Connect Europe

State of Digital Communications 2025

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Contents

Executive summary

Europe's decisive moment in connectivity

The European connectivity ecosystem, today, is identified as a major enabler of competitiveness, sustainability, security and resilience for the whole Continent. This year's report highlights that 2025 is decisive to ensure with the upcoming DNA, if it is to stay in control of its connectivity value chain and drive growth. Leadership on crucial technologies such as 5G, FTTH, 6G and network innovation in AI are at stake. However, figures show that an overly fragmented market, burdened by heavy rules and lack of scalability, has negatively impacted investment growth for the first time in years and increased of unhealthy trends in revenues and return on capital. At the same time, significant opportunities to innovate and become more secure and sustainable are up for grabs.

Europe's connectivity ecosystem represents 4.7% of the GDP, driving competitiveness and societal growth

- This year's report features new metrics measuring, for the first time, the size and importance of digital communications at large for the European economy and society. The market – comprising telecom services, network equipment and content & applications in Europe – was worth about EUR1 trillion in 2023, which represents around 4.7% of the European GDP. For comparison, agriculture, fisheries and forestry amount to 1.7% of the GDP together, while the automotive sector stands at 7%.
- The total investment in the market (including tangible fixed assets and R&D) amounted to EUR115.5bn, with telecom operators in the lead, representing 60% of the total, followed by content and application providers (just over 30%) and equipment manufacturers (almost 10%).
- If we zoom in on telecoms, Connect Europe members and their supply chain employed 1 million people, with 537.000 people employed directly, 376.000 indirectly, and over 100.000 contracted.
- Today, the connectivity services provided by Connect Europe members are used by 276 million Europeans (or 61.5% of the population).

Innovation and sovereignty in European connectivity: a “decisive” moment

- This year’s report shows how the connectivity ecosystem is dramatically transforming, driven by technology. There are sizeable opportunities – and important risks – related to Europe’s ability to stay in control of its own **value-chain**. The report therefore tracks progress on network innovation and shows Europe as still being weak on critical technologies such as 5G SA and edge cloud, but making inroads – gradually – on Open RAN, network APIs, AI for network operations and R&D for 6G.

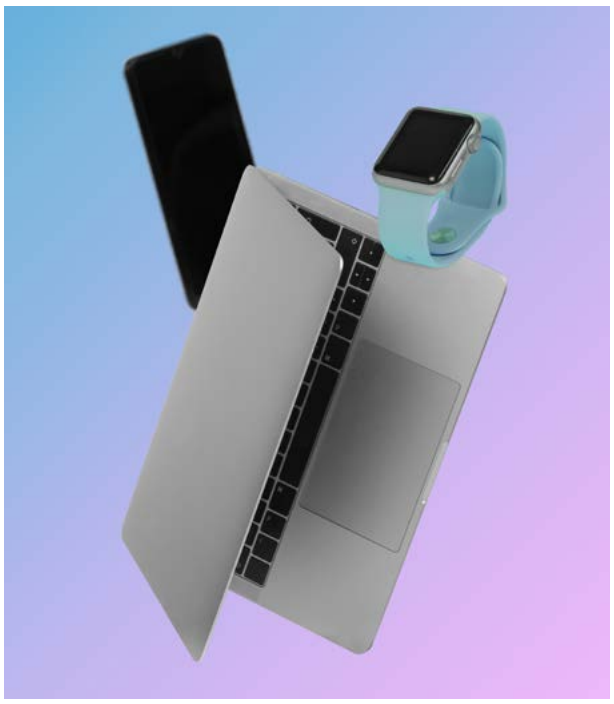
- In Europe, the coverage of **5G Standalone (SA)** – the most advanced form of 5G, able to serve the complex needs of industrial customers – continues to trail other areas of the world: at the end of 2024, 5G SA coverage of the population reached 91% in North America, 45% in Asia-Pacific and only 40% in Europe. This happens despite the fact that Europe almost doubled the number of its commercial 5G SA networks, from 10 in 2023 to 19 in 2024.

- In terms of adoption of **Open RAN** (virtualised and open Radio Access Networks), with a total of 62 trials and commercial deployments by the end of 2024, Europe (16) is ahead of North America (10), but behind Asia and Japan (24). In this context, a survey of European operators shows that 52% of them have already deployed some AI functionality for RAN automation and optimisation, or have started trials.

- As to **edge cloud**, by the end of first half of 2024, 8 operators in Europe had launched commercial edge cloud offers. Despite this, Europe trailed the Asia-Pacific region, which counted 21 operators with commercial edge cloud offers, but is in line with North America, that counts 7. Meanwhile, edge cloud deployment in Europe remains limited, with just 320 live operator edge nodes and 1100 overall edge nodes, falling short of the EU’s ambitious 10,000-node target.

- On **Application Programming Interfaces (APIs)** – which are essential enablers of the Network-as-a-service business model – Europe has so far dominated the early stage market, with European operators amounting to almost half of the Network API platform-related announcements by region (followed by the Asia-Pacific and North America).

- R&D in **6G** is also tracked in this year’s report, with telecom operators, operator-led industry groups and vendors leading 51% of the over 200 projects tracked by Analysys Mason.



Investment in connectivity decreases for the first time in seven years, in a low revenue context

- With the telecom sector being at the heart of the connectivity ecosystem and of European competitiveness, it should be a cause of concern that historic trends of low profitability and low investment appear to have aggravated.

- For the first time in seven years, the **total telecom investment** in Europe has declined by 2%, going from EU59.1bn in 2022 to EU57.9bn in 2023. This decline happens at a time in which the EU is still far from achieving the Digital Decade Targets.

- In 2023, when compared to our global peers, telecom **investment per capita** in Europe, at EUR 117.9, was half that of the USA (EUR 226.4) and lower than in Japan (EUR 187.6) and South Korea (EUR 173.1).

- Revenues and investment remain interlinked. The report finds that European operators have effectively absorbed **inflation** on behalf of their customers, meaning that revenue decreased in real terms. In 2023, European telecom revenue declined by 4.4% in real terms, as opposed to the Consumer Price Index, which increased by 6.4%.

- Meanwhile, in 2023, Mobile Average **Revenue** Per User (ARPU) in Europe declined by 5.9% compared to the previous year (real terms). Also, Europe continues to trail all global peers with a mobile ARPU of EUR14.8 compared to EUR41.7 in the USA, EUR26.0 in South Korea, and EUR22.6 in Japan.

- Of the total EUR64.5 billion invested in the European telecoms sector by operators and upstream partners in 2023, around 46% was dedicated to FTTH, about 30% to mobile networks, and the rest covered aggregation/ core transport networks, IT and various non-network assets such as offices and stores.

- Connect Europe members consistently remain responsible for the largest part of operator investment in Europe, as they represent around 70% of the total sector capex.

5G: European coverage grows, but lags all global peers

- By the end of 2024, 5G in Europe is set to grow to 87% of the population, up from 80% the previous year. However, Europe will still trail behind all its global peers: South Korea (99%), the US (98%), Japan (97%), and China (90%).

- The European median mobile downlink speed of 71.0Mbit/s was lower than that in the USA (107.9Mbit/s), in South Korea (143.1Mbit/s) and in China (105.2Mbit/s).

- By October 2023, European operators had spent a total of EUR29 billion at spectrum auctions for the principal 5G bands and about EUR1.5 billion more is expected from operators in the future.

Gigabit connectivity: still far from the EU Digital Decade Targets

- In 2024, Europe still trailed all global peers on availability of gigabit-capable networks, but was ahead in terms of FTTH roll-out.

- Europe's **gigabit-capable** coverage reached an estimated 82.5% in 2024, as opposed to 99.0% in China, 97.6% in South Korea, 90.3% in the USA and 93.9% in Japan.

- In comparison, Europe's **FTTH** coverage of the population (excluding FTTB) reached an estimated 70.5%, which is better than South Korea's 67.4% and the USA's 54.8%.

- Our estimates confirm that by the end of this decade more than 8% of the European population – meaning at least **45.4 million people** – will still be without access to a fixed gigabit connection, thus falling short of the corresponding EU Digital Decade target.

- Analysys Mason estimates that, in order to reach 99% of the European population, an additional EUR109 billion in FTTH alone would be required between now and 2030.

Data usage keeps growing, with AI as a future driver

- Mobile data usage in Europe increased by 26.5% year-on-year in 2023, and is expected to rise a further 15.2% in 2024.

- Fixed internet traffic increased by 16% year-on-year in 2023 (Figure 6.7) and is expected to rise by around 12% in 2024.

- The report also identifies a series of AI applications that have the potential to further increase volumes of data uploaded or downloaded over fixed and mobile networks. Among those identified, the following consumer applications stand-out: AI-assisted creation tools (making it quicker and easier to create content), AI generated game environments and in-game avatars (making games more appealing), or AI personal assistants (automating the collection and sending of data). In the enterprise market the collection of additional telemetry data from IoT systems for AI analysis, and enterprise use of AI-enabled AR tools are the most likely drivers of future traffic increases.

- The greatest impact on network traffic will be felt at data centres, where traffic volumes related to AI

data ingest and AI-related data centre interconnect will grow fast, with a CAGR uplift of 50% or more.

Fundamentals of the sector: fragmented markets, low returns, stretched investment capacity

- European retail **markets** taken as a whole remain uniquely fragmented. In 2024, Europe had 41 mobile operating groups with more than 500 000 customers, compared with 5 in the USA, 4 in both China and Japan and only 3 in South Korea.

- **ROCE**, return on capital employed, is a common metric to determine the return of investment. The ROCE for telecom operators is 0.7 percentage points lower that it was in 2017: in 2017 ROCE was 6.6%, while in 2023 it was 5.9%, well below the cost of capital. This signals that it is increasingly difficult for European telcos to generate adequate returns.

- In parallel, the sector's **investment capacity** continues to be stretched. In 2023, capital intensity for Connect Europe members (i.e. capex as a proportion of revenue) remained very high at around 21.4%, a level higher than all its global peers. Coupled with weak revenue this results in an increasingly indebted sector. In 2023, the net debt/EBITDA ratio of Connect Europe members touched 2.57, one of the highest levels it has been in recent years.

Tackling the challenges of the century: sustainability and security high on Europe's telecom agenda

- Connect Europe members are accelerating their efforts to reduce their scope 1 and 2 emissions, which are steadily decreasing year-on-year and represent now one-third of those recorded in 2017 (using the market-based calculation method).

- In 2023, the levels of total waste generated by Connect Europe members dropped to 481kTonnes, from 508kTonnes in 2020; and the proportion of waste recycled, reused or refurbished rose to 86%, from 82% in 2022.

- In parallel, the report lists and describes some of the top security challenges currently facing the sector, including the integrity of submarine cables, AI security, vendor embargoes and quantum encryption.

From Enrico Letta's Report on the EU Single Market to Mario Draghi's Report on European competitiveness, it has now become clear that telecom operators and advanced connectivity services are recognized as key enablers of productivity gains and sustainable growth. The jury is still out on whether adequate reforms will be put in place that allow Europe's connectivity ecosystem to scale and grow again.

Introduction

Two key reports highlight Europe's weakened competitive position

In November 2024 the European Council issued the Budapest Declaration.[1] This declaration is a response to two reports, *Much more than a market* by Enrico Letta (April 2024) and *The future of European competitiveness* by Mario Draghi (September 2024), and a set of actions for the Union to implement. These two reports identify a common basic set of shortcomings in the EU economy and the challenges it faces:

- Europe's diminishing share of the global economy
- the fragmented and subscale nature of European companies
- a widening innovation and productivity gap between Europe and the USA and Asia.

The Letta report goes on to lay out measures to modernise and strengthen the Single Market; the Draghi report goes on to lay out a new industrial strategy for Europe.

The Budapest Declaration states unequivocally: "Business as usual is no longer an option". As the European Council is the highest political body in the EU, and the body responsible for setting its overall strategic agenda, these calls for action should in theory follow through to concrete implementation. This is welcome, and its implementation is also a matter of urgency.

Both reports place particular emphasis on the digital communications sector

The digital communications sector gets a detailed analysis in both reports. This is because:

- it is peculiarly beset by the structural problems that have bedevilled other European industries;
- it is a key industry to drive renewed innovation, improved productivity, and ultimately economic growth while enabling the green transition.

What both reports draw attention to in the communications sector is the divergence between the implementation of long-standing European competition policy and the implementation of a pro-growth industrial policy that would meet the challenges Europe faces.

