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European Gigabit Society progress: how to stimulate further deployments of high-speed broadband networks?

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European Gigabit Society progress: how to stimulate further deployments of high-speed broadband networks?

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Abstract

This paper examines the challenges and progress in meeting the European Gigabit Society's (EGS) targets for high-speed broadband networks and explores the implications of the new targets set for the Digital Decade (DD). With a focus on the availability of gigabit connectivity and 5G networks, the study analyses the existing gaps and their evolution from June 2017 to June 2021. The analysis highlights the significant disparity in broadband deployment, particularly in rural areas, where network operators and private investors face financial constraints and uncertainty regarding returns on investment.

By utilizing the latest available data, this research estimates the remaining investment gap to achieve the EGS and DD targets and identifies areas where the gaps are most pronounced. Furthermore, the study assesses the probability of closing these gaps within the specified timeframe. The lack of transparency regarding specific areas and populations without coverage is identified as an additional hurdle for stakeholders and public-private initiatives seeking to initiate actions.

In addressing these challenges, the paper proposes alternatives to facilitate network rollouts in rural areas, aiming to bridge the gaps and bring coverage closer to the EGS and DD objectives. This research sheds light on the state of broadband deployment, highlighting areas that face higher risks and challenges. By doing so, it contributes to our understanding of the feasibility of achieving the EGS and DD targets and provides valuable insights to inform strategies aimed at enhancing connectivity in underserved regions.

1. Introduction

Aware of the importance of high-speed broadband networks for driving economic and social development, the European Union has been actively working for years to establish objectives and promote their deployment.

In September 2016, the European Commission adopted a new set of initiatives and legislative proposals, including a strategy on Connectivity for a European Gigabit Society (EGS). This strategy outlined an interim target for the year 2020, which aimed to make intermediate 5G connectivity available as a fully-fledged commercial service in at least one major city in each EU Member State (Target EGS1). Additionally, it set three main strategic objectives for the year

2025: (i) All urban areas and all major terrestrial transport paths to enjoy uninterrupted 5G coverage (Target EGS2); (ii) Gigabit connectivity for all main socio-economic drivers such as transport hubs and main providers of public services as well as digitally intensive enterprises (Target EGS3); and (iii) all European households, rural or urban, to have access to Internet connectivity offering a downlink of at least 100 Mbps, upgradable to gigabit speed (Target EGS4).

Furthermore, in December 2022, the European Commission introduced the "2030 Digital Compass: the European way for the Digital Decade." This policy program aims to empower citizens and businesses through digitalization. A pivotal component of this initiative is the establishment of a Digital Compass, which will translate the Commission's digital ambitions into a set of concrete objectives for 2030. The Digital Compass is guided by four cardinal points: *"The first two are focused on digital capacities in secure and sustainable digital infrastructures and education & skills, and the other two are focused on the digital transformation of business and public services."*

The second cardinal point, secure and performant sustainable digital infrastructures, acknowledges that *"excellent and secure connectivity for everybody and everywhere in Europe is a prerequisite for a society in which every business and citizen can fully participate"*. This objective relies on leveraging high-capacity networks and 5G technology as facilitators to achieve gigabit connectivity. In line with this vision, the Digital Compass establishes new targets for network deployment by 2030: (i) All European households to be covered by a Gigabit network (Target DD1); and (ii) all populated areas to be covered by 5G (Target DD2).

However, the current state of gigabit broadband networks and their deployment rate suggest that meeting these targets within the designated timeframe is unlikely. This challenge is particularly pronounced in rural areas, where network operators and private investors are more hesitant to invest in broadband infrastructure due to higher financial requirements and greater uncertainty regarding the return on investment. Furthermore, the lack of transparency regarding the specific areas and populations lacking coverage presents a barrier for potential stakeholders and public-private initiatives that are eager to act.

The objective of this paper is to estimate the extent of the gap that needs to be closed to achieve the targets set by the European Gigabit Society (EGS) and the Digital Decade (DD). This estimation is based on the most up-to-date data available, which corresponds to June 2021. Additionally, the paper examines the evolution of this gap from June 2017 to the present. Furthermore, the study provides an estimation of the existing gaps that need to be addressed to meet the new targets established for the Digital Decade. By assessing the current state of broadband deployment and identifying the existing gaps and the areas where they are most relevant, this research contributes to understanding the magnitude of the challenge and informs strategies for achieving the connectivity objectives set by the EGS and the Digital Decade.

Therefore, the paper delves into exploring and proposing alternative approaches that can facilitate network rollouts in rural areas. The intention is to address the gaps in coverage and bring these areas closer to meeting the EGS and DD objectives. By offering insights and recommendations for network deployment strategies in rural regions, the paper aims to contribute to bridging the existing gaps and advancing progress towards achieving comprehensive broadband coverage as envisioned by the European Gigabit Society and the Digital Decade.

2. Methodology and data

This paper adopts the methodology employed in the study conducted by Ferrandis et al. (2021) as a basis. From this, the model has been adapted to incorporate the latest data sets provided by the European Commission and to expand its scope to estimate the targets outlined in the Digital Decade¹. Main stages of the model are shown in Figure 1.

