	26,672	10%
Digital Europe Programme (DIGITAL)	7,948	7,948	100%	1,275	16%	6,673	84%
Horizon Europe (HE)	35,199	13,826	39%	7,320	21%	6,506	18%
Connecting Europe Facility - Digital (CEF-Digital)	1,709	1,709	100%	373	22%	1,336	78%

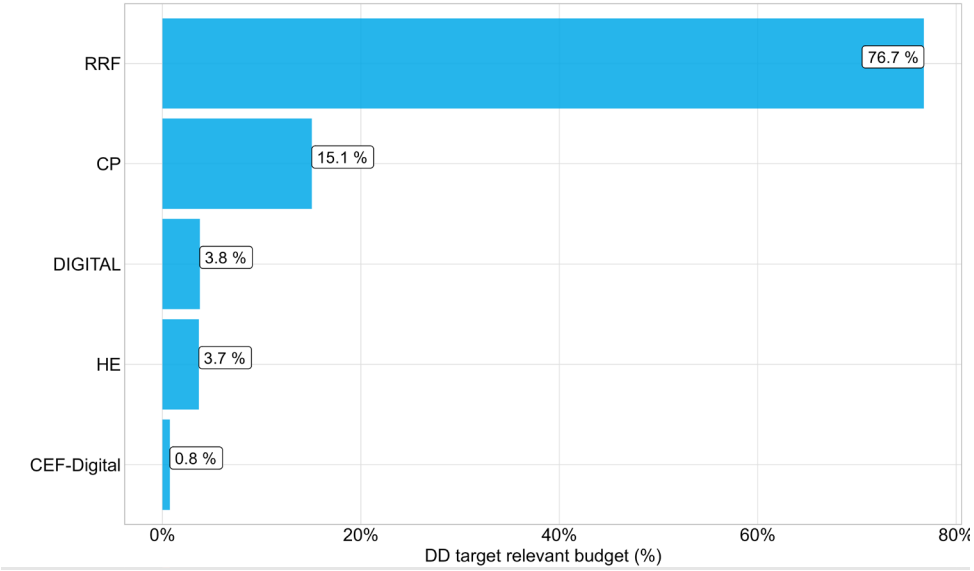
Source: JRC calculations

[27] https://data.jrc.ec.europa.eu/collection/id-00396

In terms of budget, a total of around EUR 177 billion has a potential impact on Digital Decade targets. This represents about 18% of the total budget with differences across funding instruments. While the more horizontal funds like RRF, CP and HE allocate, respectively, a 21%, 10% and 18% share of funds with potential impact on the achievement of the Digital Decade targets, DIGITAL and CEF-Digital are much more specialised and around 80% of their budget has potential to impact the DD targets.

Figure 2 shows how the different funding instruments contribute to the DD-targets relevant budget. The Recovery and Resilience Facility is the largest contributor with close to 77% of the total DD-targets relevant budget, followed by Cohesion Policy that contributes with EUR 27 billion (15%). The rest of funds have a much smaller contribution in absolute terms. The Digital Europe Programme represents 3.7% of the total budget, Horizon Europe 3.6%, and the digital part of the Connecting Europe Facility represents 0.8% of the total. These smaller funds contribute less in proportion to the Digital Decade (with a total of almost EUR 15 billion) but they are expected to have an impact on some specific DD targets on which the funding instruments are focused (for example, the Chips JU presents a significant contribution to the *semiconductors* DD target).

Figure 2. DD-targets relevant budget (share of total DD-targets relevant budget) by funding instrument



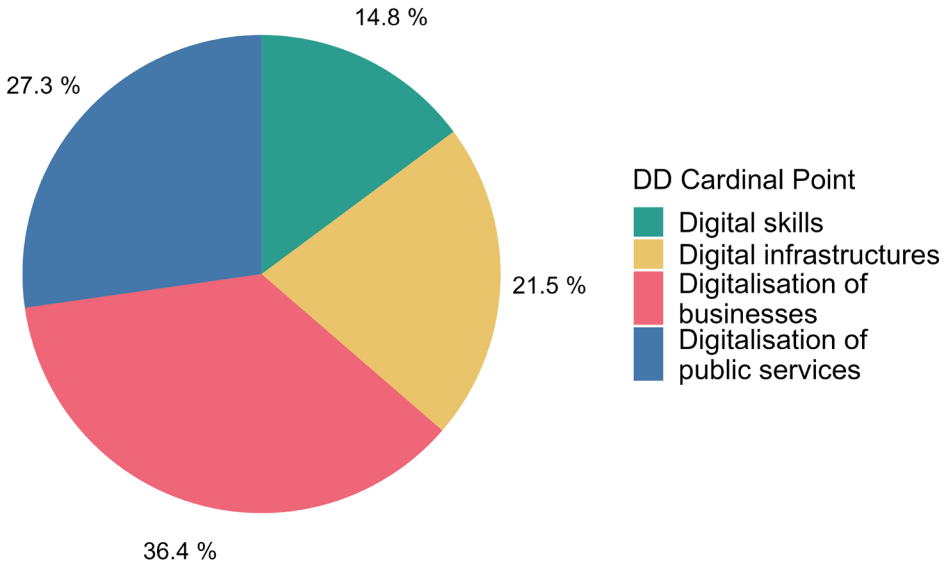
Source: JRC calculations

3.2 The contribution to Digital Decade cardinal points

The Digital Decade establishes a series of targets to achieve by 2030, which are grouped around four cardinal points: *digital skills,* which encompasses the acquisition of basic digital skills by 80% of the population and having 20 million ICT specialists in employment; *digital infrastructures*, that sets a 100% coverage of gigabit and 5G networks, the deployment of 10,000 edge nodes, building the first quantum computer and Europe's 20% of the semiconductor global market share by value; *digitalisation of businesses*, that includes the 75% uptake by firms of either cloud computing technologies, data analytics (named big data until 2022) or artificial intelligence (AI) , the basic digitalisation of SMEs, and doubling the number of innovative scale-ups (unicorns); and the *digitalisation of public services*, which encompasses the online provision of key public services, and that 100% of citizens have access to electronic identification and to electronic health records.

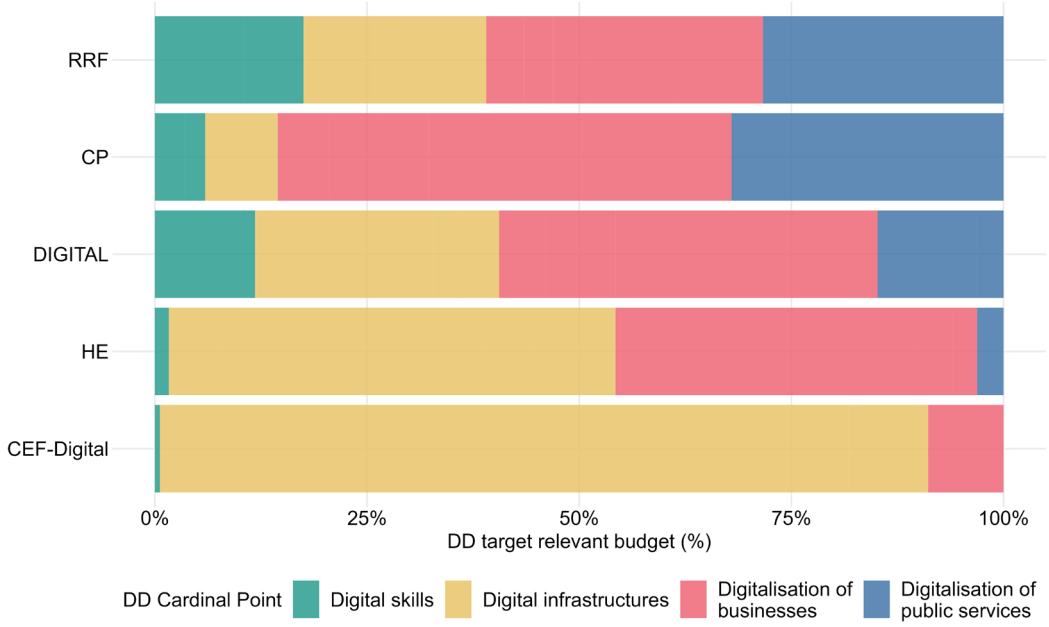
Figure 3 shows the distribution of funds across the four cardinal points. *Digital skills* receive around 15% of the funds for the two targets encompassed by the cardinal point. *Digital infrastructures* receive almost 22% of the funds and constitute the second cardinal point with less funding. The *digitalisation of businesses* is the cardinal point that receives the most funding, accounting for around 36% of the total. Finally, the *digitalisation of public services* receives 27% of the total and is one of the main focusses of the funding instruments analysed.