The Letta report highlights the relative fragmentation of the sector compared with other industries, which hinders its economic sustainability. Hence "due consideration should be given to the necessity of some level of consolidation within national markets". While the report notes that there are no significant regulatory barriers to geographical expansion within the EU, it points out that without the ability to make a return on investment in any given national market, pan-European consolidation will remain unattractive.

[1] Budapest Declaration on the New European Competitiveness Deal

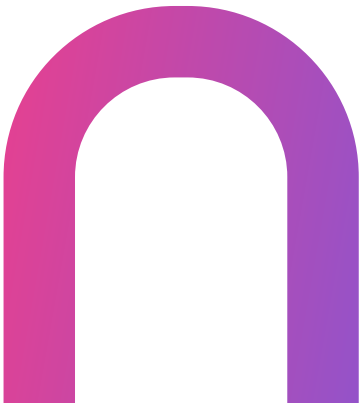
The Draghi report lays great emphasis on the digital sector, which will account for most of the new value created in the global economy, and highlights the deficiencies in the European digital sector. It identifies the gap in digital as the main driver behind the productivity gap between the EU and the US. It emphasises the importance of reducing dependencies on non-European suppliers. Specifically:

- The EU relies on other countries for over 80% of its digital products, services, digital infrastructure and intellectual property.
- The EU's share of global revenues in ICT dropped from 22% to 18% from 2013 to 2023, while the US share increased from 30% to 38%.
- Only four of the 50 largest tech providers by market capitalisation are EU companies.

Among the many recommendations for the digital communications sector that the Draghi report makes are:

- Reform the EU's regulation and competition stance so as to encourage network operator consolidation thereby helping to achieve the Digital Single Market for Telecoms;
- Reduce country-level ex ante regulation in favour of ex post competition enforcement;
- Harmonise EU-wide spectrum licensing, support longer licence duration and fewer band reservations;
- Simplify and harmonise cybersecurity and lawful intercept regulations;
- Establish passporting of B2B services to enable EU operators to provide services across the EU;
- Strengthen EU-based telecoms equipment and software providers;
- Provide central coordination of standards for edge computing, network APIs and IoT;
- Encourage the definition of commercial contractual agreements for terminating data traffic and infrastructure cost-sharing between internet service providers or telecom operators owning the infrastructure and very large online platforms with a safeguard of mandatory final arbitration.

In addition the report recommended the adoption of a new EU Telecoms Act to embed the changes in law and to implement a new strategic vision for telecommunication services.



The Draghi report emphasises the EU relies on other countries for over 80% of its digital products, services, digital infrastructure and intellectual property.

Towards a stronger European digital communications sector

The digital communications sector is positioned to play a vital role in delivering improved European competitiveness, scale and resilience. At the same time, the overriding issues facing the sector are broadly aligned with those faced by European industry as a whole.

While substantial investments and modernisation have achieved a great deal in terms of delivery of infrastructure and innovative services, the underlying structure of the sector (lack of scale/fragmentation, over-regulation, insufficient returns to make major investments for growth) still largely works against the broader aims of strengthening European industrial competitiveness. Much could still be done to make the sector more competitive, financially healthier, and more productive, so that it can deliver on sector-specific targets, and at the same time play a pivotal role in delivering the broader aims of a stronger, more competitive Europe.

This report analyses where the sector is now, its development over recent years, and compares it to the digital communications sectors in other countries and regions that naturally compete with Europe.

In this report "Europe" means the Connect Europe perimeter, which encompasses the EU27 plus Albania, Bosnia and Herzegovina, Iceland, Montenegro, North Macedonia, Norway, Serbia, Switzerland and the UK.

The digital communications market landscape in Europe

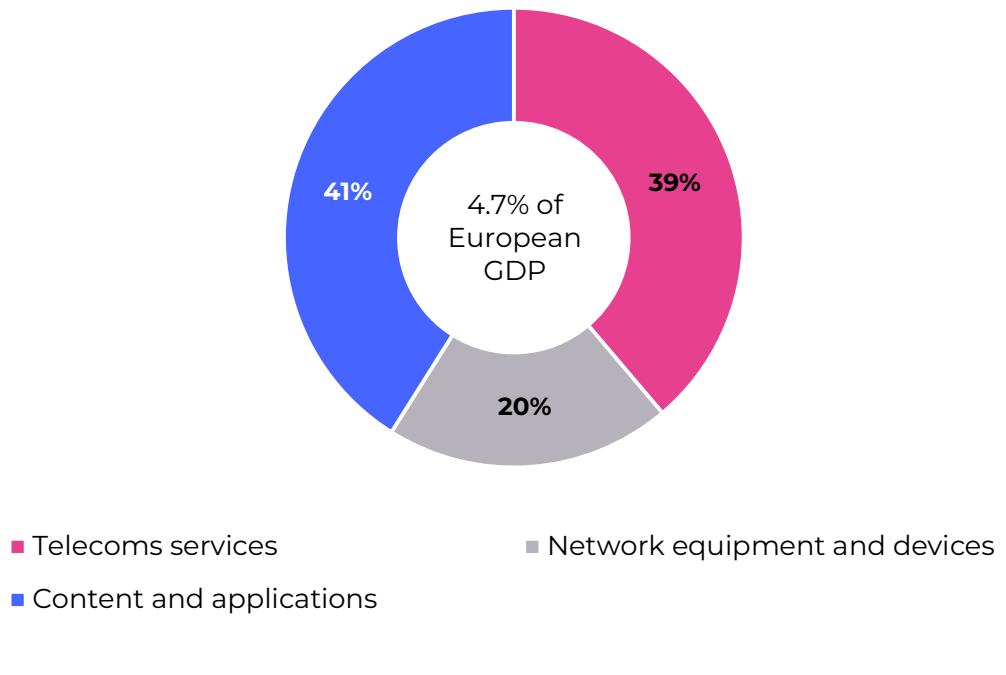
The digital communications market is crucially important in the context of European business as a whole. It represents a substantial share of GDP, and its players invest billions of euros per year in tangible assets and research and development.

The digital communications market is defined here as including:

- telecoms services;
- telecoms equipment and communications devices;
- content and applications including media (film, TV, and music), software publishing, data centre services and web portals.

The market was worth around **EUR1 trillion to the European economy** in 2023 - around 4.7% of European GDP. Turnover in the telecoms services market accounted for 39% of that figure at EUR397 billion.

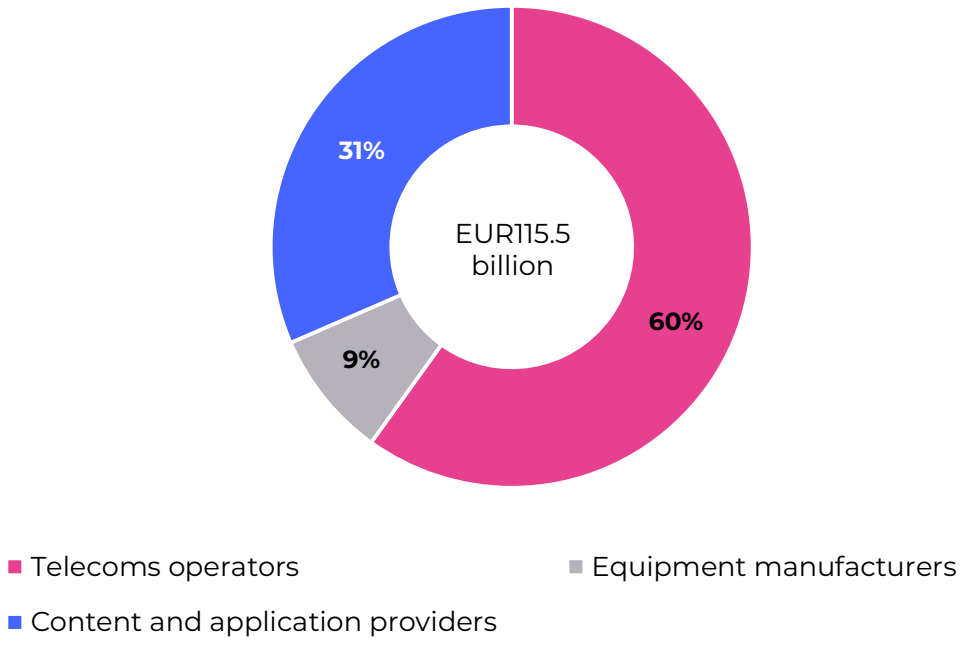
FIG 0.1 : Turnover by communications market component, Europe, 2023



Source: Eurostat and Analysys Mason estimates, 2024

Companies in Europe's digital communications market invested **around EUR115.5 billion in 2023** including investment in tangible fixed assets and in R&D. The majority of this (60%) was invested by the telecoms operators. These figures exclude investment in TV, video and music content.

FIG 0.2 : Investment in tangible fixed assets and R&D in Europe by communications market player type, 2023



Source: Eurostat and Analysys Mason estimates, 2024

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Direct benefits of operator investment for Europeans

On the network infrastructure targets the European Commission's report indicates that "additional investment of up to at least EUR200 billion is needed to ensure full gigabit coverage across the EU".

1.1 THERE HAS BEEN SOLID PROGRESS TOWARDS AMBITIOUS TARGETS

The European Union's Digital Decade Policy program sets out a range of targets designed to propel the region along the road towards "a successful digital transformation for people, businesses and the environment". The targets are aligned along four key themes: digital infrastructure, digital transformation of businesses, digital skills and digital public services. Provision of fixed and mobile broadband services underpin the entire program, but the EU has also set its sights on the next generation of digital applications and services – those that very high-speed broadband networks were specifically designed to enable.

Digital infrastructure. The program indicates that there should be universal access to FTTH and 5G services, with 100% coverage by 2030. In its latest report (published September 2024) the EU stated that in 2023, 89% of the EU's households had 5G coverage and 64% had FTTH coverage. A higher proportion of households (79%) were covered by a fixed very high capacity network. Rural coverage of FTTH in the EU rose from 40.7% to 52.8% between 2022 and 2023, and rural coverage of 5G rose from 51.0% to 73.7% over the same period.[2] The digital infrastructure program also targets deployment of 10 000 edge nodes and that the EU share of global semi-conductor production should double and comprise 20% of the world's production value by 2030.

Business. 2030 targets for business include 75% of firms using cloud computing and AI, the number of 'unicorns' doubling (equalling 498) and 90% of small and medium-sized enterprises (SMEs) to be using automated, digital processes for operations. In 2023 there were 263 unicorns in the EU, and 64% of the SME digital process target had been achieved, along with 52% of the cloud computing target and 11% of the AI target.[3]

[2] See Digital Decade 2024: Broadband Coverage in Europe 2023
[3] See Report on the state of the Digital Decade 2024, July 2024.

Skills. By 2030 there should be 20 million ICT specialists in Europe. In 2023, 48% of this goal had been reached (9.8 million). These targets specify a higher proportion of female ICT specialists, as in 2021 81% of ICT specialists were male. Additionally, 80% of the population should have basic digital skills – 69% of this target had been achieved (55.6% of the population).

Public services. The EU has a target of 100% of key public services for citizens and businesses being accessible online by 2030; the scores were 79% for citizen-relevant services and 85% for business-relevant services in 2023. In addition to this, all medical records should be accessible online by 2030 and 80% of European citizens should have their ID online.

Progress is reviewed biannually to advise member states on their trajectory. According to the latest report (published in July 2024) progress has been made on many fronts, but the EU is still far from reaching its targets. The digitalisation of businesses targets will not be met if progress continues at its current trajectory, and progress on skills is further off target. Member states are also behind the trajectory needed to achieve the target of 100% online accessibility of public services.

On the network infrastructure targets the report indicates that “additional investment of up to at least EUR200 billion is needed to ensure full gigabit coverage across the EU”. These financial estimates are for fibre and full 5G. They are calculated on the basis of the capital cost of a single network covering all remaining gaps. Actual build-out will not happen that way; there will be overbuild on the fibre side and overlapping coverage on the mobile side, so real investment levels will be significantly higher.