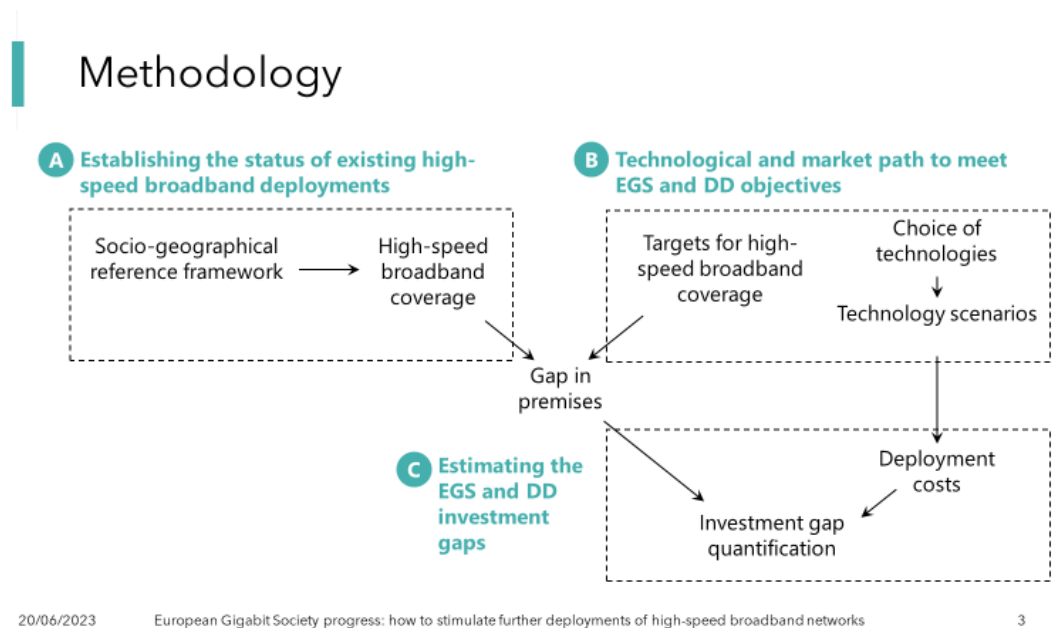


Figure 1. Methodology used for estimations

These stages encompass various analytical processes and calculations utilized to estimate the investment gap and assess the progress towards achieving the EGS and DD targets. The model considers relevant factors such as geographic coverage, demographic data, and infrastructure development, among others.

A. Establishing the status of existing high-speed broadband deployments

The data collection process commences by retrieving information from the Eurostat database, which includes population data, land area measurements, and the number of households and enterprises for each NUTS3 region. These parameters form the basis of establishing a socio-geographical reference framework for each NUTS3 region.

To create this framework, a combination of five distinct geotypes is aggregated. These geotypes encompass urban, suburban, semi-rural, rural, and extremely rural classifications. To achieve

¹ By leveraging the adapted model, this paper aims to provide a comprehensive analysis of the broadband deployment progress, identify areas of concern (particularly rural regions), and offer insights on alternative strategies to facilitate network rollouts. The utilization of this methodology strengthens the research's ability to generate accurate estimations and provide valuable information for policymakers, stakeholders, and initiatives working towards bridging the gaps in broadband coverage.

this aggregation, more detailed data at the municipal LAU2 or NUTS5 level is utilized. This more granular data includes specific information regarding the area, population, and the degree of urbanization, as determined by the DEGURBA classification.

Subsequently, data pertaining to the existing coverage of high-speed broadband in each NUTS3 region is sourced from the European Commission (2022). However, it is worth noting that the data often contain wide intervals, necessitating further refinement to obtain a single representative figure for each region.

To achieve this refinement, additional analysis and calculations are conducted to derive a consolidated and representative value that accurately represents the high-speed broadband coverage for each NUTS3 region. This refinement process helps to provide a more precise and concise understanding of the current state of broadband coverage in the respective regions and ensures consistency with the national data available in the European Commission's Digital Agenda and Digital Economy and Society Index databases.

By following this methodology, the model establishes a comprehensive and consistent dataset that incorporates socio-geographical characteristics and high-speed broadband coverage information for the NUTS3 regions.

B. Technological and market path to meet EGS and DD objectives

Following the data collection and refinement process, the model employed in this paper proceeds with a series of assumptions² to determine the appropriate technologies³ required to meet the different targets of high-speed broadband coverage established by the European Gigabit Society (EGS) and the Digital Decade (DD).

In the case of objectives EGS1, EGS2, and DD2, the assumption is straightforward as these targets already specify 5G as the supporting technology. Therefore, the model considers the deployment and coverage requirements associated with 5G technology to estimate the progress towards achieving these objectives.

For objectives EGS3, EGS4, and DD1, the assumption is made that all new broadband deployments will be based on fibre technology. This aligns with the current strategies employed by operators in each country, where fibre-optic infrastructure is considered the primary choice for achieving high-speed broadband coverage.

As part of the model's assumptions, it considers the repurposing and updating of existing fibre and cable infrastructure to support gigabit speeds. This approach ensures the efficient utilization of the existing infrastructure, minimizing the need for extensive new deployments.

However, there is one exception to this assumption, specifically concerning target EGS4, which involves the deployment of 5G at nominal quality for extremely rural areas. In these areas, the

² These assumptions consider various factors such as the geographical characteristics of each region, the existing infrastructure, and the desired level of coverage specified by the targets. By making these assumptions, the model can assess the technological requirements and implications for achieving the defined broadband coverage objectives.

³ The selection of technologies considers factors such as the availability and suitability of different broadband technologies. The model considers the capabilities and limitations of each technology in terms of their capacity, reach, and cost-effectiveness.

model recognizes that deploying fibre infrastructure is prohibitively expensive, making it impractical to achieve by the specified timeframe of 2025.

Instead, the model acknowledges the unique challenges and cost considerations associated with extremely rural areas and assumes that 5G technology (at nominal quality) will be employed to provide connectivity in those regions. This recognition reflects the practical limitations and financial constraints that make deploying fibre infrastructure in such areas unfeasible within the given timeframe.

C. Estimating the EGS and DD investment gaps

In the final step of the analysis, this study estimates the cost of broadband deployment by integrating data from various academic literature, institutional studies, and industry references.

To account for country-specific factors that influence the readiness for new broadband deployments, the study incorporates a correction factor. This correction factor considers various geographic, sociodemographic, and regulatory aspects that vary across countries. Geographic characteristics, such as the level of mountainous terrain, can impact the difficulty and cost of deploying broadband infrastructure. Sociodemographic factors, including the dominant types of buildings, influence the infrastructure requirements and deployment strategies. Regulatory aspects, such as infrastructure sharing precedents, laws, municipal licenses, and permissions, affect the overall feasibility and cost of deployment.

By integrating these country-specific factors into the model, the study calculates specific cost values for each technology and geotype. This enables a more accurate estimation of the investment required to bridge the gap between the existing broadband coverage and the desired targets. By applying the determined costs to the coverage gap, the study derives investment gaps, providing insights into the financial requirements necessary to achieve the defined broadband coverage objectives.