Figure 3. DD-targets relevant budget (%) by DD cardinal point



Source: JRC calculations

Figure 4. DD-targets relevant budget (%) by funding instrument and DD cardinal point



Source: JRC calculations

As noted, not all funding instruments have the same thematic objectives. As seen in Figure 4, RRF funding is distributed homogeneously across the four cardinal points, hinting that Member States

have taken advantage of the large funding available to tackle several areas. Cohesion Policy, however, has a strong focus on the *digitalisation of businesses* and of *public services*, being the fund that mostly contributes in percentage to this latter cardinal point. DIGITAL has a stronger focus on *digital infrastructures* and the *digitalisation of businesses*. Horizon Europe and CEF-Digital are the most specialised funding instruments: 95% of Horizon Europe funding is mapped on *digital infrastructure*s and the *digitalisation of businesses*, while more than 90% of CEF-Digital is focused on *digital infrastructures*, particularly 5G and gigabit.

3.3 From cardinal points to Digital Decade targets

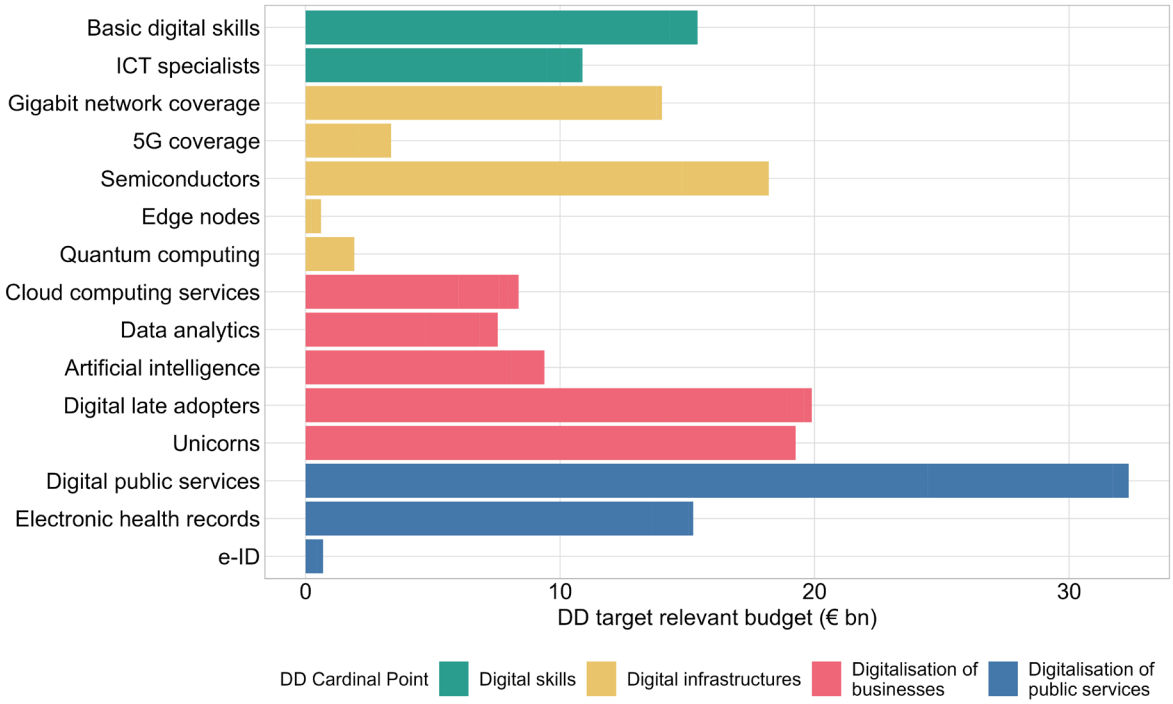
The results by cardinal point can be disaggregated at DD target level. As noted in subsection 2.2, in this study we present the mapping of funding instruments to 15 DD targets, including two sub-targets for connectivity and three for uptake of digital technologies. It should be noted that, given the large size of RRF with respect to the rest of funds, and that it is the largest contributor to all targets except for edge nodes (see Figure A.2 and Figure A.3 in Annex 3), the overall allocation of budget across targets closely resembles that of RRF.

The *online provision of key public services* is allocated more than EUR 30 billion of budget, representing 18% of the total DD-target spending (Figure 5). This may reflect the fact that public services are mostly financed by the public sector, with a minor role played by private entities. This target is followed by the *uptake of digital technologies by businesses* (*cloud computing services, data analytics, artificial intelligence*), that collectively accounts for EUR 25 billion. *Digital late adopters* and *unicorns* are the third and fourth targets that receive the most funding, with a bit less than EUR 20 billion each. This highlights the emphasis put on businesses, including small and medium enterprises and start-ups, in funding allocations. The fifth target that receives a relatively large allocation is *semiconductors*. As we will see later in more detail, this amount is single-handedly led by the Spanish PERTE Chips plan, which accounts for 70% of the total budget mapped into *semiconductors*. In an industry with sizable entry costs, large investments are necessary to succeed and this is an industry that would benefit from coordinated economic efforts at the EU level. The Chips Joint Undertaking and IPCEI Microelectronics are expected to contribute to this but, with a combined EUR 4 billion of budget, the allocation may be too low, especially compared to state aid from the US Chips Act and Chinese Government.

Quantum computing, an advanced technology deemed critical for EU's economic security (European Commission, 2023), is among the targets that receive the lowest amount of EU budget according to our data, together with *edge nodes* and *e-ID*. This result can be explained by the fact that RRF does not contain any intervention field targeting directly *edge nodes*. It is expected to indirectly benefit from funding in complementary areas from RRF (e.g., cloud computing), and directly from specific investments covered by other funding instruments (like Horizon Europe's Main Work Programme or the Key Digital Technologies Joint Undertaking), together with IPCEI Next Generation Cloud Infrastructure and Services (IPCEI-CIS)). In the case of q*uantum computing*, similarly RRF does not include an intervention field focused on quantum, but we identify a few RRF measures targeting this

technology ([28]). *Artificial intelligence* (considered on its own) occupies a middle position even though the EU also considers it a key enabling technology crucial for economic security (European Commission, 2023). Although achieving a 75% adoption rate in any of the advanced technologies (*cloud computing services*, *data analytics, AI*) constitutes a single DD target, the economic and technological impact of AI is expected to be greater than that of the other technologies, even though they are all intertwined. The similar investments estimated by our mapping into each of the three uptake indicators can be also explained by the methodological choices, where we make an equal split across the three sub-targets in cases where the available information does not allow us to match funding allocations individually to each of the three technologies. The large funding allocated to *innovative scale-ups* (*unicorns*) can be explained similarly, as we split the budget of programmes related to the digitalisation of firms in the absence of further details equally across all the targets of the cardinal point: *uptake of technologies*, *digital late adopters* and *unicorns*.

Figure 5. DD-targets relevant budget (*billion EUR*) by DD target



Source: JRC calculations

[28] The mapping of RRF is performed at intervention field level, with the exception of two intervention fields for which we do the mapping for each national measured declared under. These are "2 - 009bis - Investment in digital-related R&I activities (including excellence research centres, industrial research, experimental development, feasibility studies, acquisition of fixed or intangible assets for digital related R&I activities)" and "6 - 021quater - Investment in advanced technologies such as: High-Performance Computing and Quantum computing capacities/Quantum communication capacities (including quantum encryption); in microelectronics design, production and system-integration; next generation of European data, cloud and edge capacities (infrastructures, platforms and services); virtual and augmented reality, DeepTech and other digital advanced technologies. Investment in securing the digital supply chain.", for which we have identified some national measures targeting *quantum computing*.

Simultaneously looking at the funding distribution across targets with the progress towards the targets reported in Annex 2 of the State of the Digital Decade 2024 communication ([29]) can give a general idea of how these EU funding instruments might contribute to achieve the targets. It goes without saying that, without an adequate impact evaluation exercise, it is not possible to assess whether these amounts are sufficient or not. However, this exercise can help to understand how aligned the budget allocation and the evolution of the trajectories towards the targets are. In general, we detect some misalignments, where relatively large amounts of funds are directed towards areas which are close to meeting targets by 2030, and few resources channelled towards other targets that need important reforms and resources to be met. For example, *online provision of key public services* receives the largest amount of funding while this target is already on good track to reach 100% by 2030. The businesses uptake of any of the three advanced technologies (*cloud computing services, data analytics, AI*) is expected to be close to 75% by 2030 according to the updated baseline trajectory ([30]), although it presents adoption disparities by technology type, and receives an average amount of funds. Other targets, such as *basic digital skills*, *gigabit*, or *digital late adopters*, receive an amount of budget that is more closely aligned with their projected trajectories.