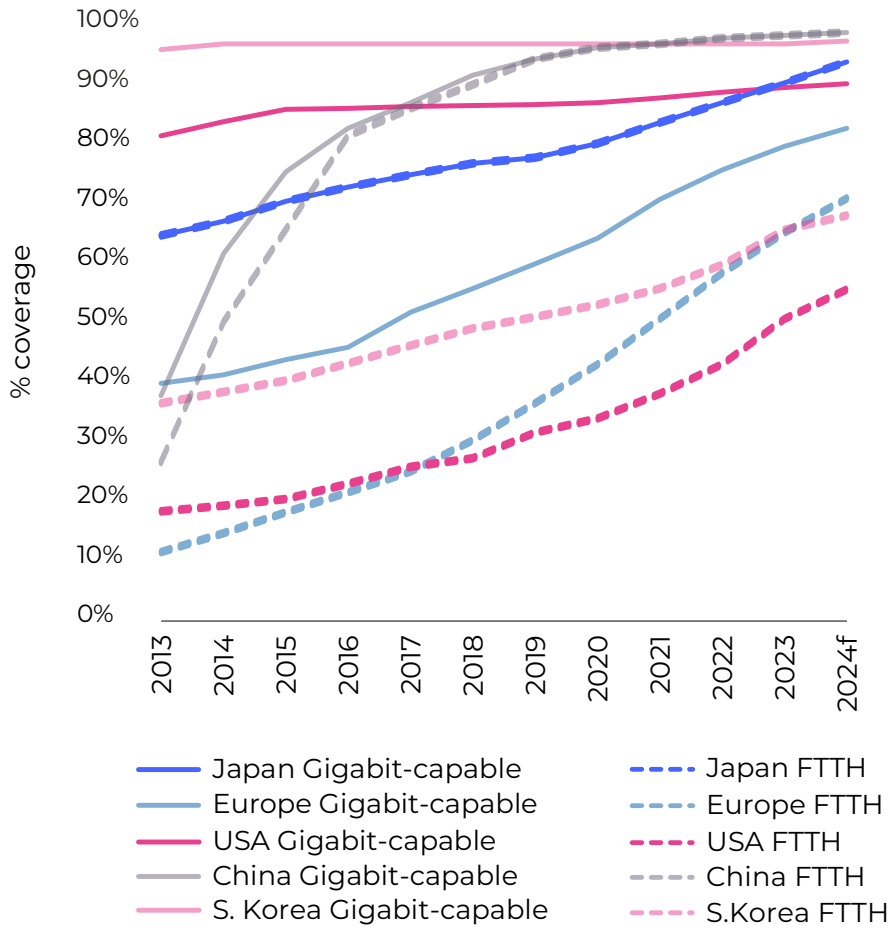
In office since December 2024, the newly approved college of Commissioners will work on the renewed focus on EU competitiveness for the next five years. Executive Vice-President Teresa Ribera Rodríguez in charge of Clean, Just and Competitive Transition, is responsible for ensuring Europe stays on track with its goals in the European Green Deal and for working towards a new approach to competition policy, enabling companies to innovate and compete in global markets. Executive Vice-President Henna Virkkunen in charge of Tech Sovereignty, Security and Democracy, will oversee the EU path towards reaching Europe’s 2030 Digital Decade targets and lead the review of the implementation strategy and digital targets in 2026. She will work to improve access to secure, fast, and reliable connectivity, as part of a broader strategy for connected collaborative computing, promoting the use of AI, cloud services and quantum computing. To this end, she will be working on a new Digital Networks Act to help boost secure high-speed broadband, both fixed and wireless.

FTTH coverage and speeds

Fixed broadband networks are the workhorse of the digital ecosystem, carrying about 88% of all combined mobile and broadband traffic in Europe in 2023. This means that improving fixed broadband connectivity is key to achieving the European Commission’s targets for achieving gigabit-capable networks. Multiple connectivity options are available, and they will all be part of a technology-neutral response to the “full gigabit

connectivity for all" challenge: fibre-to-the-home (FTTH or 'full fibre'), fibre-to-the-building (FTTB) with LAN-type cabling, and cable HFC with DOCSIS3.1 and, in the future, possibly DOCSIS4.0. While certain variants of 5G fixed-wireless access (FWA) hold the potential for gigabit connectivity, few existing FWA services offer such high downlink speeds. The largest share of new investment in fixed connectivity has, however, been in FTTH.

FIG 1.1 : Gigabit-capable and FTTH population coverage, China, Europe, Japan, South Korea and the USA, 2013-2024f



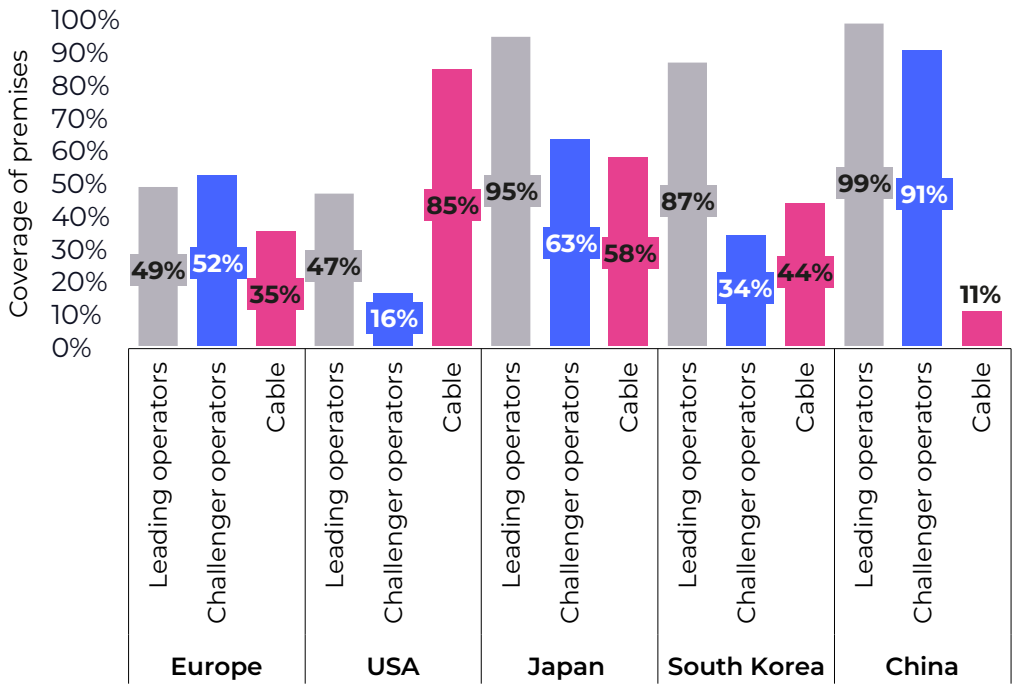
Source: Analysys Mason, 2024

Figures above include non-EU European countries within the Connect Europe perimeter.

Fiberising fixed access networks is a huge undertaking and represents the largest single investment in networks for a century. The pace of FTTH build has outstripped that in the USA, although the pace is picking up. By the end of 2024, population coverage of FTTH alone in Europe had reached 70.5%, and for all gigabit-capable networks, 82.5%.

Several FTTH investment models have developed over the recent past. Leading operators have launched joint-ventures and co-investments across key European markets, while infrastructure-focused private equity funds have been backing both wholesale-only operators as well as alternative operators.

FIG 1.2 : Coverage of gigabit-capable or gigabit-upgradeable networks by leading[4], challenger and cable operators, China, Europe, Japan, South Korea and the USA, 2024f

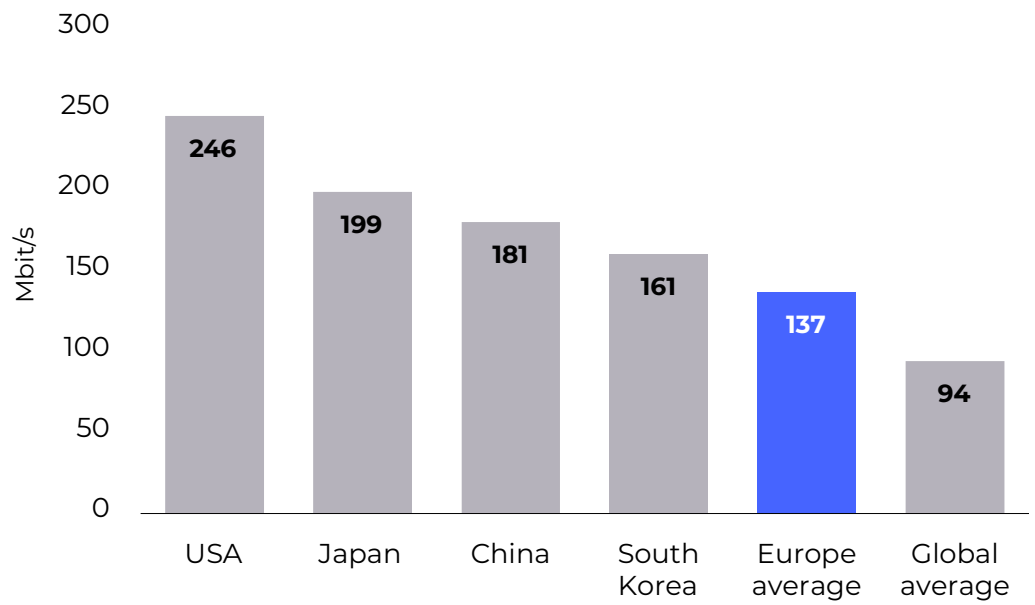


Source: Analysys Mason, 2024

[4] Leading operators in their home markets. Home markets are where the operator is the historical incumbent. Connect Europe members can be challenger operators in non-home markets.

Europe still trails behind its peer countries in terms of median speeds. A higher proportion of Europeans is reliant on xDSL than in comparator Asian markets; and while cable networks, originally installed to deliver multichannel TV, can be upgraded to deliver gigabit internet access; a larger proportion of European households (59%) lack access to those cable networks compared to the USA (15%).

FIG 1.3 : Median fixed downlink speeds, China, Europe, Japan, South Korea and the USA, September 2024



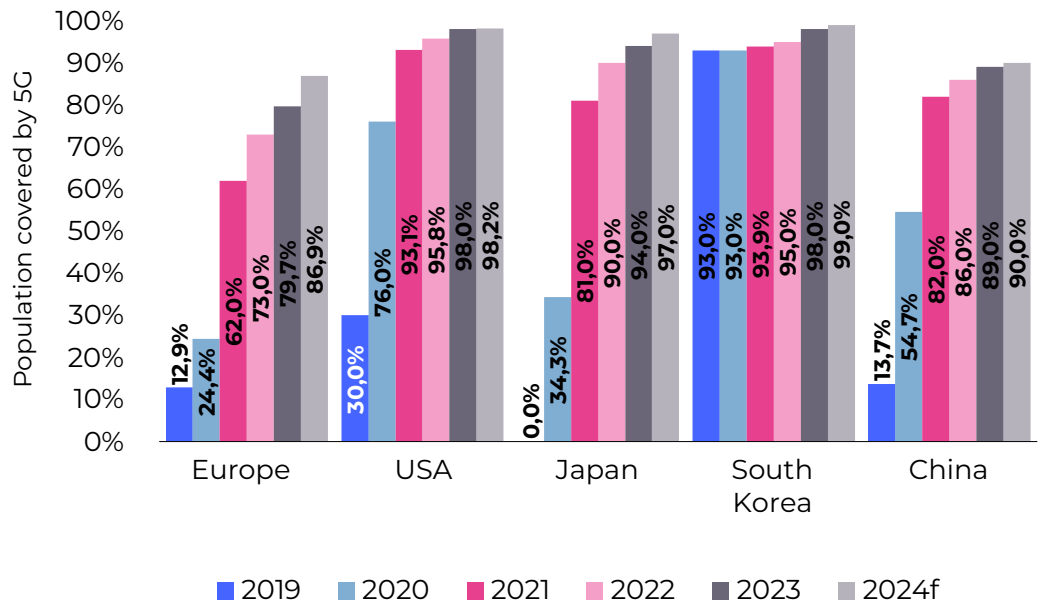
Source: Ookla[5], 2024

5G coverage and speeds

By the end of 2024 we forecast that around 87% of the population of Europe will live within outdoor range of at least one MNO 5G network, up from 80% at the end of 2023. The equivalent coverage figure for the population of EU member states at the end of 2024 is 90%, up from 82% at the end of 2023. Individual member states, including the three most populous, had coverage well over 95%. Nevertheless, Europe and EU coverage remains lower than in Japan, South Korea and the USA.

[5] See Ookla Speedtest Global Index. Data extracted for September 2024. The Europe figure is a calculated as an average weighted by population.