3. Main results: Evolution of the investment gap

As a result of its application, the model provides an estimate of the investment required for network deployments that would close the existing coverage gaps that prevent us from meeting each of the targets set by the European Gigabit Society and the Digital Decade. Results are obtained for every NUTS3 region across the 27 countries that comprise the European Union. By aggregating this data, the model provides figures for the investment gap at a country level and for the European Union as a whole.

As an example, Table 1 includes an extract of the results obtained for the EGS targets in the 28 NUTS3 that comprise Czech Republic.

NUTS3	REGION	EGS1	EGS2	EGS3	EGS4	TOTAL EGS
CZ010	Hlavní město Praha	17.7	20.1	19.9	24.4	59.7
CZ020	Středočeský kraj	0.0	51.2	92.8	114.0	236.4
CZ031	Jihočeský kraj	0.0	47.1	245.6	273.1	514.1
CZ032	Plzeňský kraj	0.0	35.8	180.7	211.4	387.8
CZ041	Karlovarský kraj	0.0	15.5	73.9	85.2	158.4
CZ042	Ústecký kraj	0.0	25.0	40.4	49.6	105.7

NUTS3	REGION	EGS1	EGS2	EGS3	EGS4	TOTAL EGS
CZ051	Liberecký kraj	0.0	14.8	27.6	33.9	69.9
CZ052	Královéhradecký kraj	0.0	22.3	70.3	84.3	160.9
CZ053	Pardubický kraj	0.0	21.2	66.9	82.1	154.6
CZ063	Kraj Vysočina	0.0	31.8	160.3	195.1	350.3
CZ064	Jihomoravský kraj	0.0	33.7	72.6	89.1	178.4
CZ071	Olomoucký kraj	0.0	24.7	70.0	82.8	161.7
CZ072	Zlínský kraj	0.0	18.6	36.4	44.7	91.1
CZ080	Moravskoslezský kraj	0.0	25.4	64.5	79.2	154.2
CZ	Czech Republic	17.7	387.1	1221.8	1449.0	2783.3

Table 1. Investment gap to meet EGS targets for NUTS3 regions in Czech Republic (in million euros)

European Gigabit Society (EGS)

As it is shown in Table 2, according to the analysis, the total investment gap to meet the targets of the European Gigabit Society (EGS) amounted to 174.8 billion euros as of mid-2021. When examining the results on an individual target basis, it becomes evident that Target EGS4 is the most demanding, requiring a total investment of 100.6 billion euros to be fulfilled. This target faces challenges due to the larger number of premises that need to be covered, as well as the higher unitary costs associated with deploying fiber in rural areas.

Following closely is Target EGS3, which requires 63.1 billion euros. Similar to Target EGS4, it faces challenges in terms of deploying fiber to reach main socio-economic drivers and digitally intensive enterprises. The costs associated with covering these areas contribute to the higher investment requirement.

In contrast, Target EGS2 has a comparatively lower investment requirement of 21.7 billion euros. This target benefits from the lower deployment costs associated with 5G technology as compared to fiber. The focus on providing uninterrupted 5G coverage to urban areas and major terrestrial transport paths contributes to the relatively lower investment needed.

Finally, Target EGS1 has the lowest investment requirement among the targets, totalling 2.9 billion euros. This target specifically focuses on achieving intermediate 5G connectivity in at least one major city in each EU Member State. The investment requirement is lower due to the limited number of premises that need to be covered, restricted to the capital cities of each country.

	EGS1	EGS2	EGS3	EGS4	TOTAL EGS
Mid-2021	2.9	21.7	63.1	100.6	174.8

Table 2. Investment gap to meet EGS targets (in billion euros)

When aggregating the results for all the NUTS3 regions within each country, it is possible to determine the investment gaps on a national basis. **¡Error! No se encuentra el origen de la referencia.** illustrates that as of mid-2021, the largest investment gaps were observed in France (56.6 billion euros), Italy (27.7 billion euros), and Germany (18.9 billion euros). These three countries collectively account for nearly 60% of the total investment gap.

On the other hand, countries such as Malta, Luxembourg, Cyprus, Latvia, and Estonia have comparatively lower investment requirements to fulfil the objectives of the European Gigabit Society (EGS). This suggests that these countries are relatively closer to achieving the desired broadband coverage targets, with smaller investment gaps to bridge.

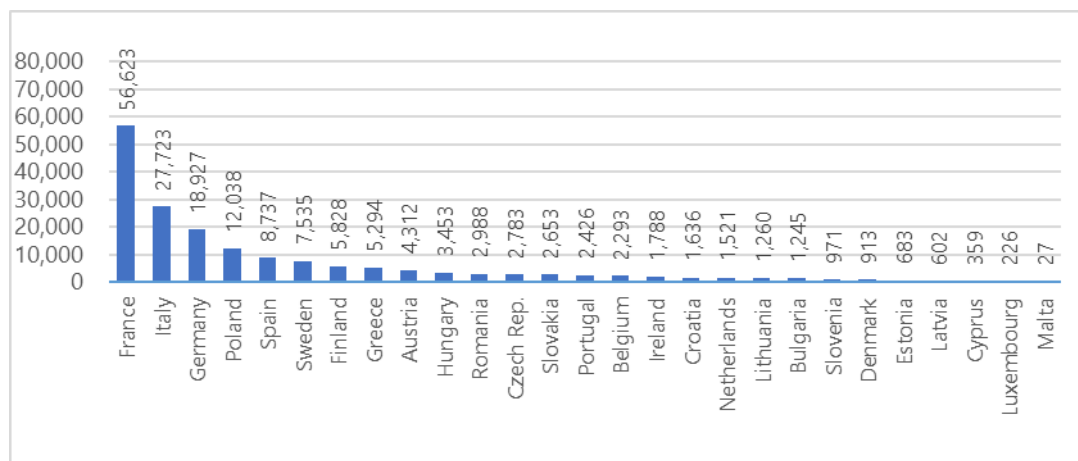


Figure 2. Investment gap to meet EGS targets in mid-2021 per country (in million euros)

Table 3 presents a detailed breakdown of the investment gap per country and per target. It takes into account the overlaps that exist between the targets to avoid double-counting and provide accurate estimations of the overall investment required.