3.4 Analysis by Member States

As a final step in our analysis, it is worth drawing attention to how the funding instruments are allocated across and within Member States. This is only possible for two out of the five funds, as RRF and CP are the only ones for which there is data at country level. Nevertheless, given that they represent 92% of the DD-target related funding analysed, results are sufficient to paint an overall representative picture of funding patterns across countries.

Figure 6 gives an overview of how the DD-targets relevant budget is distributed among Member States in absolute values (Panel A) as well as in relation to the country's population (Panel B). **Italy** is the country that receives the largest budget for DD-targets relevant spending in absolute terms, followed by **Spain**, **Germany** and **Poland** Panel A). The map that displays the Member States' RRF and CP budget per capita (Panel B) highlights how **Spain, Greece, Italy** and **Portugal** devoted high amounts of budget to DD targets in terms relative to their population. In general, the plot shows that **Mediterranean, Balkan** and **Eastern Europe** countries allocate higher amounts per capita of RRF and CP funds with potential to impact DD targets, compared to other Member States.

This distribution is consistent with the rules of RRF funding distribution to Member States, which follow the established budgetary criteria of the EU —currently based on (i) population, (ii) the inverse of gross domestic product (GDP) per capita, and (iii) the average unemployment rate over the past 5 years (2015-2019)— plus the observed loss in real GDP over year 2020 (for 50% of the funds) and the observed cumulative loss in real GDP over the period 2020-2021 (for the remaining 50%) ([31, 32]).

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29 Communication from the Commission to the European Parliament, the Council and the European Economic and Social Committee and the Committee of the Regions: State of the Digital Decade 2024. Annex 2: Update of the Union-level projected trajectories for the digital targets.

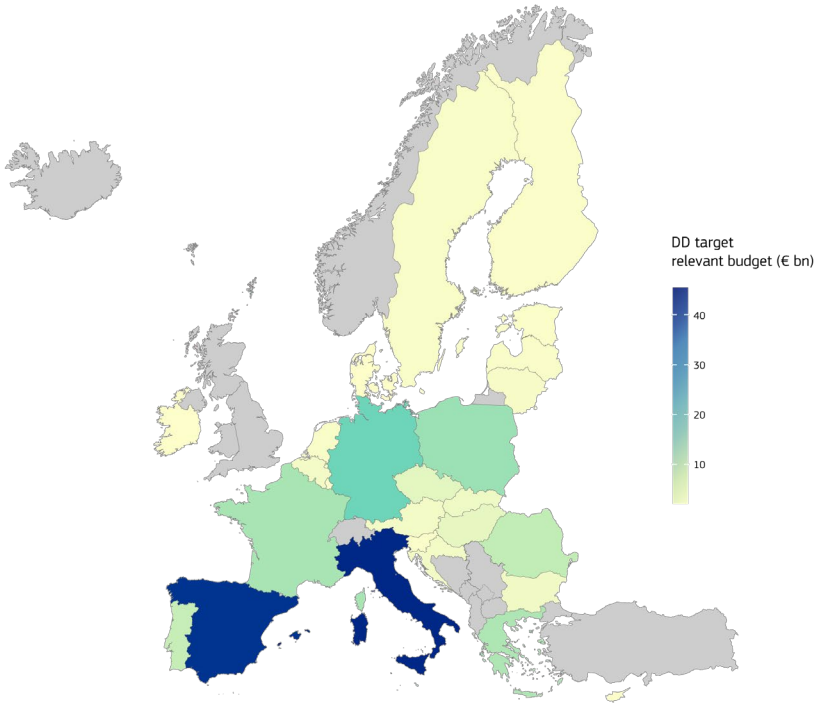
30 "The forecast 2030 value along the 'business as usual' trajectory is 72.3%, not far from the 75% EU target" (Annex 2 of the State of the Digital Decade 2024 communication).

31 https://ec.europa.eu/commission/presscorner/detail/en/qanda_21_481

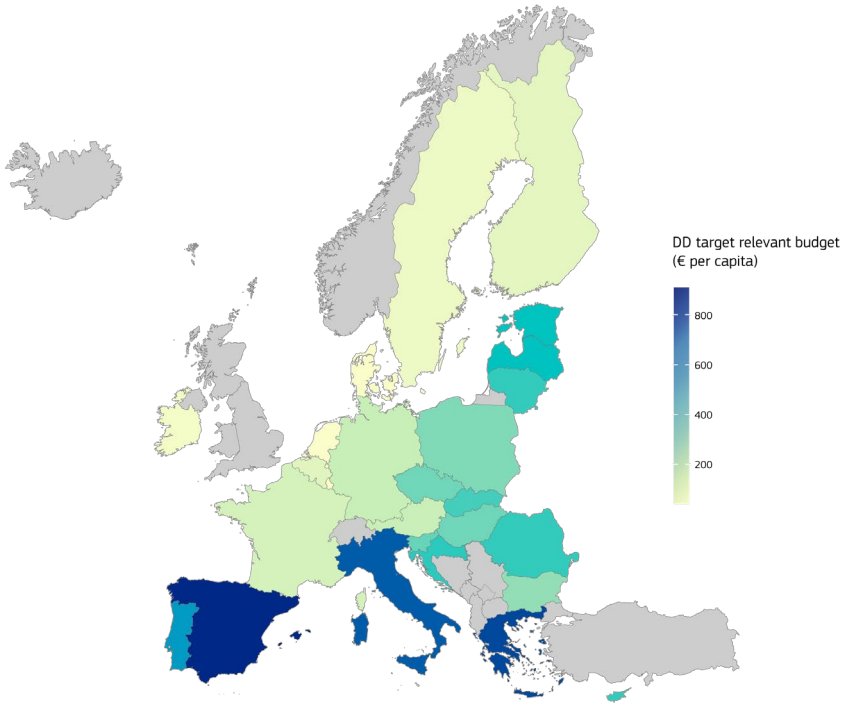
32 https://commission.europa.eu/system/files/2023-05/2022%2006%2030%20update%20maximum%20financial%20contribution%20RRF%20grants.pdf

Figure 6. RRF and CP DD-targets relevant budget

Panel A. Budget by Member State (*billion EUR*)



Panel B. Budget by Member State (*EUR per capita*)

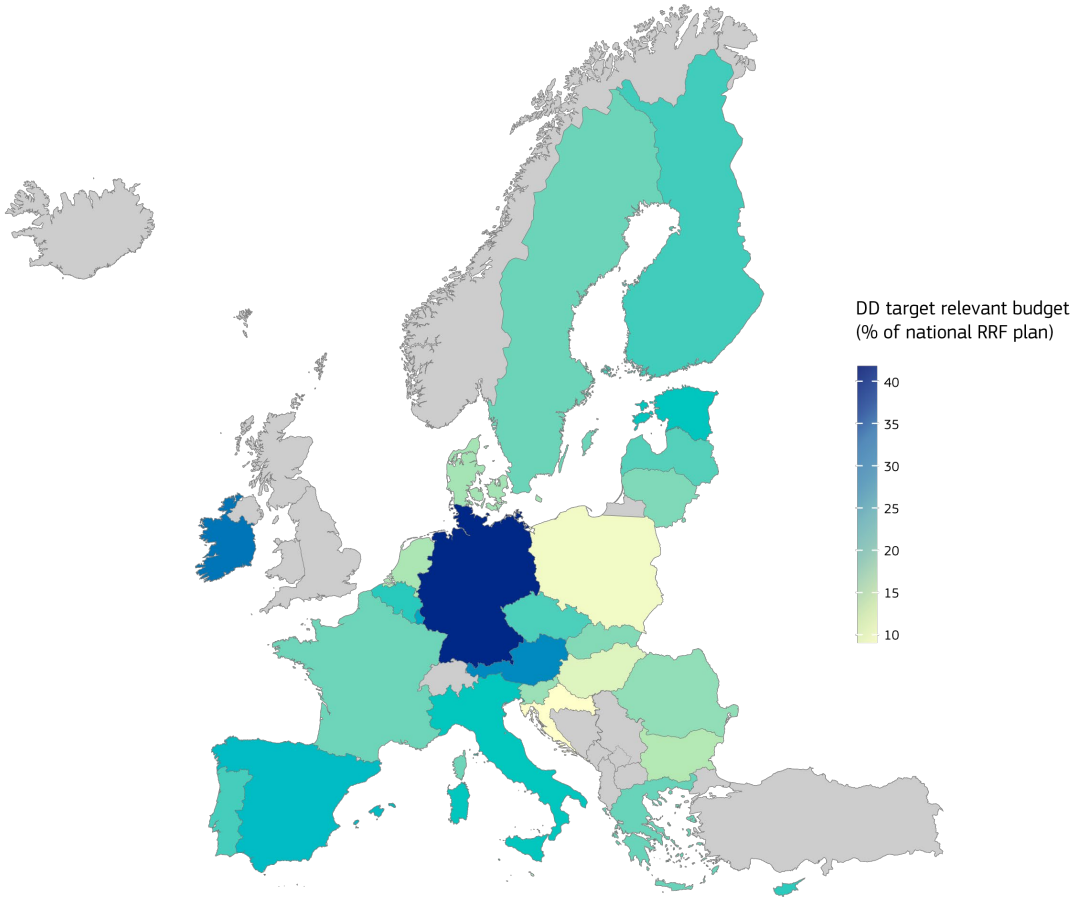


Source: Eurostat (Population, 1st January 2023) and JRC calculations.
Administrative boundaries: © EuroGeographics. Cartography data downloaded using giscoR