FIG 1.4 : Percentage of the population covered by at least one 5G mobile operator, China, Europe, Japan, South Korea and the USA, 2019–2024f

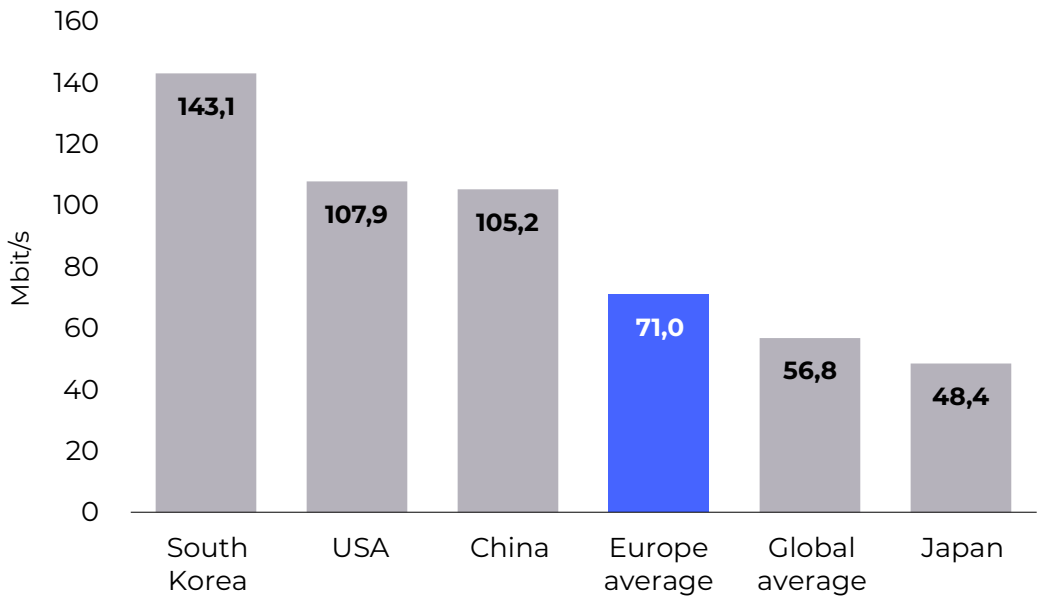


Source: Analysys Mason, 2024

It is important to add nuance to coverage figures, as they should also be viewed in the context of the spectrum used. Low-band spectrum (600MHz in North America but 700MHz elsewhere) enables rapid roll-out of networks to provide basic 5G coverage. However, capacity is limited, and a 5G network based on low-band spectrum on its own offers only marginal improvements in end-user experience when compared with LTE networks. Dynamic spectrum sharing (DSS), which allows 4G and 5G services to be provided simultaneously from the same infrastructure, has a similar effect in terms of delivering a 5G service, but provides only for a 4G experience. 5G networks using mid-band spectrum at 3.5GHz offer substantially improved capacity and experience. The deployment of 3.5GHz-based capacity is now the focus of most 5G operators worldwide. Where deployment of 5G in mid-band spectrum follows 5G in low-band spectrum, the overall coverage figure will not change, whereas the customer experience changes significantly.

The average end-user speeds delivered on mobile networks broadly reflect the state of roll-out of mid-band 3.5GHz 5G networks, without which the performance enhancement of 5G would be modest.

FIG 1.5 : Median mobile downlink speeds, China, Europe, Japan, South Korea and the USA, September 2024



Source: Ookla[6], 2024

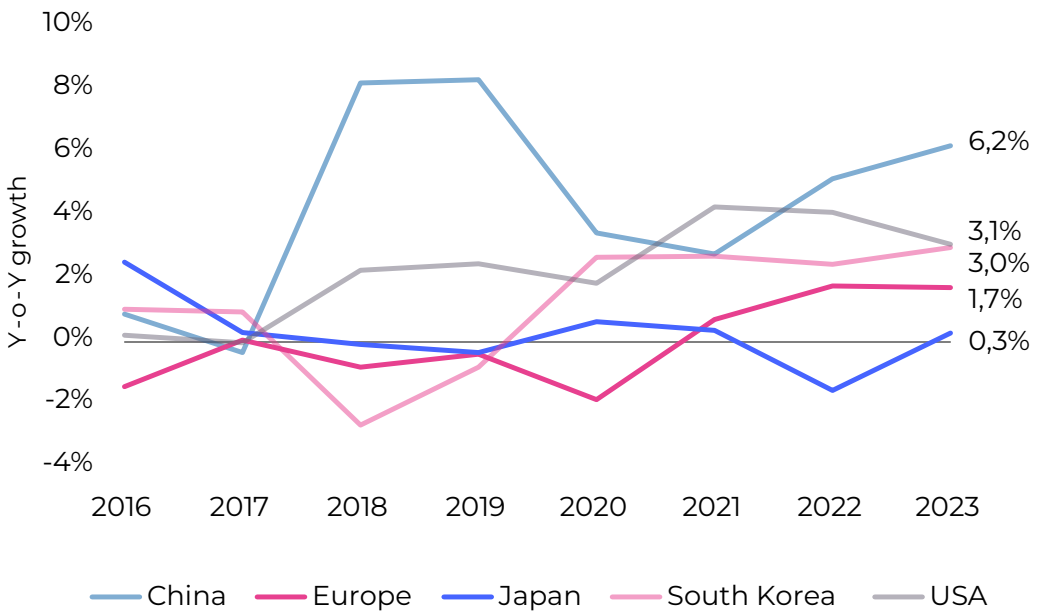
Median European mobile downlink speeds are higher than the global average, but they are lower than those in South Korea, China and the USA. It is important to recognise, however, that with mobile, speed is a complex interplay between installed capacity and usage, and therefore recorded medians can fall as well as rise; China's median speed is lower in 2024 than in 2023.

[6] See Ookla Speedtest Global Index. Data extracted for September 2024. The Europe figure is a calculated as an average weighted by population.

1.2 REVENUE GROWTH REMAINS WEAK AND HAS BEEN FALLING IN REAL TERMS SINCE 2016

Retail revenue growth in the European telecoms sector stood at 1.7% in 2023, a growth-rate barely changed since 2022, and in real terms it fell 4.4%. Mobile, just over half of revenue, grew at 2.5% and fixed grew at 0.9%. Given the high level of bundling of fixed and mobile, especially in the consumer segment, accurately assessing the split of revenue is increasingly difficult. Revenue growth was weaker than in China, South Korea and the USA.

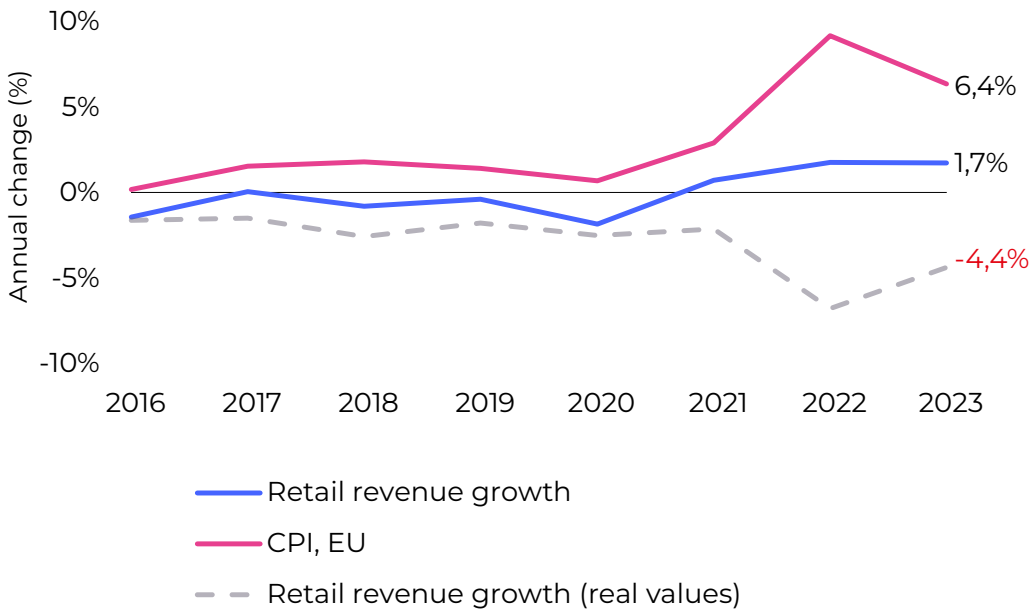
FIG 1.6 : Revenue growth, China, Europe, Japan, South Korea and the USA, 2016-2023



Source: Analysys Mason, 2024

The inflation rate in the EU remained high at 6.4% in 2023, even though it fell from 9.2% in 2022. It was higher than in any of the comparator countries.

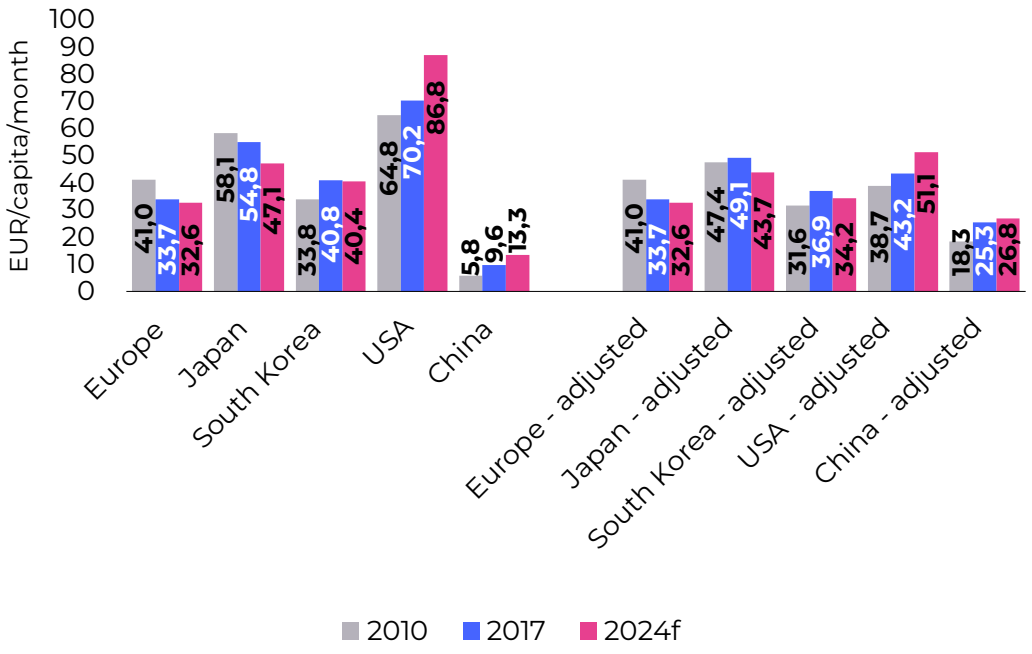
FIG 1.7 : Revenue growth compared to inflation, EU, 2016-2023



Source: Analysys Mason, 2024

Since 2017, average spend per capita on telecoms services in the comparator countries has headed in different directions. Spend per capita has increased in the world's two largest economies, plateaued in South Korea, and fallen in Europe and Japan. The figures for Japan reflect the falling value of the yen in relation to the euro.

FIG 1.8 : Average spend per capita on mainstream telecoms, nominal and adjusted for GDP/capita (PPP), China, Europe, Japan, South Korea and the USA, 2010, 2017 and 2024f

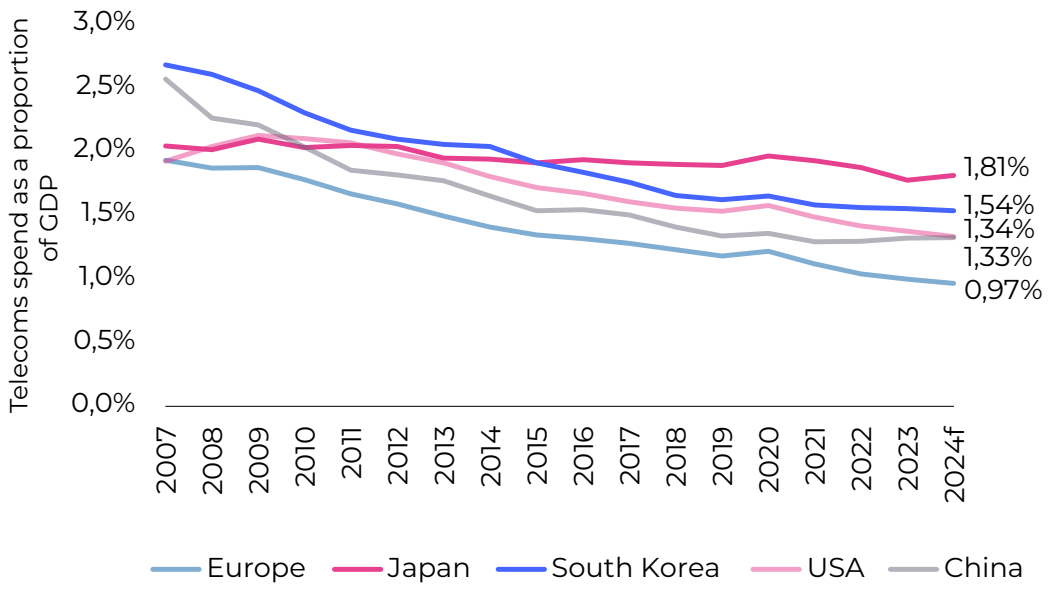


Source: Analysys Mason, 2024

For the first time in Europe, retail telecoms spend[7] fell to just below 1% of GDP in 2023, and looks set to fall again in 2024. In 2007 it was close to 2%. The swift decline in the value of telecoms services in relation to GDP is common to most advanced economies: the share declines despite improving quality of services. What sets Europe apart is that retail telecoms has represented a consistently lower share of GDP than elsewhere.