One important consideration is that Target EGS1 already includes Target EGS2 for urban geotypes within the capital cities of each country. This means that the investment required to achieve Target EGS2 is already accounted for within the investment gap of Target EGS1.

Additionally, a portion of Target EGS3 is already covered by Target EGS4. This implies that some of the investment needed to fulfil Target EGS3 is already accounted for within the investment gap of Target EGS4.

Of particular significance is the achievement of targets in Malta, where Target EGS1, Target EGS3, and Target EGS4 have already been fulfilled. Malta's success in meeting these targets can be attributed to the complete coverage of 5G technology in its major city and the provision of 1 Gbps broadband coverage to the entire country.

Additionally, countries such as Austria, Denmark, Finland, and Hungary have also achieved Target EGS1, indicating their progress in providing 5G connectivity in at least one major city within their respective territories.

	COUNTRY	EGS1	EGS2	EGS3	EGS4	TOTAL EGS
AT	Austria	0.0	487.7	1457.3	2622.7	4312.3
BE	Belgium	279.2	1170.1	440.7	783.3	2293.3
BG	Bulgaria	40.0	338.3	358.2	615.0	1244.8
CY	Cyprus	57.9	20.3	136.3	171.7	358.9
CZ	Czech Rep.	17.7	387.1	1221.8	1449.0	2783.3
DE	Germany	29.6	3598.9	4357.8	11695.2	18927.1
DK	Denmark	0.0	292.3	185.6	470.7	912.7

	COUNTRY	EGS1	EGS2	EGS3	EGS4	TOTAL EGS
EE	Estonia	82.3	153.5	293.4	223.5	683.3
EL	Greece	138.5	486.7	2445.6	2766.1	5294.1
ES	Spain	528.9	2292.6	3469.3	3132.2	8736.7
FI	Finland	0.0	805.8	2870.4	2398.3	5827.9
FR	France	673.3	2815.1	22003.1	36011.8	56622.9
HR	Croatia	20.8	230.4	547.2	945.0	1636.2
HU	Hungary	0.0	475.9	1023.3	2166.0	3453.0
IE	Ireland	65.1	86.4	717.6	1075.4	1788.4
IT	Italy	0.0	1806.7	9711.1	18319.3	27723.1
LT	Lithuania	153.1	189.3	446.4	602.2	1259.6
LU	Luxembourg	179.6	39.0	7.8	11.9	226.0
LV	Latvia	123.1	131.4	243.4	204.8	602.5
MT	Malta	0.0	26.6	0.0	0.0	26.6
NL	Netherlands	2.2	450.5	460.2	713.4	1520.9
PL	Poland	73.6	1209.5	4451.8	7290.9	12037.8
PT	Portugal	51.6	888.3	915.1	716.5	2425.9
RO	Romania	38.6	770.0	835.9	1493.0	2988.0
SE	Sweden	168.7	2171.6	2833.2	2822.3	7535.3
SI	Slovenia	21.7	105.2	388.4	541.7	970.9
SK	Slovakia	115.3	231.6	1296.0	1311.6	2652.6
EU-27		2861.0	21660.9	63117.1	100553.4	174843.9

Table 3. Detail of the investment gap to meet EGS targets in mid-2021 (in million euros)

Table 4 illustrates the evolution of the investment gap over the past few years. The data shows a notable decrease in the total investment gap, which has declined from 308.1 billion euros in mid-2017 and 262.8 billion euros in mid-2019 to 174.8 billion euros in mid-2021.

The primary driver of this substantial reduction of 123.4 billion euros is the expansion of high-speed broadband networks capable of providing 1 Gbps speeds. This expansion has resulted in a decrease of 36.6 billion euros in the investment gap for Target EGS3 and a decrease of 72.6 billion euros in the investment gap for Target EGS4.

	EGS1	EGS2	EGS3	EGS4	TOTAL EGS
Mid-2017	12.7	52.3	99.7	173.2	308.1
Mid-2019	12.8	52.5	83.8	140.2	262.8
Mid-2021	2.9	21.7	63.1	100.6	174.8

Table 4. Evolution of the investment gap to meet EGS targets (in billion euros)

However, it is worth noting that there are some inconsistencies in the input data that has a direct impact on the results, as they lead to a significant reduction of 9.8 billion euros in Target EGS1 and 30.6 billion euros in Target EGS2 in the last four years. This inconsistency comes from the unavailability of public data on 5G coverage until mid-2020, what prevents any conclusive analysis regarding the evolution of 5G gaps over time.

The analysis of the total investment gap over the four-year period from mid-2017 to mid-2021 raises concerns about the feasibility of achieving the European Gigabit Society (EGS) objectives by 2025. The progress made in closing the investment gap has not been sufficient to indicate a trajectory that would meet the targets within the specified timeframe.

While there is some potential for the closure of Target EGS1 and Target EGS2 based on the current deployment pace, it is important to note that significant challenges remain, particularly in achieving Target EGS3 and Target EGS4. These targets, which involve providing gigabit connectivity to all main socio-economic drivers and ensuring broadband access for all European households, including rural areas, require substantial investment and infrastructure deployment.

Considering that the reduction in the investment gap from 2021 to 2025 is expected to mirror the progress made from 2017 to 2021, there remains an estimated gap of approximately 50 b€ that needs to be closed by the year 2025. This assessment highlights the need for increased efforts to bridge the remaining investment gap and achieve the ambitious EGS objectives within the specified timeframe.

Digital Decade (DD)

As it is shown in Table 5, The total investment gap to meet the Digital Decade targets amounted to 164.8 billion euros in mid-2021. Target DD1 is the most demanding, requiring a total of 113.1 billion euros to be fulfilled. Similarly to the EGS, this target is affected by the higher costs associated with deploying fiber in rural areas. Target DD2 requires 51.6 billion euros, bringing the total amount needed to meet the Digital Decade targets to 164.8 billion euros.

	DD1	DD2	TOTAL DD
Mid-2021	113.1	51.6	164.8

Table 5. Investment gap to meet Digital Decade targets (in billion euros)

Figure 3 illustrates the investment gaps on a national basis. In mid-2021, the largest gaps were observed in France (47.3 b€), Germany (22.9 b€), and Italy (19.9 b€). These three countries combined accounted for nearly 55% of the total investment gap. On the other hand, countries such as Malta, Cyprus, Luxembourg, Denmark, and Lithuania require relatively lower investments to achieve the objectives of the Digital Decade.