The designations employed and the presentation of material on the map do not imply the expression of any opinion whatsoever on the part of the European Union concerning the legal status of any country, territory or area or of its authorities, or concerning the delimitation of its frontiers or boundaries. Kosovo - This designation is without prejudice to positions on status, and is in line with UNSCR 1244/1999 and the ICJ Opinion on the Kosovo declaration of independence.*

Focusing on RRF only, Figure 7 shows another perspective of the allocation of the fund. If we consider the allocation of budget to DD targets compared to the total RRF allocation, **Germany** appears to be the Member State that is putting the strongest effort into DD targets (over 40% of total national RRF plan). Other countries that devoted high amounts of RRF into DD targets are **Ireland** (34%) and **Austria** (32%).

Figure 7. Share of RRF DD-targets relevant budget over total RRF budget by Member State



Note: Although one of the pre-requisites of the RRF was to devote at least 20% of the budget to digital objectives, we recall that here we estimate the amounts supporting the Digital Decade targets (a narrower concept). Most of the measures with a digital tagging are expected to directly contribute to Digital Decade targets and the remaining part (e.g., related to transport or smart energy) is also expected to support the Digital Decade general objectives, although not considered in these calculations. Consequently, the share of the measures considered to be directly relevant for the DD targets may lie below 20%.

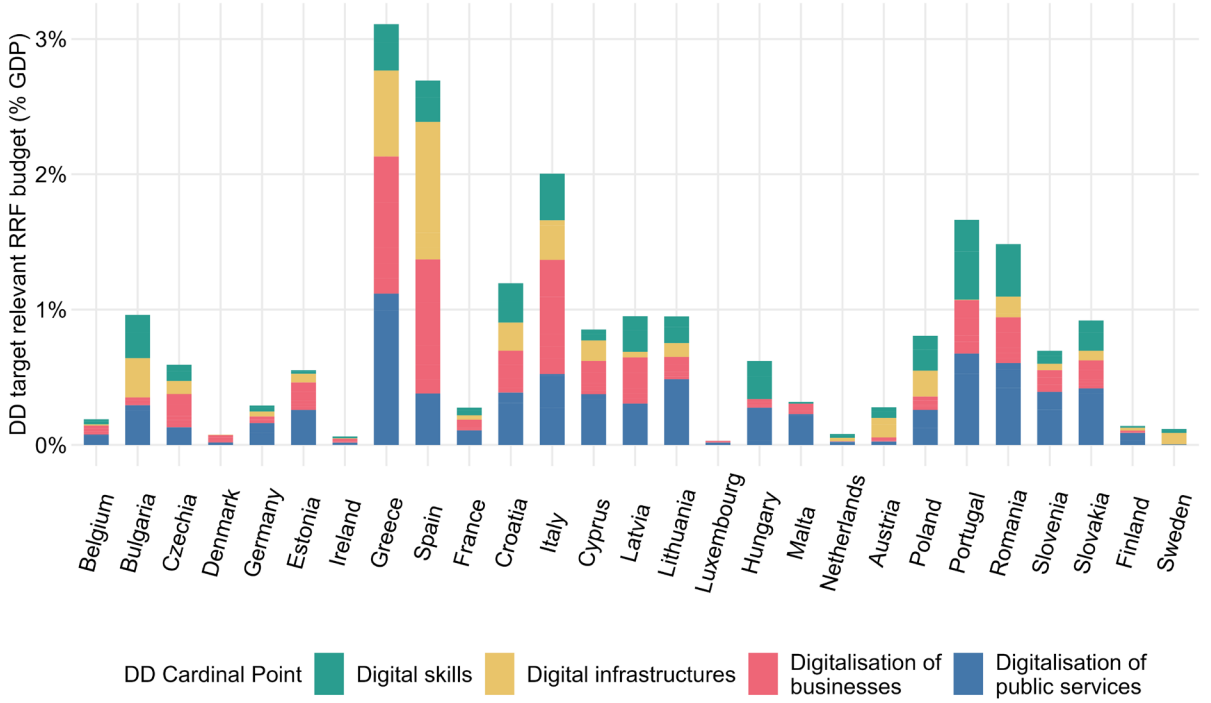
Source: JRC calculations.

Administrative boundaries: © EuroGeographics. Cartography data downloaded using giscoR

The designations employed and the presentation of material on the map do not imply the expression of any opinion whatsoever on the part of the European Union concerning the legal status of any country, territory or area or of its authorities, or concerning the delimitation of its frontiers or boundaries. Kosovo - This designation is without prejudice to positions on status, and is in line with UNSCR 1244/1999 and the ICJ Opinion on the Kosovo declaration of independence.*

One of the requirements in RRF is that every Member State must allocate at least 20% of the total budget to digital measures ([33]) (and 37% to green measures). Note that the shares represented on the map refer to DD targets (and DD-target relevant budget is narrower than digital budget), which explains why some countries have shares below the 20% threshold. Indeed, all MS allocated at least 20% of the RRF budget to digital measures, but not necessarily to Digital Decade targets. The difference of allocations on DD targets between MS is linked to the fact that some countries are more focused on other type of measures; for example, **Croatia** shows (in Figure 6 – Panel B) an average RRF and CP DD-targets relevant budget considering its population (EUR 355 per capita), but it appears at the bottom of the ranking in Figure 7 (with only a 9% share). This is because Croatia has the third highest environmental tag in its RRF plan (32.49%), showing a bigger effort on those measures compared to DD targets. A similar consideration can be done for **Poland**, which shows a high climate tag in its RRF plan (46.57%), while the budget allocated to DD targets is below 20%.

Figure 8. DD-targets relevant RRF budget (as a share of GDP) by country and DD cardinal point



Source: Eurostat (GDP 2023 at current prices) and JRC calculations.

Lastly, Figure 8 highlights how the contribution of each Member State to DD targets varies in terms of their respective GDP. Similarly to what happens with absolute values, **Mediterranean**, **Balkan** and **Eastern Europe** countries devote higher shares of their GDP to DD targets compared to the rest

[33] Please note that the digital measures under REPowerEU do not contribute to the achievement of the 20% digital target, as Member States are subject to an exemption from applying the digital tag to this plan's measures. Member States are expected to *"provide a qualitative explanation of how the measures in their recovery and resilience plans, including those in the REPowerEU chapters, are expected to contribute to the digital transition and its resulting challenges"* (source: https://commission.europa.eu/document/download/3ccfc38a-2c0c-4923-ac0d-45d27a6a41cb_en?filename=C_2023_876_1_annexe_EN_0.pdf). This implies that only a part of the digital REPowerEU measures are captured in our analysis, as a few Member States proceeded with the tagging (despite the exemption).

of the EU. Moreover, the allocation of budget across DD targets shows commonalities across countries and few divergences. While most of the countries invest heavily in the *digitalisation of public services* and of *businesses*, when we focus on Digital Decade targets we observe interesting deviations from this pattern that may reflect different priorities and specialisation paths.