[7] Excludes non-connectivity related value-added services in B2C and B2B, excludes TV/video, excludes wholesale and interconnect revenue.

FIG 1.9 : Telecoms spend as a proportion of GDP, China, Europe, Japan, South Korea and the USA, 2007–2024f



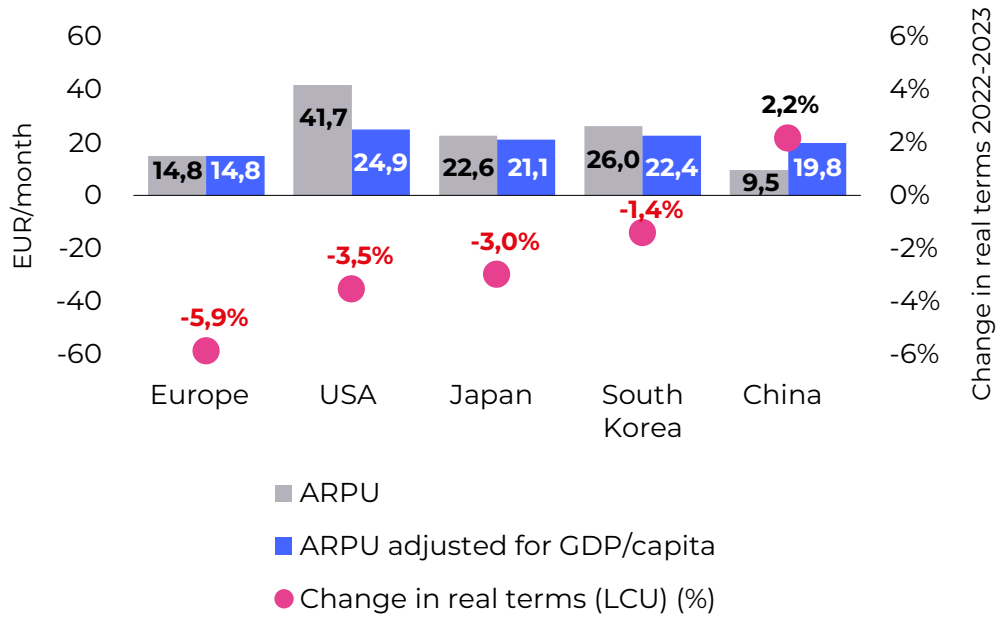
Source: Analysys Mason, 2024

The discrepancy between telecom services spend as a proportion of GDP in Europe and in the other advanced economies shows that regulatory initiatives have likely resulted in artificially low prices, arguably below consumer valuations.

Average revenue per user (ARPU) in both mobile and fixed remains low in Europe, particularly so in mobile. Low prices may be good for consumers and businesses in the short term, but they are not fit for encouraging long-term investment in innovative services, network evolutions or for investing in network coverage where the commercial case is marginal: indeed they often make the commercial case for network expansion non-existent.

Mobile ARPU in Europe stood at just EUR14.8 in 2023, a decline in real terms of 5.9% compared to 2022, and substantially lower than all comparator countries when adjusted for differences in GDP/capita. This reflects artificially high competition, stagnating demand for larger data bundles, and mobile discounts in European fixed-mobile bundling.

FIG 1.10 : Mobile ARPU (excluding IoT SIMs), nominal and adjusted for GDP/capita (PPP), and change in real terms (LCU), Europe, USA, Japan, South Korea and China, 2023

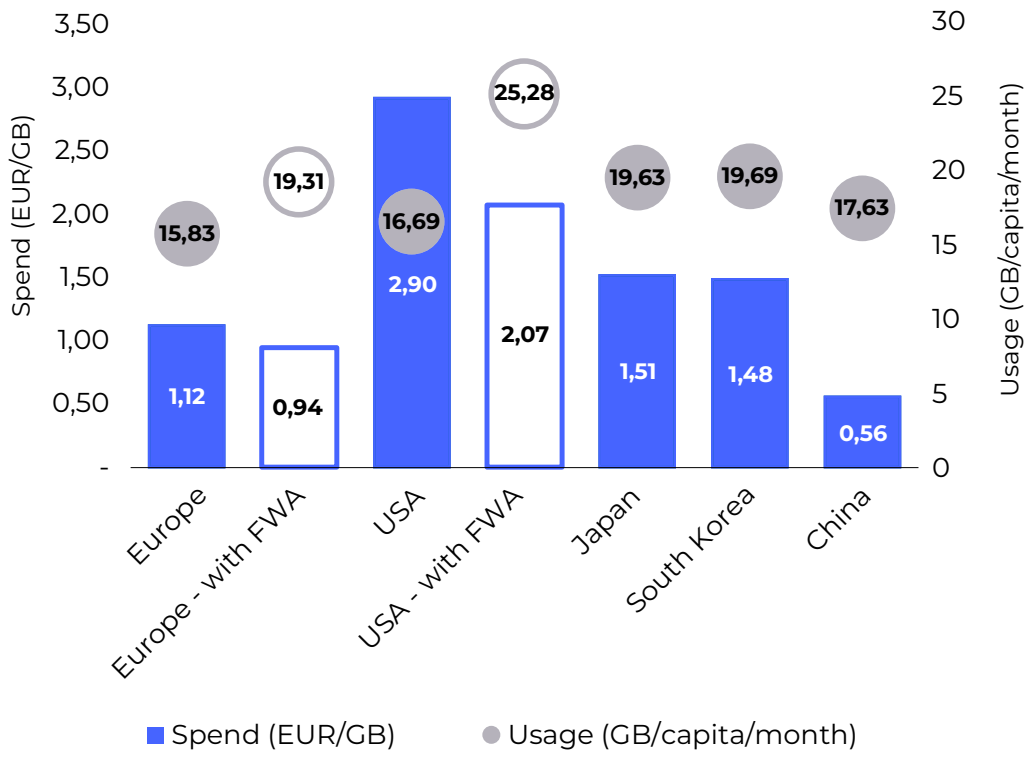


Source: Analysys Mason, 2024

While the differences between Europe and comparator countries in terms of average mobile data usage per capita are evening out, a reflection of a saturation effect in smartphone usage already evident in the most advanced 5G markets such as South Korea, the differences between how much users pay per gigabyte used remain extremely marked[8]. Revenue per used gigabyte of mobile data in the USA is 159% higher than in Europe.

[8] It is important to note that this figure is not based on the retail price of data packages, but revenue divided by data used.

FIG 1.11 : Average spend per gigabyte of mobile data used and average mobile data usage per capita, China, Europe, Japan, South Korea and the USA, 2023

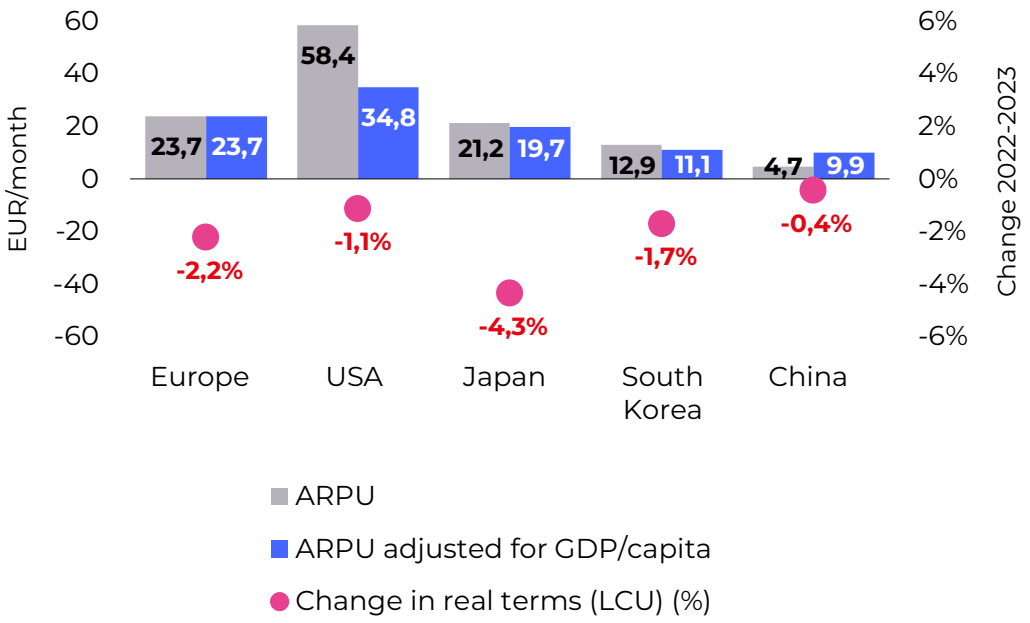


Source: Analysys Mason, 2024

Figures above are not directly comparable with the figures from last year's report, due to splitting out the impact on total traffic and on revenue of FWA in this year's report. FWA is an important component of traffic on mobile networks in the USA (34% of total traffic in 2023), and to a lesser extent in Europe (18% of total traffic in 2023), but has much weaker impact in Japan, South Korea and China. The distinction is an important one to make because FWA – particularly in the USA – is a means of monetising fallow capacity, and has usage levels that come close to fixed broadband usage (around 25 times higher than mobile). FWA therefore generates a tiny fraction of the revenue per gigabyte generated by mobile services. Yet even when FWA traffic and revenue is taken into account, revenue per gigabyte of data in the USA is more than double that in Europe.

European fixed broadband ARPU fares a little better in relation to comparators, but remains much less than fixed broadband ARPU in the USA.

FIG 1.12 : Fixed broadband ARPU, nominal and adjusted for GDP/capita (PPP), and change in real terms (LCU), Europe, USA, Japan, South Korea and China, 2023



Source: Analysys Mason, 2024

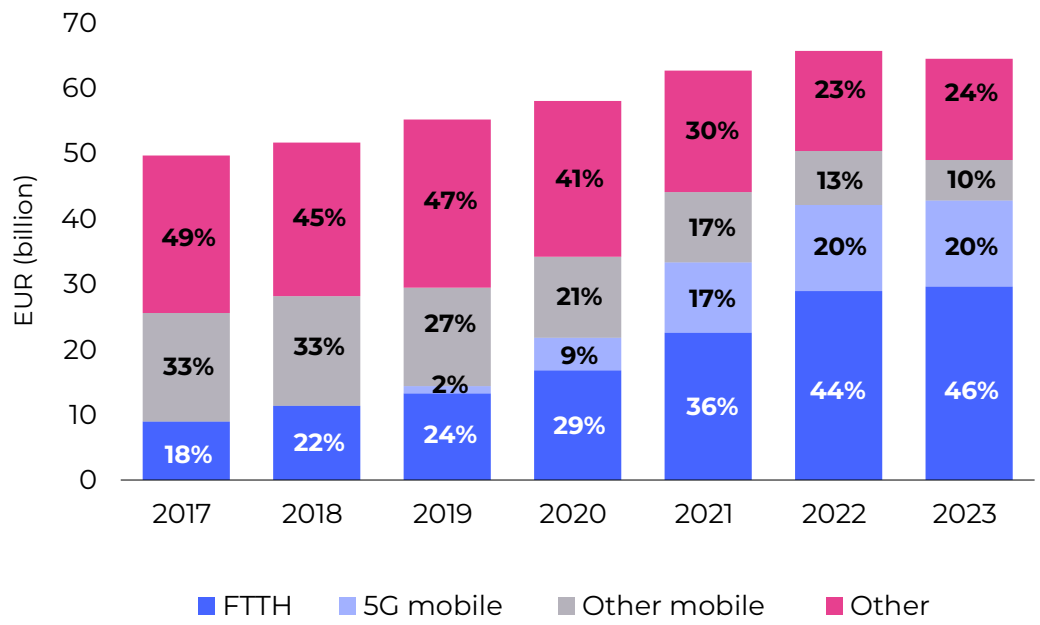
The USA has easily the largest monthly fixed broadband ARPU at EUR58.4. The USA has lower levels of competition in fixed broadband than Europe, although recent investment in FTTH, plus the launch of competitive FWA services, have increased competition for the hitherto dominant cable players. It also, critically, imposes no *ex ante* SMP regulation in broadband access. The miniscule level of fixed broadband ARPU in China requires some explanation.[9] The total of the reported subscriber bases of the main service providers now significantly exceeds the number of premises (residential and business) in China. It is our understanding that fixed broadband (almost invariably FTTH) is normally sold in fixed-mobile bundles that carry such a heavy discount that end-users may subscribe to more than one broadband connection. Thus many reported fixed broadband subscriptions are likely to be inactive, and these depress ARPU. It is also likely that FMC bundling in South Korea, where prices are set to encourage churn on mobile, depresses ARPU there. Something of the opposite effect may be felt in Europe (i.e. low additional SIM prices in FMC bundles depresses mobile ARPU).