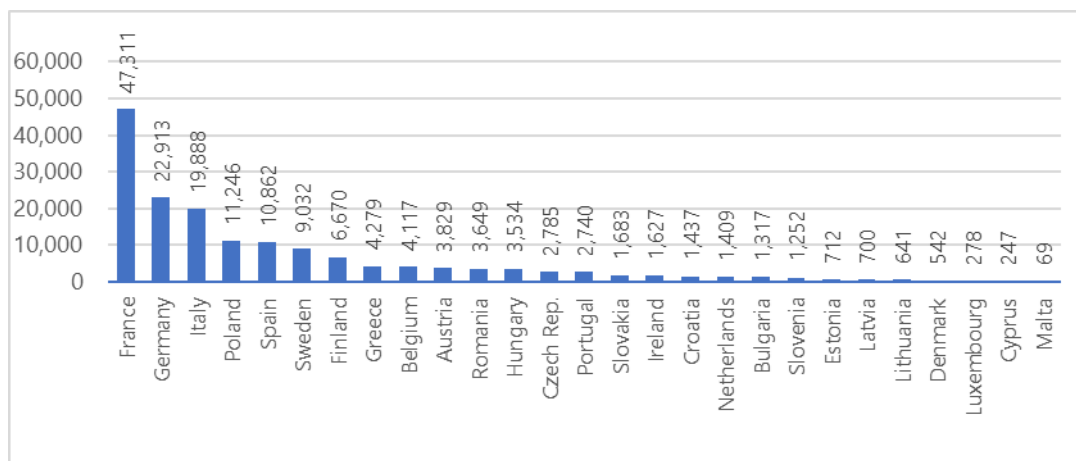


Figure 3. Investment gap to meet DD targets in mid-2021 per country (in million euros)

Table 6 a detailed breakdown of the investment gap per country and per target. In this case, there is no overlap between the targets, as one focuses on the deployment of fixed fiber networks, while the other pertains to the deployment of wireless 5G networks. The total investment required to meet both Digital Decade targets can be calculated by summing the investments needed for each individual target. It is worth noting that Malta is the only country where at least one of the targets has already been achieved, as the current coverage of 1 Gbps broadband stands at 100%.

	COUNTRY	DD1	DD2	TOTAL DD
AT	Austria	2871.8	957.0	3828.8
BE	Belgium	783.3	3333.7	4117.0
BG	Bulgaria	685.2	632.0	1317.2
CY	Cyprus	189.5	57.9	247.5
CZ	Czech Rep.	1484.6	1300.1	2784.7
DE	Germany	11747.0	11166.1	22913.1
DK	Denmark	470.7	71.7	542.4
EE	Estonia	452.2	260.2	712.3
EL	Greece	3264.9	1013.8	4278.6
ES	Spain	5570.9	5291.1	10862.0
FI	Finland	5640.4	1029.4	6669.8
FR	France	38470.5	8840.9	47311.4
HR	Croatia	1006.3	430.2	1436.6
HU	Hungary	2207.1	1327.2	3534.4
IE	Ireland	1114.1	512.6	1626.7
IT	Italy	18690.0	768.3	19458.3
LT	Lithuania	646.7	423.1	1069.8
LU	Luxembourg	11.9	179.6	191.5
LV	Latvia	426.7	359.4	786.1
MT	Malta	0.0	69.3	69.3
NL	Netherlands	713.4	263.1	976.4
PL	Poland	7318.7	4131.2	11449.9
PT	Portugal	1051.8	1828.9	2880.6
RO	Romania	1615.6	2121.7	3737.3

	COUNTRY	DD1	DD2	TOTAL DD
SE	Sweden	4802.6	3996.0	8798.6
SI	Slovenia	553.3	385.6	938.9
SK	Slovakia	1343.2	886.3	2229.5
EU-27		113132.4	51636.3	164768.8

Table 6. Detail of the investment gap to meet Digital Decade targets in mid-2021 (in million euros)

European Gigabit Society + Digital Decade

While the European Gigabit Society (EGS) targets and the Digital Decade (DD) targets were established at different times, it is important to consider them as interconnected objectives rather than separate initiatives. The EGS targets can be seen as a steppingstone towards meeting the DD targets by 2030. Therefore, it is essential to analyze the requirements of a gradual evolution scenario that considers the cost of bridging the EGS gaps first before addressing the DD gaps. This approach recognizes the need to build upon the progress made in achieving the European Gigabit Society targets to effectively meet the broader objectives of the Digital Decade.

Table 7 Table 3 presents an estimate of the investment required to achieve the targets set in both the EGS and the DD programmes. It is important to consider the overlaps between these targets when calculating the total investment. In the case of Target DD1, a significant portion is already covered by Target EGS4, resulting in a reduced investment gap of 15.1 billion euros instead of the standalone analysis figure of 113.1 billion euros.

Similarly, Target DD2 has overlaps with Target EGS1 and Target EGS2, leading to a reduced investment gap of 44.3 billion euros instead of the standalone analysis figure of 51.6 billion euros. By accounting for these overlaps, the total investment required can be more accurately assessed, avoiding double-counting, and ensuring a more precise evaluation of the investment needed to achieve the combined targets of the EGS and the Digital Decade.

	TOTAL EGS	DD1 ONCE EGS4	DD2 ONCE EGS1 AND EGS2	TOTAL DD ONCE EGS	TOTAL EGS + DD
Mid-2021	174.7	15.1	44.1	59.2	234.0

Table 7. Investment gap to meet EGS and Digital Decade targets in mid-2021 (in billion euros)

Figure 4 provides an overview of the investment gaps on a national basis. In mid-2021, the largest gaps were observed in France (67.7 billion euros), Italy (29.5 billion euros), and Germany (28.9 billion euros). These three countries together account for approximately 54% of the total investment gap. On the other hand, countries such as Malta, Luxembourg and Cyprus have relatively lower investment requirements to fulfil the objectives of the EGS and the DD.