The heatmap in Figure 9 depicts countries in rows and Digital Decade targets in columns; the cells colour on each row becomes darker as more budget is allocated to a specific DD target, compared to the country's total DD-targets relevant budget. In general, most Member States devote the highest share of their DD-targets relevant budget to the target *online provision of key public services*, followed by *e-Health records* (e.g. **Ireland**, **France** and **Hungary** in addition to **Finland**) and *gigabit network coverage* (e.g. **Austria** and **Sweden**). However, there are noteworthy differences. **Spain** is investing heavily in *semiconductors,* especially through the RRF-financed PERTE Chips plan, placing great emphasis on design capabilities. These investments could be highly complementary to the EIC's "Accelerator Challenge" fund, which also focuses on chip design. The **Netherlands**, which recently announced its Quantum strategy ([34]) and launched the RRF-financed Quantum Delta NL project, shows large investments in *quantum computing,* adding on top of its already rich quantum research ecosystem ([35]). None of the countries allocated the highest amounts to *digital skills* DD targets, while **Italy** and **Denmark** assigned a similar share of RRF and CP budget to online provision of key *public services*, *unicorns* and *digital late adopters*. As already explained in subsection 2.2, in this study we are providing separate results for the *cloud computing services*, *data analytics* and *AI* sub-targets, but when considered jointly they also attract a considerable amount of funding. In fact, if in Figure 9 we considered the three targets together, the resulting amount would closely resemble that of *digital late adopters* in most countries.. **Italy** would become the country that allocated the highest share of RRF and CP budget to *cloud, data analytics* and *AI,* overcoming the online provision of key *public services* DD target. Other countries that invest relatively high amounts in the adoption of technologies by businesses are **Hungary**, **Denmark** and **Ireland**.

[34] De Nationale Technologiestrategie: https://www.rijksoverheid.nl/documenten/beleidsnotas/2024/01/19/de-nationale-technologiestrategie

[35] According to DGTES (De Prato et al., forthcoming), the Netherlands is the EU country with the third most number of active players in research and innovation in quantum technologies, only behind Germany and France.

Figure 9. RRF and CP DD-targets relevant budget by DD target (million EUR)

Country Name	Basic digital skills	ICT specialists	Gigabit network coverage	5G coverage	Semi-conductors	Edge nodes	Quantum computing	Cloud computing services	Data analytics	AI	Digital late adopters	Unicorns	Digital public services	eHealth records	e-ID	Total
Belgium																1,254
Bulgaria																1,595
Czechia																3,152
Denmark																322
Germany																13,147
Estonia																539
Ireland																347
Greece																8,553
Spain																43,588
France																8,967
Croatia																1,368
Italy																45,342
Cyprus																320
Latvia																747
Lithuania																993
Luxembourg																29
Hungary																2,787
Malta																119
Netherlands																893
Austria																1,394
Poland																9,963
Portugal																6,091
Romania																6,666
Slovenia																637
Slovakia																1,794
Finland																564
Sweden																859

Note: The heatmap displays the target specialisation of the Member States' RRF and CP budget jointly. The colour on each row reflects the relative amount of the Member State's RRF and CP investment in a target compared to the country's RRF and CP investment in all targets. The darker the cell colour, the higher the amount allocated to that target.

Source: JRC calculations

4 Conclusions

The Digital Decade Policy Programme sets out digital targets and general objectives to be collectively achieved by the EU and its Member States by 2030. Yet, evidence regarding the amount of EU funds allocated to the targets remains scarce. In this report, we build and analyse a unique dataset that allow us to quantify Digital Decade investments under the MFF 2021-2027 and provide interesting insights about the volume and distribution of funds across Digital Decade targets.

Our analysis highlights the very high relevance for the Digital Decade targets of the Recovery and Resilience Facility. RRF is the largest contributor to the DD-target spending. This means that RRF has the potential to strongly impact the Digital Decade if national measures target the right areas of intervention to provoke long-term changes in the economic structure of the EU and are implemented adequately. The rest of programmes are also relevant and target more specific actions and areas, but the implementation of RRF will be more determinant to the future of Europe than any other funding instrument.

Funding instruments have a strong focus on the *digitalisation of public services* and the *digitalisation of businesses*. These two Digital Decade cardinal points account together for around 64% of all DD-targets relevant budget. The *online provision of key public services*, *uptake of digital technologies by businesses* (*cloud computing services, data analytics* and *AI* altogether), the *basic digitalisation of SMEs and start-up*s and *innovative scale-ups* (*unicorns*) are the targets receiving the most funding. Interestingly, other targets that are deemed critical for the economic security of Europe, such as *quantum computing* or *AI* (the latter taken individually) receive a low or average amount of EU funds, while only Spain invests heavily on *semiconductors.*

Italy leads the way in DD-relevant budget allocated in absolute terms. Spain, Greece, **Croatia**, **Portugal** and **Latvia** also allocate **notable amounts in *EUR per capita* terms.** Regarding the intensity of the DD spending relative to the RRF funding allocated, **Germany**, **Ireland** and **Austria** are the countries that use the largest part of their funds in Digital Decade targets-related investments. The distribution of funds across targets is overall quite homogeneous across Member States, prioritising the *digitalisation of key public services*, *SMEs* and *start-ups*, with few, interesting divergences that reflect Member State's efforts to specialise and develop certain areas that might be strategic for their national interest.

As we enter the second half of the EU's 2021-2027 MFF and approach the equator of the Digital Decade, monitoring the budget allocated into each of the targets is a relevant exercise for policymakers. With the larger emphasis put by the European Commission on economic security, strategic industrial development and resilient value chains, these results become increasingly relevant for the digital transition and industrial policy of the European Union.

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List of abbreviations and definitions

5G	Fifth-generation wireless
6G	Sixth-generation wireless
AI	Artificial Intelligence
BUDG	Directorate-General for Budget
CEF-Digital	Connecting Europe Facility – Digital
CF	Cohesion Fund
Chips	Chips Joint Undertaking
CNECT	Directorate-General for Communications Networks, Content and Technology
COVID-19	Coronavirus disease 2019
CP	Cohesion Policy
DD	Digital Decade
DG	Directorate-General
DGTES	Digital Techno-Economic ecoSystem
DIGIT	Directorate-General for Digital Services
DIGITAL	Digital Europe Programme
ECFIN	Directorate-General for Economic and Financial Affairs
EDIH	European Digital Innovation Hub
e-Health	Electronic health
EIC	European Innovation Council
e-ID	Electronic identification
EISMEA	European Innovation Council and SMEs Executive Agency
EIT	European Institute of Innovation and Technology
ERC	European Research Council
ERDF	European Regional Development Fund
EU	European Union
EuroHPC	European High-Performance Computing Joint Undertaking
FISMA	Directorate-General for Financial Stability, Financial Services and Capital Markets Union
GDP	Gross domestic product
GROW	Directorate General for Internal Market, Industry, Entrepreneurship and SMEs
HE	Horizon Europe

ICT	Information and Communications Technology
IHI	Innovative Health Initiative Joint Undertaking
Interreg	European Territorial Cooperation Fund
IPCEI	Important Projects of Common European Interest
IPCEI-CIS	IPCEI Next Generation Cloud Infrastructure and Services
JRC	Joint Research Centre
JU	Joint Undertaking
JUST	Directorate-General for Justice and Consumers
KDT	Key Digital Technologies Joint Undertaking
MFF	Multiannual financial framework
MS	Member State
PERTE	Strategic Project for Economic Recovery and Transformation
REGIO	Directorate-General for Regional and Urban Policy
R&I	Research and Innovation
RRF	Recovery and Resilience Facility
RTD	Directorate-General for Research and Innovation
SME	Small and Medium-sized Enterprise
SNS	Smart Networks and Services Joint Undertaking
US	United States
WP	Work programme

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Annexes

Annex 1. Data sources and limitations of the mapping

I. Data sources

Funding Instrument / Component		Data sources
Recovery and Resilience Facility (RRF)		IT tool Fenix (Directorate-General for Economic and Financial Affairs (DG ECFIN)). Last access: 15 March 2024
Cohesion Policy (CP)		The available data are publicly accessible from the Cohesion Open data platform ([36]) and cover the period from 2021 to 2027. Last access: 11 March 2024
Horizon Europe (HE)	Horizon Europe (HE) main work programmes	Dataset provided by Directorate-General for Communications Networks, Content and Technology (DG CNECT) (WP 2021-2022) and Directorate-General for Research and Innovation (DG RTD) (WP 2023-24).
	European Innovation Council (EIC) calls	Dataset provided by the European Innovation Council (EIC)
	Chips Joint Undertaking	DECISION CHIPS GB 2023.58 Adopting the multiannual work programme for the years 2023-2027 and repealing decision GB 2023.51 DECISION KDT GB 2022.35 approving the Key Digital Technologies Joint Undertaking's annual budget for the year 2023 DECISION KDT GB 2022.23 adopting the first amendment of the Joint Undertaking's annual budget for the year 2022 DECISION KDT GB 2022.36 Adopting KDT work programme for the year 2023 KDT GB 2022.26 WORK PROGRAMME 2022 V16 – 29 August 2022 KDT ED 2022.27 WORK PROGRAMME 2021 V13_2022-02-24
	European High-Performance Computing (EuroHPC)	DECISION OF THE GOVERNING BOARD OF THE EuroHPC JOINT UNDERTAKING No 44/2023 Adopting the Joint Undertaking's Work Programme and Budget for the year 2024 DECISION OF THE GOVERNING BOARD OF THE EuroHPC JOINT UNDERTAKING No 54/2023 Amending the Joint Undertaking's