[9] China continues to have by far the lowest ARPU in both the fixed and mobile markets, but there are a two important market differences to take into account. First, Chinese operators are majority state-owned. This means, despite the Chinese government renouncing direct involvement in telecoms prices in 2014, operators still follow its 'guidance'. Such guidance aims to improve connectivity speeds while lowering prices, and on occasions the government can request price decreases. Second, regional operating divisions of the mobile companies have the freedom to adjust local prices according to local economic conditions. Taken as a whole, China still has GDP per capita at about a third that in Europe.

1.3 OVERALL CAPEX ON EUROPEAN TELECOMS NETWORKS FELL IN 2023 AFTER A DECADE OF GROWTH

Evidence collated by European national regulatory authorities indicated that the long rise in capital expenditure on telecoms peaked in 2022 and declined by 2% in 2023.

FIG 1.13 : European telecoms capex, FTTH, 5G, 4G and other, 2017-2023



Source: Analysys Mason, 2024

The data is collected by NRAs in differing ways, but typically includes all players in the networks value-chain, including investors purely in passive network infrastructure (towers, passive fibre infrastructure etc.). The total figure is therefore higher than operator capex alone, and the figure for the peak in 2022 (EUR65.8 billion) is higher than our estimate of European capex in 2022 in last year's report (EUR59.1 billion), which was calculated based on operators alone.

An aggregation of NRA reported data shows that in 2023 about 46% of capex went towards FTTH, and a further 20% towards 5G. In other words, two thirds of investment is going towards new, faster and more reliable access networks. The main components of

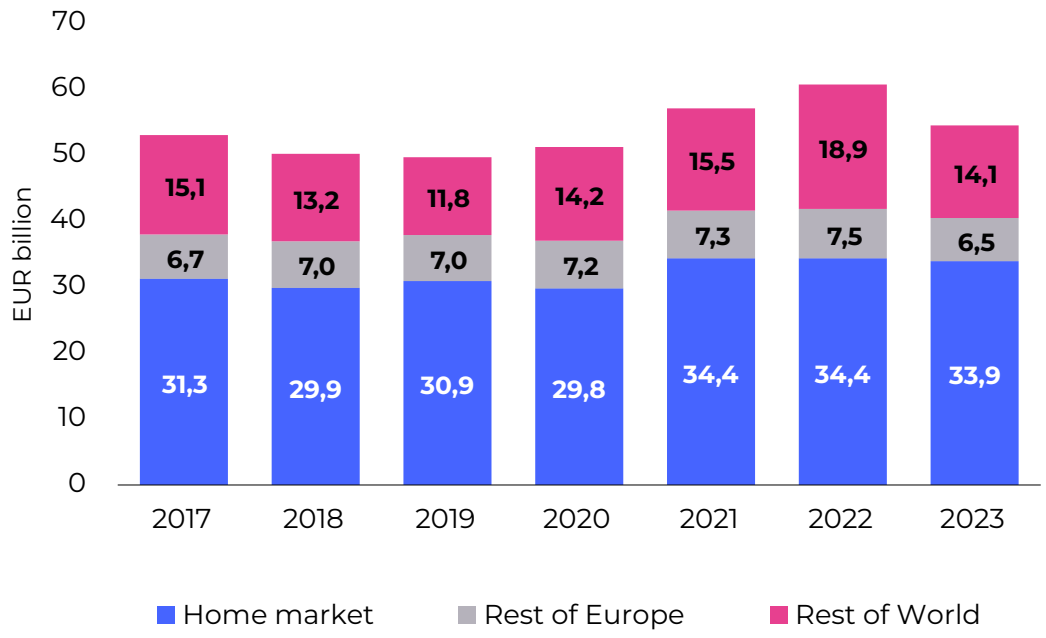
the ‘Other’ category are metro and transport networks and IT, as well as various forms of legacy fixed networks (including both copper and cable networks). The figures exclude payments for spectrum and other licences.

Clearly, the main factor that has swollen capex in Europe is FTTH, which has seen continuous growth for over a decade. Fibre infrastructure has a very extended useful asset-life, has a ‘one-off investment’ characteristic, and investment will ease off for the rest of the decade. Investment in mobile has historically been more cyclical with each generation. After the first wave of 5G network deployment, capex eased off significantly in 2023. The investment required for 6G, when it appears, is still to be assessed. The fact that several countries have reached, or will soon reach, an investment peak in terms of network roll out, at least in fixed networks, is in line with the guidance given by the majority of larger operators, and is in line with the known investment plans, particularly in fibre infrastructure, by the myriad smaller investors in this area. This does not however mean the end of network capex; there will still be investment required for network evolutions, for capacity increases where it is required, and for cybersecurity.

1.4 CONNECT EUROPE MEMBERS INVESTED EUR54.5 BILLION IN 2023

Connect Europe members are the historical operators in many European markets ('Home markets' below), are challenger operators in others ('Rest of Europe' below), and own operators in the rest of the world. At a group level, Connect Europe capex fell back in 2023 to EUR54.5 billion from EUR62.8 billion in 2022. A single factor explains much of this decline: capex at Deutsche Telekom group company T-Mobile USA fell by EUR4.1 billion as 5G coverage neared completion. The decline in capex in Europe alone was less marked. The reasons for the decline are not simply to do with the cadence of infrastructure investment needs; a lack of certainty around return on investment in a hyper-competitive market also dampens capex.

FIG 1.14 : Connect Europe member capex (excluding spectrum costs), home markets, rest of Europe and rest of the world, 2016–2023

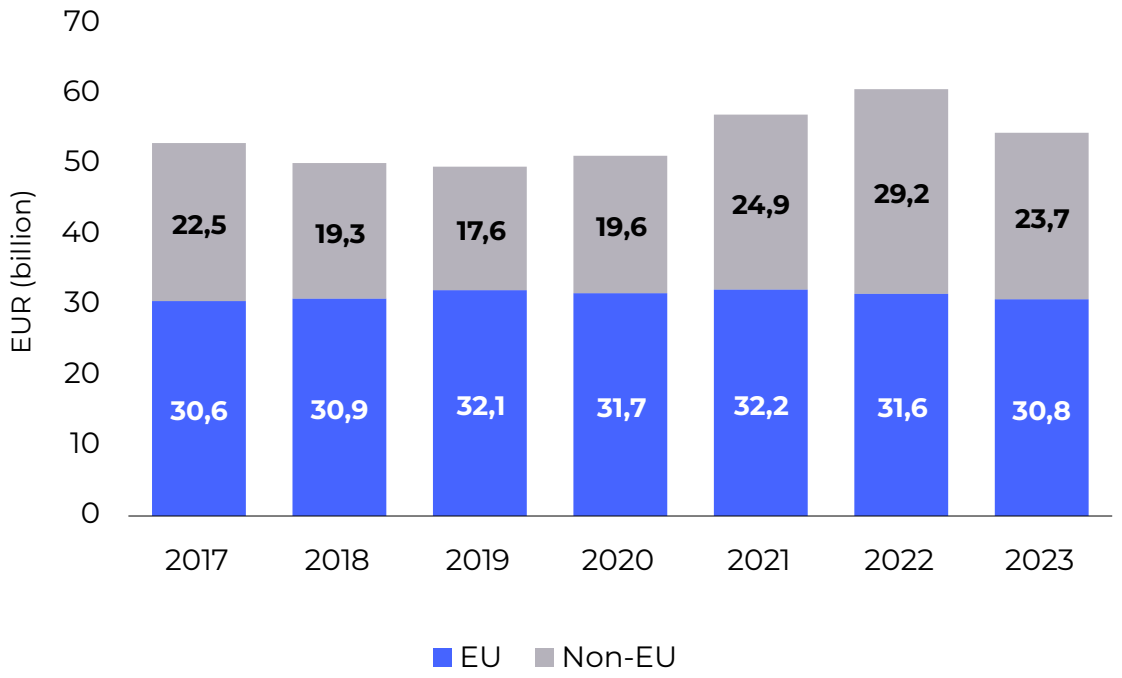


Source: Analysys Mason, 2024[10]

[10] The figures are not directly comparable with last year's report as the membership of Connect Europe has expanded.

EUR30.8 billion of this sum was invested within the EU, representing about 57% of Connect Europe group capex.

FIG 1.15 : Connect Europe member capex (excluding spectrum costs), EU and non-EU, 2016-2023

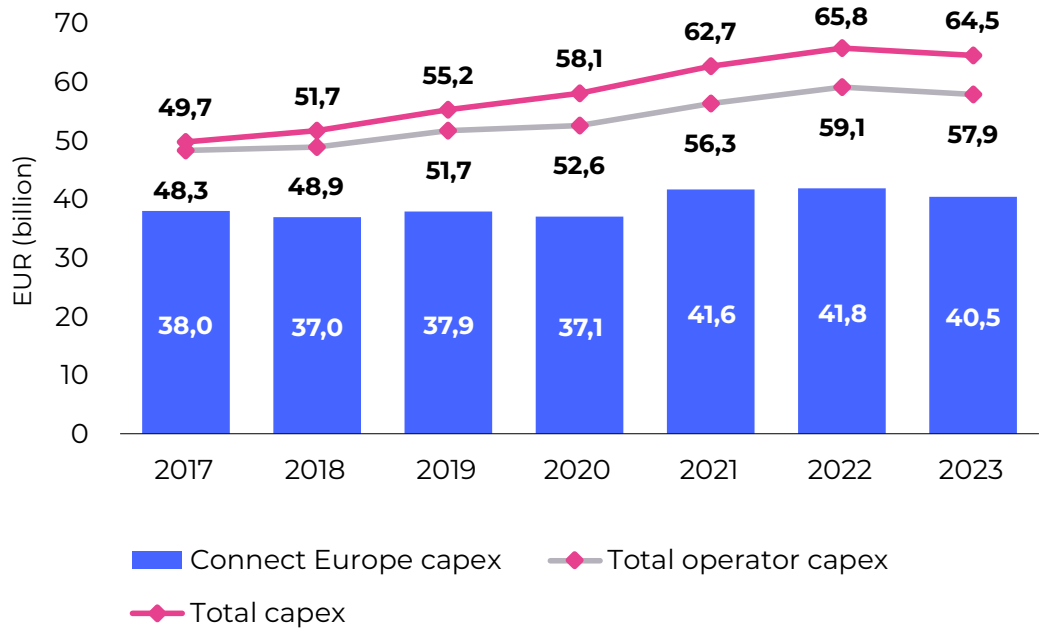


Source: Analysys Mason, 2024

Connect Europe members' share of European operator investment stood at 70% in 2023

In Europe (including in non-EU states) Connect Europe members' capex stood at EUR40.5 billion in 2023. Total operator capex stood at EUR57.9 billion and total capex for all European telecoms networks (including non-operator capex) stood at EUR64.5 billion.

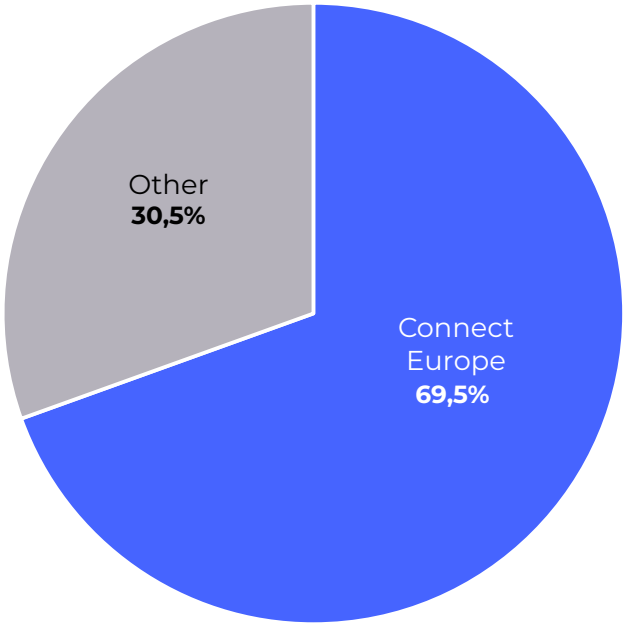
FIG 1.16 : Connect Europe member capex in Europe only (excluding spectrum costs), total operator capex, and total capex in Europe, 2017–2023



Source: Analysys Mason, 2024

FIG 1.17 shows the split of capex by operators (excluding investments by non-operators) between Connect Europe members and other operators.