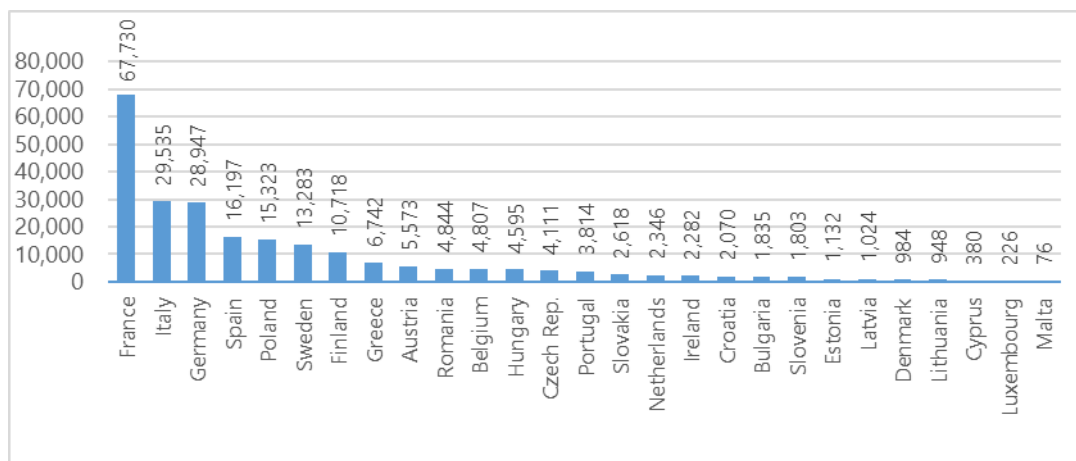


Figure 4. Investment gap to meet EGS and DD targets in mid-2021 per country (in million euros)

Table 8 provides a breakdown of the total investment gap per country and per target, considering the incremental costs to cover Digital Decade targets once the European Gigabit Society targets are met. In some countries, the cost of covering DD1 (fiber deployment) once EGS is met is zero, as there are no households in extreme-rural areas. This applies to countries such as Denmark, Luxembourg, Malta, and the Netherlands.

Similarly, in the cases of Cyprus and Luxembourg, the cost of covering DD2 (wireless 5G deployment) once EGS is met is zero, as these countries have only one NUTS3 region, which is already covered by Target EGS1. Therefore, for these countries, Target EGS1 is equivalent to Target DD2. These considerations highlight the specific circumstances of each country and the overlap between EGS and Digital Decade targets, leading to variations in the investment requirements.

	COUNTRY	TOTAL EGS	DD1 ONCE EGS	DD2 ONCE EGS	TOTAL DD ONCE EGS	TOTAL EGS + DD
AT	Austria	4312.3	303.9	957.0	1260.9	5573.1
BE	Belgium	2293.3	0.0	2514.1	2514.1	4807.3
BG	Bulgaria	1244.8	84.4	505.3	589.8	1834.6
CY	Cyprus	358.9	21.3	0.0	21.3	380.2
CZ	Czech Rep.	2783.3	45.3	1282.3	1327.6	4110.9
DE	Germany	18927.1	61.9	9958.1	10020.0	28947.1
DK	Denmark	912.7	0.0	71.7	71.7	984.4
EE	Estonia	683.3	286.3	162.5	448.8	1132.1
EL	Greece	5294.1	600.5	847.3	1447.8	6741.9
ES	Spain	8736.7	2915.0	4545.0	7459.9	16196.6
FI	Finland	5827.9	3861.1	1029.4	4890.5	10718.4
FR	France	56622.9	2938.9	8167.7	11106.6	67729.5
HR	Croatia	1636.2	73.3	360.9	434.2	2070.3
HU	Hungary	3453.0	49.2	1092.7	1141.8	4594.8
IE	Ireland	1788.4	46.2	447.6	493.8	2282.1
IT	Italy	27723.1	433.1	768.3	1201.4	28924.5
LT	Lithuania	1259.6	53.3	245.5	298.8	1558.4

	COUNTRY	TOTAL EGS	DD1 ONCE EGS	DD2 ONCE EGS	TOTAL DD ONCE EGS	TOTAL EGS + DD
LU	Luxembourg	226.0	0.0	0.0	0.0	226.0
LV	Latvia	602.5	286.6	226.4	513.0	1115.5
MT	Malta	26.6	0.0	49.7	49.7	76.2
NL	Netherlands	1520.9	0.0	260.9	260.9	1781.8
PL	Poland	12037.8	33.2	3540.5	3573.7	15611.5
PT	Portugal	2425.9	400.8	1149.4	1550.3	3976.2
RO	Romania	2988.0	147.1	1821.6	1968.7	4956.7
SE	Sweden	7535.3	2396.4	3020.2	5416.7	12951.9
SI	Slovenia	970.9	14.3	363.9	378.2	1349.1
SK	Slovakia	2652.6	37.8	713.0	750.8	3403.4
EU-27		174675.2	15089.8	44101.0	59190.8	234034.8

Table 8. Detail of the investment gap to meet EGS and Digital Decade targets in mid-2021 (in million euros)

Rural Areas

Table 9 provides a deeper analysis of the investment gap according to different geotypes for both the European Gigabit Society (EGS) targets, the Digital Decade (DD) targets, and the combination of both targets. This breakdown allows for a more detailed understanding of the investment requirements based on the characteristics of each geotype.

	EGS1	EGS2	EGS3	EGS4	TOTAL EGS	DD1	DD2	TOTAL DD	TOTAL EGS + DD
Urban	1.0	6.4	1.0	1.6	8.7	1.6	5.7	7.3	8.7
Suburban	0.8	3.6	9.1	14.4	26.0	14.4	16.0	30.4	41.3
Semi-rural	0.4	3.4	22.3	40.8	62.0	40.8	15.1	55.9	76.7
Rural	0.4	5.0	22.0	41.3	63.8	41.3	12.2	53.5	75.6
Extreme rural	0.02	3.2	8.7	2.5	14.1	15.1	2.6	17.7	31.8
Total urban	1.8	10.0	10.1	15.9	34.7	15.9	21.8	37.7	50.0
Total rural	0.9	11.7	53.1	84.6	140.0	97.2	29.9	127.1	184.1
TOTAL	2.7	21.7	63.1	100.6	174.7	113.1	51.6	164.8	234.0

Table 9. Split of investment gap in mid-2021 among geotypes (in billion euros)

When it comes to EGS targets, the investment gap is significantly higher in rural areas, accounting for 80% of the gap, which requires 140.0 billion euros compared to the 34.7 billion euros needed for urban areas.