[36] Available at: https://cohesiondata.ec.europa.eu/

	Joint Undertaking	Work Programme and Budget for the year 2023 (Work Programme and Budget Amendment no. 8) DECISION OF THE GOVERNING BOARD OF THE EuroHPC JOINT UNDERTAKING No 07/2022 Amending the Joint Undertaking's Work Plan and Budget for the year 2022 (Work Programme and Budget Amendment no. 2)
	Smart Networks and Services (SNS) Joint Undertaking	ANNEX II TO DECISION No 21/2023 OF THE GOVERNING BOARD OF SMART NETWORKS AND SERVICES JOINT UNDERTAKING SNS R&I Work Programme 2024 ANNEX II TO DECISION No 03/2022 OF THE GOVERNING BOARD OF SMART NETWORKS AND SERVICES JOINT UNDERTAKING SNS R&I Work Programme 2021-2022
	Innovative Health Initiative (IHI) Joint Undertaking	Innovative Health Initiative 2024 Work Programme Innovative Health Initiative 2023 Amended Work Programme Innovative Health Initiative 2022 Second Amended Work Programme Innovative Health Initiative Second Amended Annual Work Plan and Budget for 2021
Digital Europe Programme (DIGITAL)	Digital Europe Programme (DIGITAL) main Work Programme, Cybersecurity and European Digital Innovation Hubs (EDIHs)	ANNEX to the Commission Implementing Decision amending Commission Implementing Decision C (2023) 1862 final on the financing of the Digital Europe Programme and the adoption of the work programme for 2023 - 2024, as modified by Commission Implementing Decision C(2023) 8620 final (C(2024) 1902 final ANNEX) ANNEX to the Commission Implementing Decision amending the Commission Implementing Decision C (2023) 1862 final on the financing of the Digital Europe Programme and the adoption of the work programme for 2023 – 2024 (C(2023) 8620 final ANNEX 1) ANNEX to the Commission Implementing Decision amending the Commission Implementing Decision C (2023) 1862 final on the financing of the Digital Europe Programme and the adoption of the work programme for 2023 – 2024 (C(2023) 8620 final ANNEX 2) ANNEX to the Commission Implementing Decision on the financing of the Digital Europe Programme and the adoption of the multiannual work programme for 2021 – 2022 (C(2021) 7914 final – Annex) ANNEX to the Commission Implementing Decision on the financing of the Digital Europe Programme and adoption of the multiannual work programme - Cybersecurity for 2021 – 2022 (C(2021) 7913 final - Annex) ANNEX to the Commission Implementing Decision on the financing of the Digital Europe Programme and adoption of the

		multiannual work programme – European Digital Innovation Hubs for 2021 – 2023 (C(2021) 7911 final - Annex)
		Strategic orientations for Digital Europe Programme. Work Programme 2025-2027 (provided by Directorate-General for Communications Networks, Content and Technology (DG CNECT)). 12 April 2024
	Chips Joint Undertaking	DECISION CHIPS GB 2023.58 Adopting the multiannual work programme for the years 2023-2027 and repealing decision GB 2023.51
	European High-Performance Computing (EuroHPC) Joint Undertaking	DECISION OF THE GOVERNING BOARD OF THE EuroHPC JOINT UNDERTAKING No 44/2023 Adopting the Joint Undertaking's Work Programme and Budget for the year 2024
		DECISION OF THE GOVERNING BOARD OF THE EuroHPC JOINT UNDERTAKING No 54/2023 Amending the Joint Undertaking's Work Programme and Budget for the year 2023 (Work Programme and Budget Amendment no. 8)
		DECISION OF THE GOVERNING BOARD OF THE EuroHPC JOINT UNDERTAKING No 07/2022 Amending the Joint Undertaking's Work Plan and Budget for the year 2022 (Work Programme and Budget Amendment no. 2)
Connecting Europe Facility (CEF) – Digital	Connecting Europe Facility (CEF) – Digital	ANNEX to the Commission Implementing Decision amending implementing Decision C(2021)9463 on the financing of the Connecting Europe Facility – Digital sector and the adoption of the multiannual work programme for 2021-2025 (C(2023) 2533 final - Annex)
	European High-Performance Computing (EuroHPC) Joint Undertaking	DECISION OF THE GOVERNING BOARD OF THE EuroHPC JOINT UNDERTAKING No 44/2023 Adopting the Joint Undertaking's Work Programme and Budget for the year 2024
		DECISION OF THE GOVERNING BOARD OF THE EuroHPC JOINT UNDERTAKING No 54/2023 Amending the Joint Undertaking's Work Programme and Budget for the year 2023 (Work Programme and Budget Amendment no. 8)
		DECISION OF THE GOVERNING BOARD OF THE EuroHPC JOINT UNDERTAKING No 07/2022 Amending the Joint Undertaking's Work Plan and Budget for the year 2022 (Work Programme and Budget Amendment no. 2)

II. Example of application of the methodology

This section presents an example of application of the methodology described in subsection 2.2. Figure A.1 presents the flowchart of the methodology applied to this specific example.

Let's consider the Innovative Health Initiative (IHI) JU 2024 Work Programme, call 7, topic 2 "User-centric technologies and optimised hospital workflows for a sustainable healthcare workforce" ([37]).

Step 1: From the work programme, the initial budget for this topic is set to EUR 25 million. The digital tracker for IHI is 40% (as it only partially contains a digital component), so the digital budget is a fraction of the initial budget: EUR 10 million (coming from EUR 25 million * 40%).

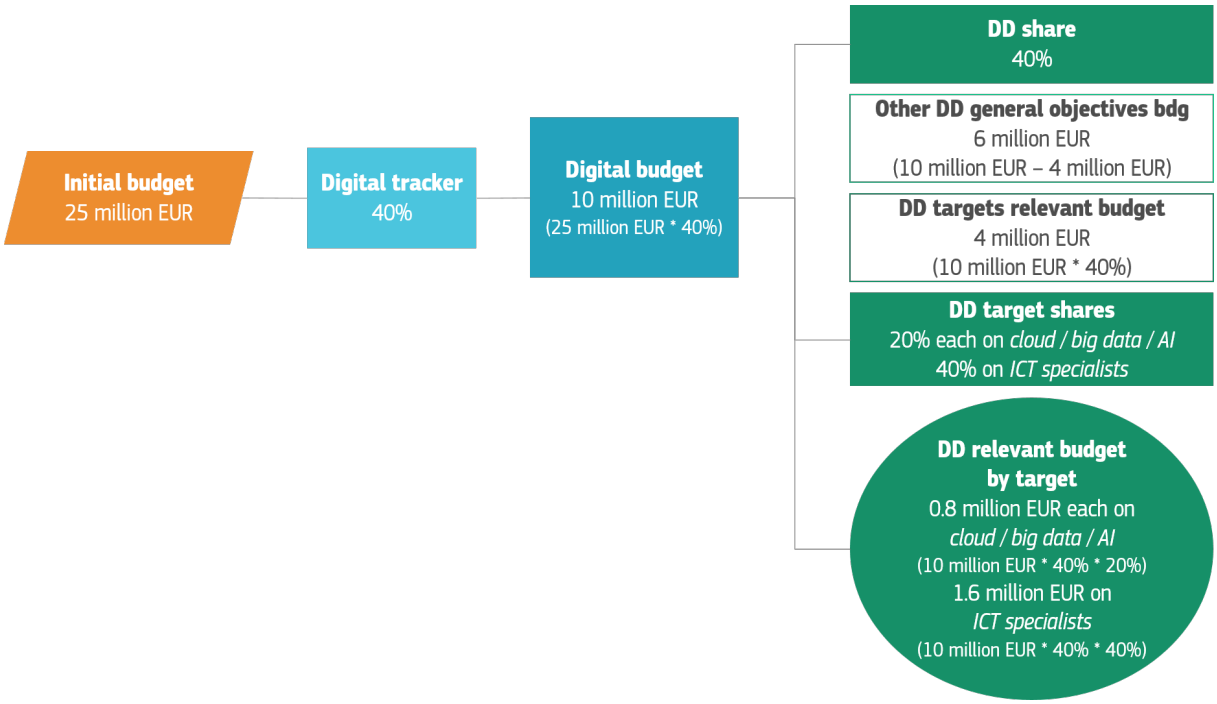
Step 2: By checking the description of the topic (under the sections *expected outcomes*, *scope* and *expected impacts*) we determine that this category shows only a partial correspondence with the Digital Decade targets, therefore we set the DD share to 40%. This way, the DD-targets relevant budget is EUR 4 million (EUR 10 million * 40%).