FIG 1.17 : Split of operator capex between Connect Europe members and other operators, Europe, 2023



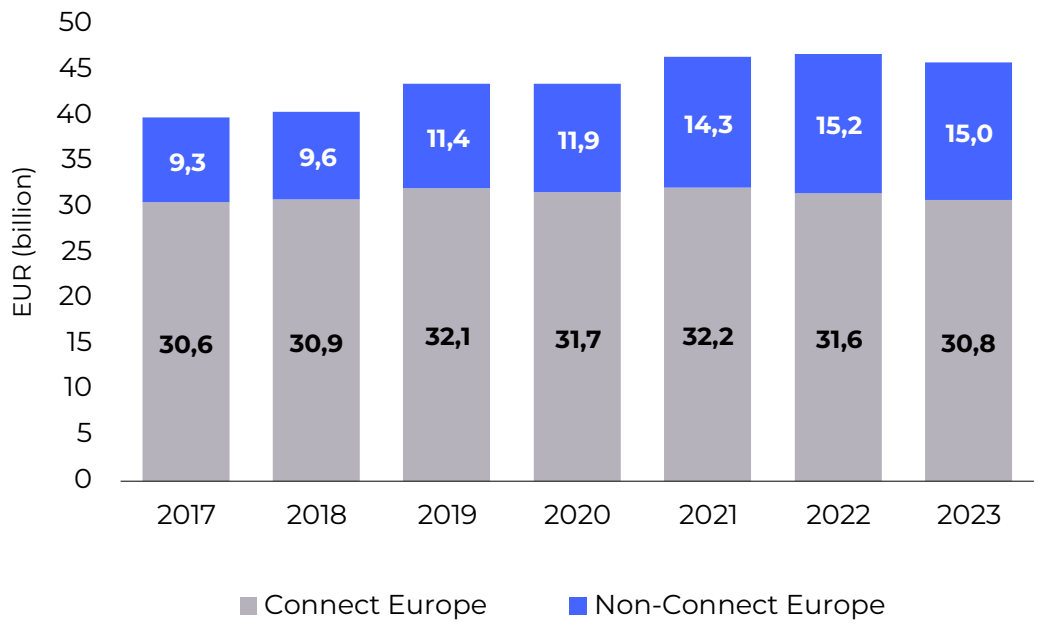
Source: Analysys Mason, 2024

On the basis of telecoms operator capex alone, Connect Europe represents 69.5% of capex. These proportions are not directly comparable with those in last year's report as they reflect the enlarged membership of Connect Europe, which now includes Liberty Global and JVs between Connect Europe members.

Within the EU, Connect Europe members spent approximately EUR30.8 billion as capex in 2023. That figure represents 67.2% of total operator capex in the EU. These figures and proportions also reflect the enlarged membership of Connect Europe.

FIG 1.18 shows the split of operator capex between Connect Europe and non-Connect Europe in the EU alone.

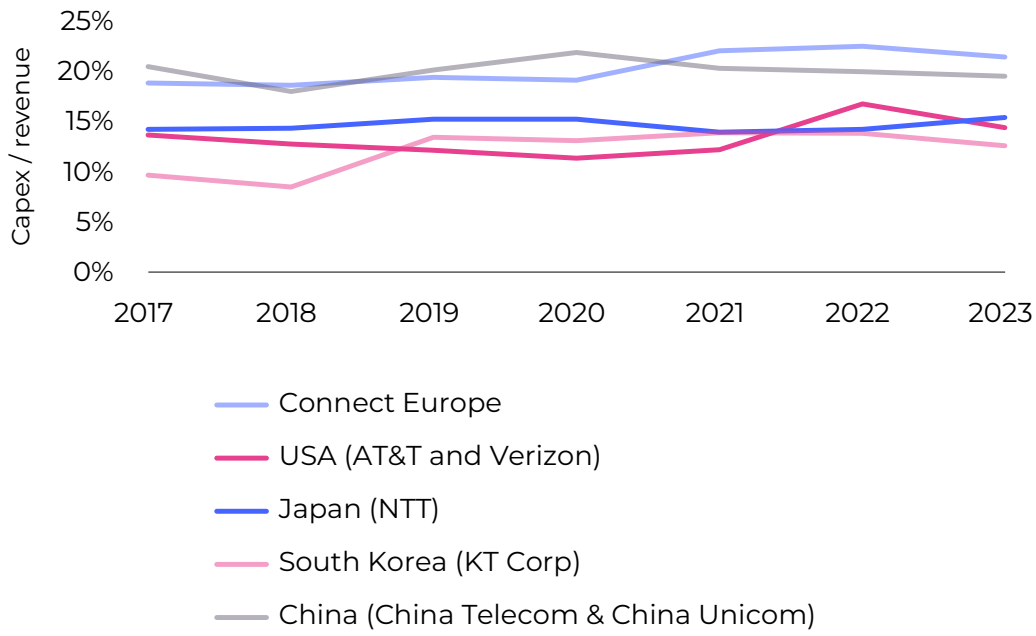
FIG 1.18 : Total operator capex, EU27, Connect Europe and non-Connect Europe, 2017-2023



Source: Analysys Mason, 2024

Connect Europe capex intensity is higher, and has been consistently higher, than for peer operators in Japan, South Korea and USA, and more recently higher than for operators in China.

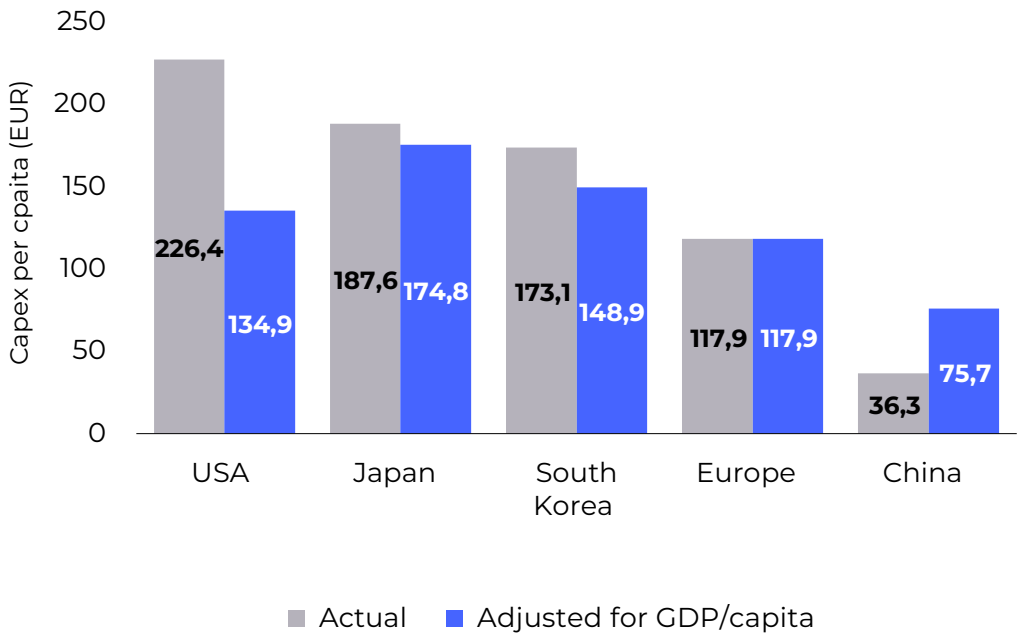
FIG 1.19 : Capital intensity in home markets, Connect Europe members and comparable leading operators in China, Japan, South Korea and the USA, 2017–2023



Source: Analysys Mason, 2024

This high capex intensity in Europe has to be seen in the context of lower revenue. The actual investment per capita is substantially lower than that in the USA and Japan, even when adjusted for differences in GDP per capita.

FIG 1.20 : Capex per capita, China, Europe, Japan, South Korea and the USA, 2023

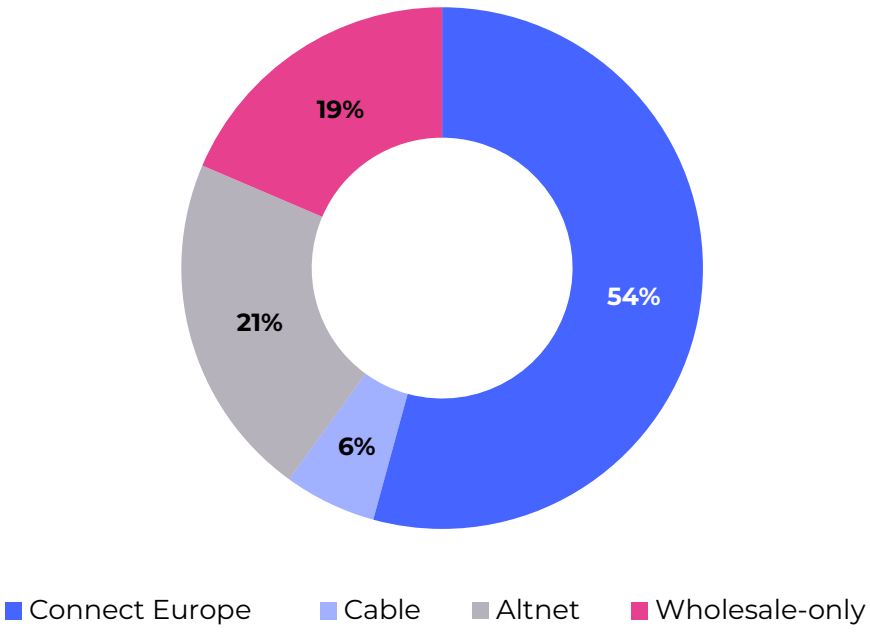


Source: Analysys Mason, 2024

Connect Europe share of FTTH investment stood at 54% in 2023

FTTH has been the largest single component of European operator capex for the past four years. Connect Europe members directly contributed EUR16.1 billion, or 54% of total investment in 2023. Fixed access capex is distributed among a greater number of players than mobile capex. A plethora of new regional and local FTTH players compete with the established telecoms operators. These can be split into two groups: wholesale-only operators and vertically-integrated altnets. Cable operators' investments in broadband can be divided into two camps: those that are self-overbuilding their legacy hybrid fibre coax (HFC) plant with FTTH, and those that are content to upgrade their HFC-based technologies (to DOCSIS3.1 and in the future DOCSIS4.0). The former is more capex intensive than the latter, although cable operators will be looking to FTTH to deliver not only improved network performance but also lower operating costs.

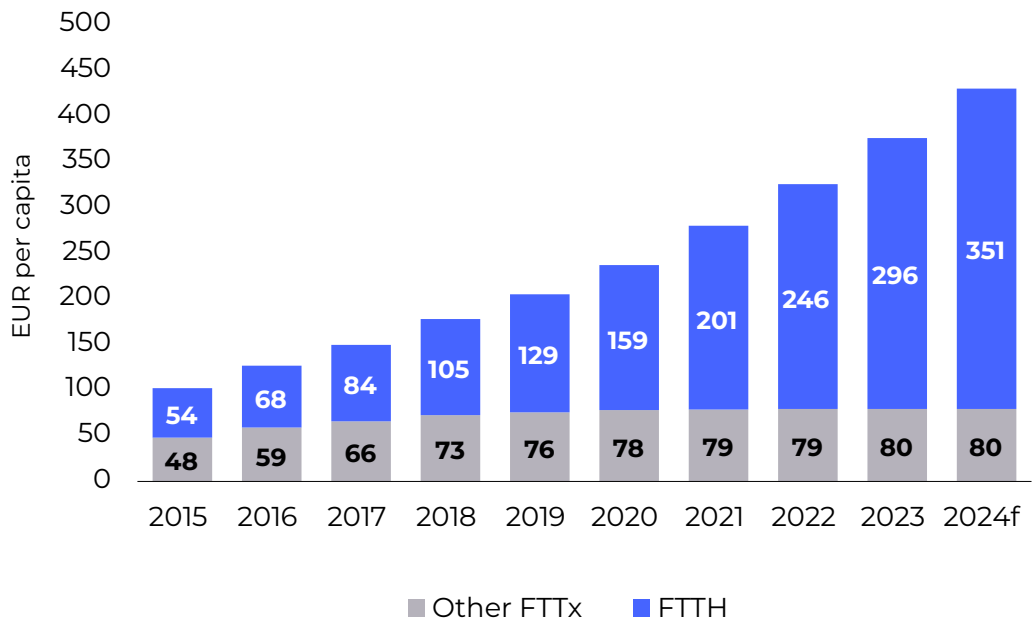
FIG 1.21 : Split of FTTH capex between Connect Europe members and other operator types, Europe, 2023



Source: Analysys Mason, 2024

The EU has encouraged infrastructure-based competition in FTTH networks, which has, in most countries, had the effect of delivering overbuilt networks in some areas and less investment in others. The level of FTTH-on-FTTH overbuild was 1.4 aggregate premises passed to 1 unique premises passed at the end of 2023. This ratio will grow as cable operators start to upgrade to FTTH.