For Target EGS1, which aims to provide 5G connectivity as a fully operational commercial service in at least one major city in each EU Member State, urban areas contribute to 67% of the gap, while rural areas make up the remaining 33%. However, it is important to note that this result is

influenced by the assumption in the model, which considers major cities as equivalent to the capitals of each country, where most people reside in densely populated areas.

In the case of Target EGS2, which aims to ensure uninterrupted 5G coverage in all urban areas and major terrestrial transport paths, urban geotypes still account for 46% of the investment gap.

For Target EGS3, which aims to provide gigabit connectivity to key socio-economic drivers such as transport hubs, major providers of public services, and digitally intensive enterprises, as well as Target EGS4, which aims to ensure that all European households, whether rural or urban, have access to Internet connectivity with a minimum downlink speed of 100 Mbps (upgradable to gigabit speed), rural areas contribute to 84% of the total required investment. This is primarily due to the need to cover larger gaps and the higher unitary cost of fiber deployments in rural areas. However, it should be noted that extremely rural regions are an exception, as the model considers 5G technology, rather than fiber, as the preferred choice for deployments in those areas.

When analyzing the Digital Decade (DD) targets, it becomes evident that the investment gap is predominantly driven by rural areas, contributing 77% of the total gap, equivalent to 127.1 billion euros, while urban areas require 37.7 billion euros to bridge the gap. Specifically, for Target DD1, which aims to ensure universal Gigabit network coverage for all European households, rural areas account for 86% of the investment gap. This can be attributed to the same factors discussed earlier for Target EGS4, including larger coverage gaps and higher costs associated with deploying fiber infrastructure in rural regions. In the case of Target DD2, which focuses on providing 5G coverage to all populated areas, rural areas contribute 58% of the investment gap.

In the combined analysis of the European Gigabit Society (EGS) and Digital Decade (DD) targets, rural areas continue to contribute significantly to the investment gap, accounting for 79% of the total gap, amounting to 184.1 billion euros. On the other hand, urban areas require 50.0 billion euros to bridge their investment gap. As mentioned earlier, the EGS targets related to the deployment of networks in rural areas (Target EGS3 and Target EGS4) face challenges in meeting their objectives within the given timeframe.

The analysis of the Digital Decade targets further supports the hypothesis that meeting the deployment targets, particularly in rural areas, by 2025 may be unlikely. Most of the investment gap is concentrated in rural geotypes, indicating the need for increased efforts and resources to bridge this gap and achieve the objectives of both EGS and DD targets.

Furthermore, it is worth noting that most of the investment gaps are concentrated in targets that involve the deployment of fiber networks, namely Target EGS3, Target EGS4, and Target DD1. On the other hand, targets related to the deployment of 5G networks, such as Target EGS1, Target EGS2, and Target DD2, appear to be less demanding or require a lower level of investment in comparison. This indicates that achieving the goals related to 5G deployment may be relatively easier or more feasible compared to the goals associated with fiber deployment.

4. Measures to stimulate further deployments of high-speed broadband networks

As previously discussed, the existing gaps in coverage underscore the importance of implementing additional measures to facilitate network rollouts in rural areas. The higher deployment costs associated with these regions often create disincentives for private initiatives.

Recognizing this challenge, the European Commission (2022) acknowledges that the primary obstacle lies in deploying gigabit networks in remote and rural areas. Addressing this issue requires targeted strategies and investment to bridge the connectivity divide and ensure equitable access to high-speed broadband across all geographical areas.

Ferrandis et al. (2022) conducted initial desk research to explore alternatives that could facilitate the deployment of broadband networks in rural areas. The study presents a comprehensive framework comprising three distinct categories based on the nature of the alternatives and the stakeholders involved: (i) alternative technologies, (ii) alternative operating models, and (iii) public policy and regulation. It concludes that while finding a technology that can completely replace fiber is challenging, alternative operating models can play a crucial role in facilitating shared investments and risks in economically less viable rural areas.

Furthermore, various measures related to public policies and regulations can also contribute positively to bridging the investment gap. However, it is important to acknowledge that these measures may introduce competition distortions or potentially discourage operators from making investments. In line with the categorization mentioned earlier, this paper examines different proposals that are being advocated within the European Union.

Some public initiatives within the European Union aim to promote the use of alternative technologies to help close the investment gap in broadband deployment. On March 2023, the EU council gave the final go-ahead for IRIS⁴ (Infrastructure for Resilience, Interconnectivity and Security by Satellite). As part of the European space strategy, IRIS will be a system of hundred of satellites that will not only provide secure governmental communications, with many applications in the domains of surveillance, crisis management and connection and protection of key infrastructures, but also mass-market services, including high-speed internet broadband for rural and remote areas. The system will provide first services in 2024 and is expected to operate at full capacity by 2027.

The project is an example of private and public institutions joining forces to ensure the financing, that will reach the estimated amount of 6 billion euros, of which 2.4 billion euros will come from the EU budget and an additional 685 million from the European Space Agency. The remaining funding required for the initiative will be covered by the private sector.

Other initiatives within the European Union are specifically focused on mobilizing the necessary investments to deploy high-speed networks in underserved areas. One of the most important is the Connecting Europe Broadband Fund⁵, that was launched in 2018 with the aim to help achieve the gigabit connectivity objectives. The fund selects greenfield projects focused on contributing to achieve the targets of the European Gigabit Society by enabling the deployment of ultra-high-speed connectivity (>100Mbps) networks for end users in underserved rural areas where typically only one network exists or is planned (grey areas) or no network exists (white areas).