Step 3: We then need to determine which of the DD targets show a clear link with the topic; the main contribution of the category seems to be related to the *digitalisation of businesses* cardinal point, and in particular to the uptake of digital technologies (*cloud, data analytics, AI*) DD target, so we decide to allocate a 60% DD target share (equally distributed among the three sub-targets as there is no clear prevalence of one of the three). From the work programme it appears that the *digital skills* cardinal point may also be affected, in particular the *ICT specialists* DD target, so we allocate the remaining 40% to it.

Step 4: The last step of the approach consists in translating these shares into budget by target, by simply multiplying them by the DD-targets relevant budget; the adoption of technologies target receives EUR 2.4 million (EUR 4 million * 60% DD target share), split equally among *cloud computing services*, *data analytics* and *AI* (EUR 0.8 million each: EUR 4 million * 20% DD target share), while the *ICT specialists* DD target receives EUR 1.6 million (EUR 4 million * 40% DD target share). Finally, the DD general objectives budget is EUR 6 million, obtained as the difference between the digital budget (EUR 10 million) and the DD-targets relevant one (EUR 4 million).

[37] https://www.ihi.europa.eu/sites/default/files/uploads/Documents/About/AWP/WorkProgramme2024.pdf page 81

Figure A.1. Explanation of the methodology through the example of Topic 2 from IHI 2024 Work Programme



Source: Authors' elaboration

III. Limitations of the mapping

The allocation of the budget across DD targets is based on a qualitative assessment, and as such, it has a degree of subjectivity. To ensure the accuracy and relevance of our analysis as much as possible, we have consulted experts from DG CNECT, DG REGIO, DG ECFIN, DG RTD, DG DIGIT, DG FISMA, DG GROW and DG JUST to validate the methodology and its practical application and output. This collaborative approach is critical to identify the most relevant categories of each investment instrument, to break down the budget across DD targets and, in sum, to apply the methodology consistently across all relevant funds.

While we have made every effort to map each measure to a specific DD target, there are cases where, after having identified the relevant cardinal point, it is not possible to establish a clear link to one or more targets. In these cases, the budget is equally split among the relevant DD indicators within the cardinal point. Consequently, the mapping result should be considered as a broad estimate, providing an indication of the possible contribution of investment instruments to the Digital Decade targets and the order of magnitude of this contribution.

Furthermore, we acknowledge that there may be other projects, activities and funding instruments apart from the ones covered in the study, which are relevant to the Digital Decade but are not included in our analysis. Additionally, it is important to note that the estimations are based on the available data and information at the time of the analysis, which may evolve over time due to revisions and

newly adopted work programmes ([38]). Therefore, the figures presented in the analysis reflect the current situation and should be viewed as an initial estimation subject to possible updates.

Despite these caveats, the methodology developed and used to allocate the budget across the Digital Decade targets is robust and validated.

[38] Due to updates or amendments of the funding instruments' plans and work programmes, the overall budget may undergo changes in the future. Also, planned amounts may differ from the actual spending, which would alter the estimated allocations to DD targets.

Annex 2. Supplementary tables

This report is accompanied by a dataset available from the JRC Data Catalogue: https://data.jrc.ec.europa.eu/collection/id-00396

Table A.1. Relevant EU budget for the Digital Decade targets (2021-2027 MFF, incl. RRF 2020-2026, *million EUR*)

Fund		**Total**	**Recovery and Resilience Facility** (2020-2026)	**Cohesion Policy** (2021-2027)	**Digital Europe Programme** (2021-2027)	**Horizon Europe** (2021-2024)	**Connecting Europe Facility – Digital** (2021-2027)
Total funding		**957,422**	651,670	260,896	7,948	35,199	1,709
Digital funding		**204,583**	150,037	31,063	7,948	13,826	1,709
Digital funding %		21%	23%	12%	100%	39%	100%
Funding DD general objectives		27,488	14,129	4,392	1,275	7,320	373
Funding Digital Decade targets	**Total target budget**	177,096	135,909	26,672	6,673	6,506	1,336
	Basic digital skills	15,405	14,294	950	128	34	0
	ICT specialists	10,881	9,506	633	661	73	8
	Gigabit network coverage	14,003	11,628	2,164	4	0	206
	5G coverage	3,362	1,967	115	4	396	879
	Semiconductors	18,200	14,801	0	1,396	2,004	0
	Edge nodes	609	0	0	220	335	35
	Quantum computing	1,918	866	0	293	669	90
	Cloud computing services	8,373	6,019	1,584	370	337	63
	Data analytics	7,552	4,718	1,584	546	678	26
	Artificial intelligence	9,386	5,278	1,584	1,227	1,266	30
	Digital late adopters	19,885	14,154	4,753	674	304	0
	Unicorns	19,257	14,158	4,753	159	187	0
	Digital public services	32,343	24,449	7,271	616	6	0
	Electronic health records	15,233	13,604	1,280	163	187	0
	e-ID	688	466	0	212	9	0

Source: JRC calculations

Table A.2. Recovery and Resilience Facility 2020-2026 DD-targets relevant budget by Member State and DD target (*million EUR*)

Country		Total DD-targets relevant	Basic digital skills	ICT specialists	Gigabit network coverage	5G coverage	Semiconductors	Edge nodes	Quantum computing	Cloud computing services	Data analytics	Artificial intelligence	Digital late adopters	Unicorns	Digital public services	e-Health records	e-ID
EU	**European Union**	**135,909**	**14,294**	**9,506**	**11,628**	**1,967**	**14,801**	**-**	**866**	**6,019**	**4,718**	**5,278**	**14,154**	**14,158**	**24,449**	**13,604**	**466**
BE	Belgium	1,105	132	88	35		20			43	43	43	128	128	391	55	
BG	Bulgaria	903	180	121	272				1	6	6	6	18	18	239	36	
CZ	Czechia	1,814	222	148	227	60			7	84	84	84	251	251	315	83	
DK	Denmark	285			13					22	22	22	67	67	67	2	
DE	Germany	11,995	1,081	721			1,500		21	892	142	142	426	426	3,644	3,000	
EE	Estonia	208	6	4	24					8	8	8	25	25	97		
IE	Ireland	312	38	25		19				16	16	16	49	49	10	75	
EL	Greece	6,851	453	302	1,403					248	248	248	744	744	2,184	278	
ES	Spain	39,378	2,692	1,799	1,312	1,575	11,951		20	1,547	1,547	2,107	4,640	4,640	5,210	340	
FR	France	7,732	995	615	240	300			350	245	245	245	735	735	993	2,003	30
HR	Croatia	906	121	100	157					26	26	26	78	78	235	57	1
IT	Italy	41,793	4,314	2,876	5,292	14	790			2,354	1,904	1,904	5,711	5,711	5,737	4,903	285
CY	Cyprus	254	14	10	45					8	8	8	24	24	101	11	
LV	Latvia	384	64	43	17					15	15	15	46	46	123		
LT	Lithuania	684	85	57	74					13	13	13	40	40	264	86	
LU	Luxembourg	24	0	0						1	1	1	3	3	13	1	
HU	Hungary	1,219	331	221						14	14	14	42	42	61	480	
MT	Malta	62	2	1						2	2	2	5	5	42	2	
NL	Netherlands	834	171	114					264	5	5	5	15	15	169	72	
AT	Austria	1,326	224	149	456		125		107	16	16	16	49	49	107	10	
PL	Poland	6,028	1,156	771	1,431					171	70	70	211	211	939	1,000	
PT	Portugal	4,416	939	626	10					117	117	117	350	350	1,393	398	
RO	Romania	4,792	752	501	94		400			121	121	121	363	363	1,363	443	150
SI	Slovenia	439	36	24	30					11	11	11	34	34	164	83	
SK	Slovakia	1,123	164	109					87	28	28	28	83	87	467	42	
FI	Finland	391	23	16	32		15		10	6	6	6	17	17	100	145	
SE	Sweden	650	99	66	464										21		

Note: RRF data extraction: 15 March 2024.