The fund has raised 555 million euros from public investors, such as the European Investment Bank (EIB), the European Commission and national banks from Germany (KfW), France (Caisse des Dépôts) and Italy (Cassa Depositi e Prestiti) and expects to unlock investments amounting 1 to 1.7 billion euros. As shown in **Error! No se encuentra el origen de la referencia.**, up to now,

⁴ <https://digital-strategy.ec.europa.eu/en/news/go-ahead-iris2-satellite-broadband-rural-and-remote-areas>

⁵ <https://digital-strategy.ec.europa.eu/en/library/connecting-europe-broadband-fund>

nine projects have been funded in Europe (eight inside the EU-27 and another one in UK) with the objective of covering almost one million premises with open access FTTH networks.

Project	Investment date	Location	Network	Target
Rune Crow	Jan 2019	Croatia	Open Access Network FTTH	117k homes
Rune Enia	Apr 2019	Slovenia	Open Access Network FTTH	190k homes in rural areas
Trooli	Apr 2019	United Kingdom	Open Access Network FTTH	400k residential and business premises in areas within semi-dense geo-types
Rede Aberta	Mar 2020	Spain	Open Access Network FTTH	400k units in the rural and semi-rural areas of Galicia
Scancom	Jul 2020	Czech Republic	Open Access Network FTTH	Over 200k homes by the end of 2030
Rodin Group	Sep 2020	Netherlands	Open Access Network FTTH	127k houses in two phases
Unifiber	Dec 2020	Italy	Open Access Network FTTH/O	195k residential houses and 8k offices within 4 years of deployment
Asteo Red Neutra	Jul 2021	Spain	Open Access Network FTTH	160k units in the rural and semi-rural areas of several provinces across Castilla & Leon and Extremadura
Fibernet	Oct 2022	Finland	Open Access Network FTTH	41k houses in a 1st phase

Table 10. Summary of projects funded by the Connecting Europe Broadband Fund

Indeed, in addition to European initiatives, national entities also play a crucial role in promoting local initiatives to bridge the digital divide. One such example is Spain's Universalisation of Digital Infrastructures for Cohesion Programme (UNICO), which was launched as part of the country's Recovery, Transformation, and Resilience Plan⁶.

⁶ Funding for UNICO is made possible through transfers from the NextGeneration EU's Recovery and Resilience Mechanism (RRM)

Under UNICO, the Spanish government opened a tender in 2021 to telecommunications operators with the objective of deploying high-speed broadband infrastructures. The goal of the program is to provide very high-speed broadband services with speeds of at least 300 Mbps, which can be scaled up to 1 Gbps, to cover 316,500 households and enterprises, mostly in white areas. Once resolved, 50 projects supported by 6 different operators have been selected, that will require an estimated investment of 388 million euros, of which 250 million will come from public aids.

In Romania, Ro-Net⁷ is a project promoted by the Romanian national Broadband Competence Office (BCO) that has deployed high-speed broadband connectivity in 695 rural localities comprising 200,000 households, apart from public and private institutions. Although a national project, funding comes mostly from the UE's European Regional Development Fund. One of the differential characteristics of this project is the operational model. It follows a design-build-operate, by which the participating operators oversee the design, the execution, and operation of the network for a period of at least 18 years.

In some other cases, the initiatives do not come from public institutions but from the citizens. In the case of the of Piltown and Fiddown, two Irish villages that are outside the areas included in the Ireland's National Broadband Plan and were unlikely to attract the interest from operators, the citizens have built their own community-owned future-proof 'fibre to the premises' (FTTP) network, with support from the EU LEADER programme⁸. In 2020, they established a social enterprise company, Broadband for Our Community (B4OC), that received support from resident volunteers to build the infrastructure, and in 2022 750 homes and businesses were connected.

Indeed, the deployment of fiber networks receives significant attention in various initiatives aimed at bridging the digital divide and ensuring high-speed connectivity. This emphasis on fiber infrastructure aligns with the hypothesis presented in the paper, which suggests that the majority of the remaining investment gap and the challenges associated with closing it are closely tied to enabling fiber connectivity in remote and rural areas.

5. Conclusions

Based on the comprehensive analysis conducted in this paper, it is evident that bridging the investment gap and achieving the objectives of the European Gigabit Society (EGS) and the Digital Decade (DD) within the specified timelines will be a challenging endeavour. The estimation model utilized in this study provides valuable insights into the magnitude of the gaps and the distribution of investment requirements across different geotypes and targets.

The findings reveal that rural areas constitute a significant portion of the investment gap, highlighting the need for focused efforts to promote network rollouts in these underserved regions. The higher deployment costs associated with rural areas, particularly for fiber infrastructure, pose a major obstacle for private initiatives. Therefore, alternative operating models and shared investments emerge as potential solutions to facilitate the deployment of broadband networks in economically less viable rural areas.

⁷ <https://digital-strategy.ec.europa.eu/en/library/ro-net-bringing-high-speed-broadband-rural-romania>

⁸ <https://digital-strategy.ec.europa.eu/en/news/broadband-our-community-future-proof-connectivity-and-better-future-two-irish-villages>

While alternative technologies can provide partial solutions, fiber deployment remains the preferred choice to ensure high-speed connectivity. Public policies and regulations play a crucial role in incentivizing and facilitating investment in rural areas. However, caution must be exercised to avoid competition distortions and potential disincentives for operators.

The European Union, as well as national entities, have taken steps to address the investment gap and promote the deployment of high-speed networks. Initiatives such as the Universalisation of Digital Infrastructures for Cohesion Programme (UNICO) in Spain demonstrate a commitment to leveraging public funds to accelerate broadband deployment. However, it is crucial to allocate sufficient resources and establish effective mechanisms to mobilize the required investment and ensure the success of these initiatives.

Wireless technologies, including 5G, receive attention in various initiatives, but the primary focus remains on fiber networks. The estimation model aligns with this focus, indicating that enabling fiber infrastructure in remote and rural areas will pose the greatest challenge in closing the remaining investment gap.

In conclusion, meeting the objectives of the European Gigabit Society and the Digital Decade by 2025 and 2030, respectively, requires concerted efforts, collaboration among stakeholders, and targeted policies. It is crucial to address the specific needs and challenges of rural areas, promote alternative operating models, and ensure adequate investment mobilization. By pursuing these strategies, there is a greater likelihood of achieving the ambitious connectivity goals and driving digital transformation across Europe, ultimately fostering economic growth, social inclusion, and innovation.

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