Source: JRC calculations

Table A.3. Cohesion Policy 2021-2027 DD-targets relevant budget by Member State and DD target (*million EUR*)

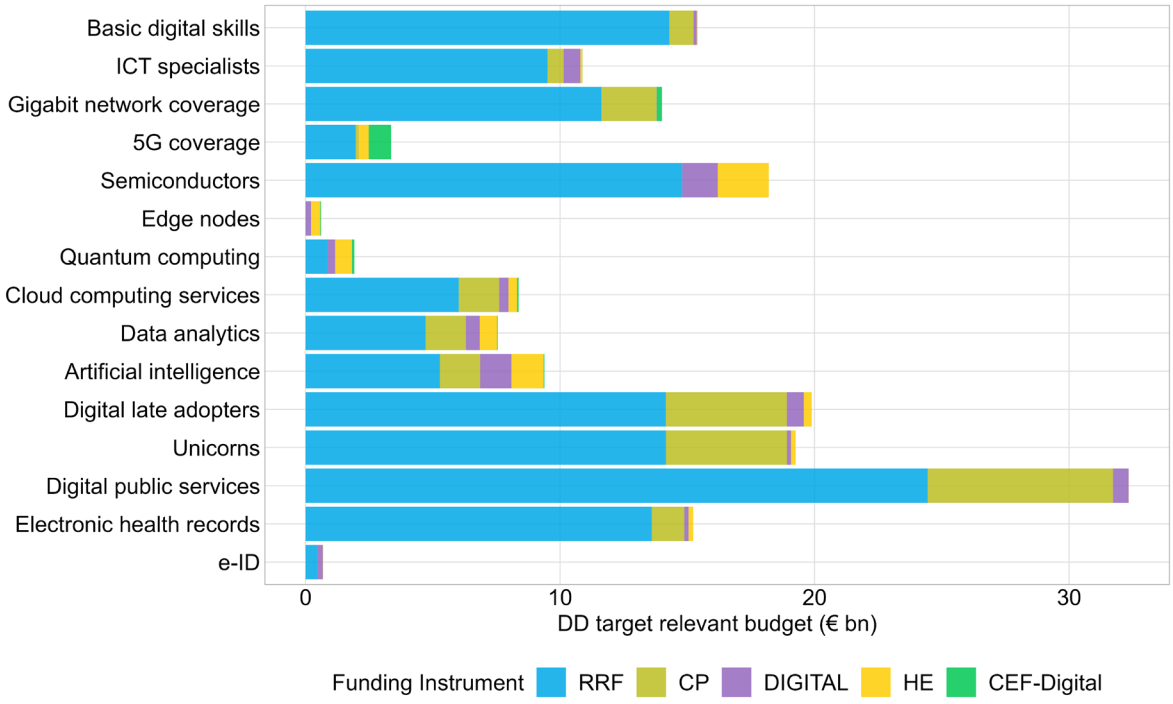
Country		Total DD-targets relevant	Basic digital skills	ICT specialists	Gigabit network coverage	5G coverage	Semiconductors	Edge nodes	Quantum computing	Cloud computing services	Data analytics	Artificial intelligence	Digital late adopters	Unicorns	Digital public services	e-Health records	e-ID
EU	**European Union**	**26,672**	**950**	**633**	**2,164**	**115**	**0**	**0**	**0**	**1,584**	**1,584**	**1,584**	**4,753**	**4,753**	**7,271**	**1,280**	**0**
BE	Belgium	150	12	8						11	11	11	32	32	35		
BG	Bulgaria	691	4	3						57	57	57	172	172	134	36	
CZ	Czechia	1,339	54	36	183					54	54	54	161	161	444	140	
DK	Denmark	37								2	2	2	7	7	17		
DE	Germany	1,150	26	17	4					112	112	112	335	335	58	41	
EE	Estonia	333	6	4	62					14	14	14	41	41	136		
IE	Ireland	35								4	4	4	12	12			
EL	Greece	1,703	37	24	246					109	109	109	326	326	374	43	
ES	Spain	4,209	227	151	155	41				198	198	198	594	594	1,558	295	
FR	France	1,233	88	58	147					75	75	75	225	225	202	65	
HR	Croatia	463	14	9	50					35	35	35	104	104	69	9	
IT	Italy	3,551	184	123	16	1				229	229	229	686	686	984	186	
CY	Cyprus	66								3	3	3	9	9	33	5	
LV	Latvia	364	13	9	29					17	17	17	50	50	140	22	
LT	Lithuania	309	11	7	22	3				23	23	23	68	68	63		
LU	Luxembourg	4	1	0						0	0	0	0	0	2		
HU	Hungary	1,569	11	8	207					121	121	121	364	364	251		
MT	Malta	58	1	0						3	3	3	10	10	12	15	
NL	Netherlands	58	2	1						6	6	6	17	17		3	
AT	Austria	68								8	8	8	23	23			
PL	Poland	3,934	34	23	739	61				159	159	159	477	477	1,460	187	
PT	Portugal	1,674	20	14	150	5				150	150	150	451	451	119	14	
RO	Romania	1,873	14	10						97	97	97	291	291	818	158	
SI	Slovenia	197	19	13	18	1				11	11	11	34	34	44		
SK	Slovakia	670	52	35	112					25	25	25	75	75	247		
FI	Finland	175	15	10						16	16	16	47	47		9	
SE	Sweden	208	20	14	24	3				15	15	15	44	44	14	2	
Interreg (sev. countries)		550	85	57						33	33	33	100	100	57	51	

Note: CP data extraction: 11 March 2024.

Source: JRC calculations

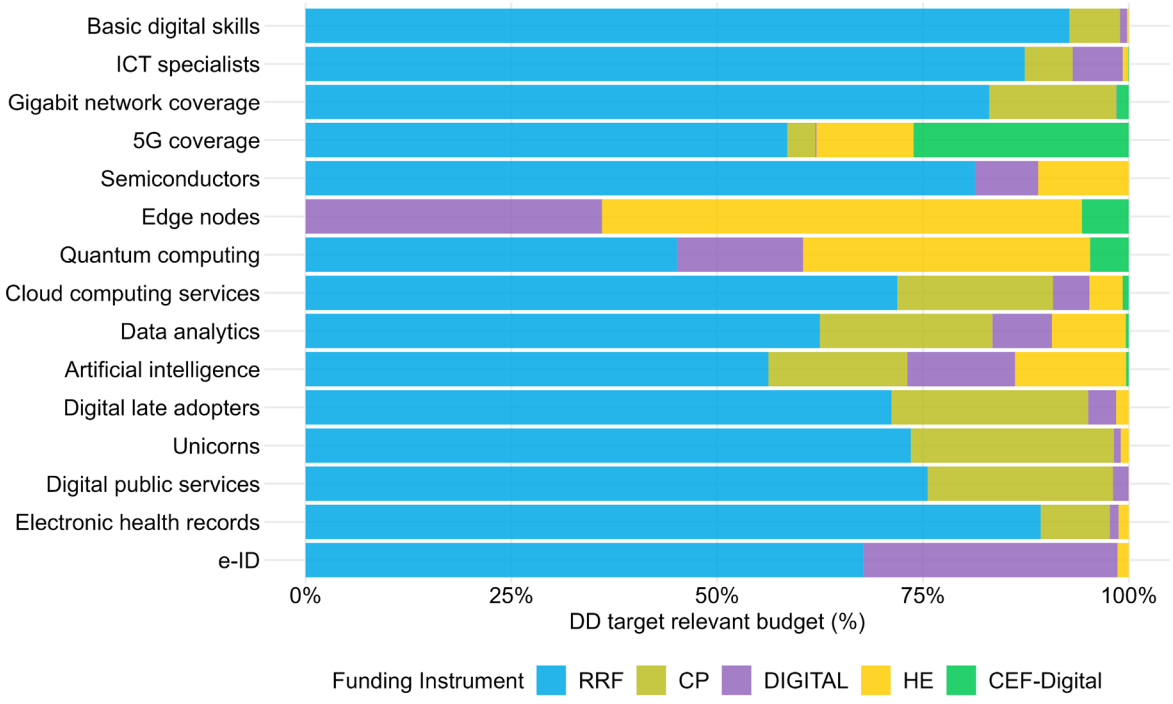
Annex 3. Supplementary figures

Figure A.2. DD-targets relevant budget (*billion EUR*) by DD target



Source: JRC calculations

Figure A.3. DD-targets relevant budget (%) by DD target



Source: JRC calculations

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