FIG 1.22 : Cumulative FTTH capex per capita, Connect Europe and others, 2015–2024f



Source: Analysys Mason, 2024

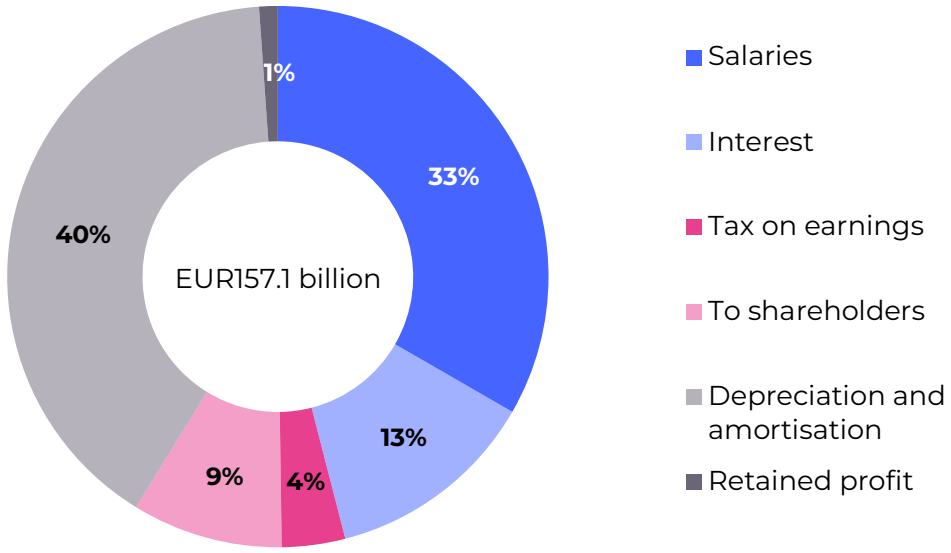
The total investment in FTTH by the end of 2024 stood at EUR296 per capita, the equivalent of EUR579 for every premises in Europe, including those not yet covered. If earlier waves of telco investment in FTTx (including fibre to the cabinet and fibre to the building) are included the figures rise to EUR376 per capita and EUR734 per premises.

02

Connect Europe members deliver substantial indirect benefits for Europeans

Operators are embedded in the overall economy and in people's lives, and therefore how operators spend on the opex side has many indirect benefits for Europeans. Value-added (essentially revenue minus the direct cost of goods and services) stood at EUR157.1 billion in 2023. The distribution of this value has substantial indirect benefits for the broader European economy, for employees, for suppliers and for shareholders.

FIG 2.1 : Distribution of value added, Connect Europe members at the group level, 2023

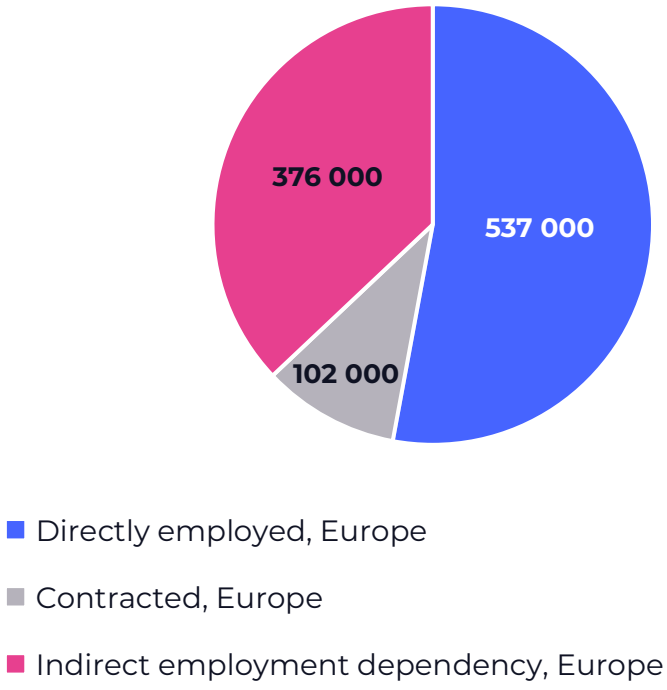


Source: Analysys Mason, 2024

2.1 INVESTING IN QUALITY EMPLOYMENT

Connect Europe members are substantial employers and create many high quality jobs. They employ over a million people in Europe including those employed directly, those employed by subcontractors, and those employed by the companies that supply goods and services to them (i.e. indirect employment dependency). These figures exclude around 291 000 directly and indirectly employed people working for Connect Europe members outside Europe.

FIG 2.2 : Direct and indirect employment by Connect Europe members in Europe, 2023



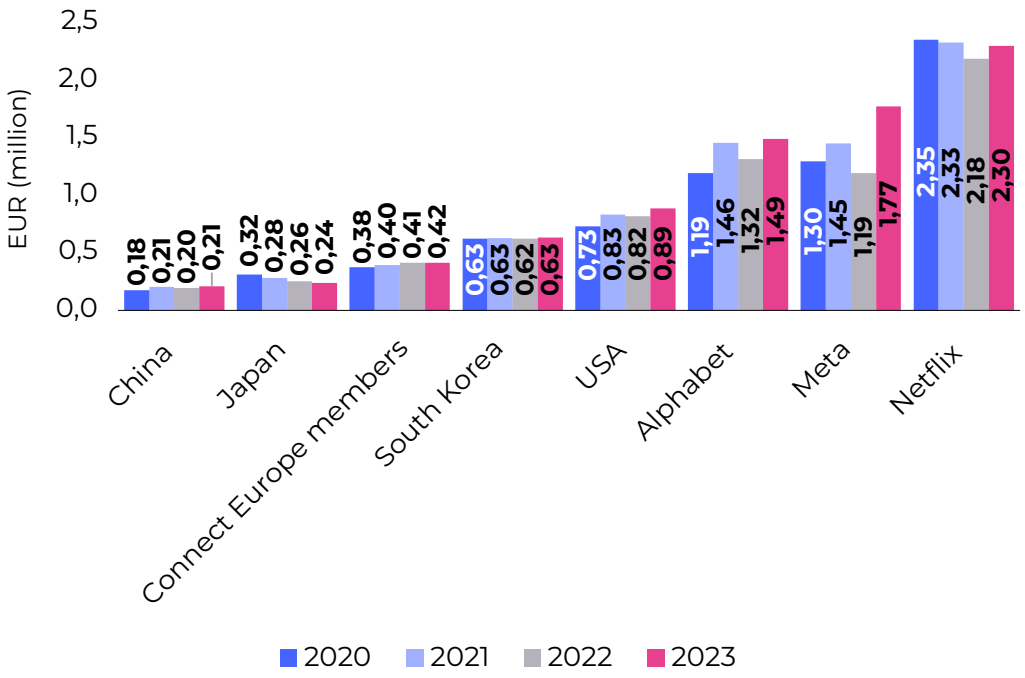
Source: Analysys Mason, 2024

Boosting productivity

FIG 2.3 compares the revenue per employee for Connect Europe members and their counterparts in China, Japan, South Korea and the USA, plus leading content and application providers (CAPs). Connect Europe members have recorded incremental productivity gains in recent years, but the process is slow and not above inflation. The disparity between Connect Europe members and US operators can be attributed to economies of scale and substantial differences in revenues. The declining figures for Japan reflect what are, unusually, growing levels of staffing set off against flat revenue and a depreciating yen; in local currency revenue per employee has been stable over the period. In local currency the figures for South Korea would show gains in productivity.

CAP productivity, measured this way, has fluctuated more, reflecting a higher level of hiring and firing relative to their headcounts than is typical – or indeed possible – for infrastructure-heavy network operators.

FIG 2.3 : Revenue per employee for Connect Europe members, operators in China, Japan, South Korea and the USA and selected CAPS, 2018–2023

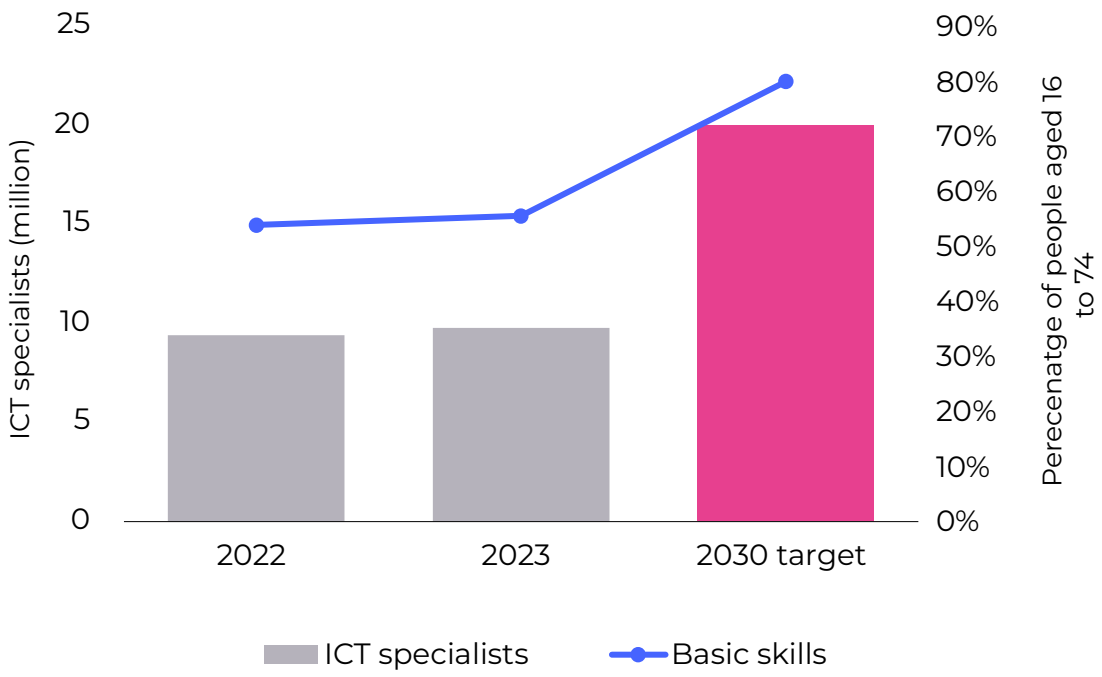


Source: Analysys Mason, 2024

Addressing the ICT skills shortage

A key factor in improving productivity of employees will be increasing the skill levels of Europe's workforce. The European Commission reported in its latest State of the Digital Decade report[11] that although a steadily increasing proportion of the population is reasonably well equipped with basic ICT skills, the region looks likely to fall well short of the European Commission's target of 80% of all adults between 16 and 74 being equipped with basic skills by 2030, and based on current rates of improvement the region is even further away from its target number of 20 million ICT specialists by 2030.

FIG 2.4 : Size of the ICT skills gap



Source: European Commission, 2024

[11] Report on the state of the Digital Decade 2024 | Shaping Europe's digital future at https://digital-strategy.ec.europa.eu/en/library/report-state-digital-decade-2024

The variation in skills knowledge between countries remains wide, with fewer than 28% of adults having basic skills at the low end, and nearly 83% at the high end.

Operators have launched a range of projects designed to increase ICT skills and ensure that both internal and external talent are equipped with the latest technological competencies to thrive in a rapidly evolving digital world. Examples include:

Orange - Initiatives on skills

Orange has committed to bridging the skills gap through various initiatives. By 2025, each country of the Orange footprint will have an Orange Digital Center providing inclusive digital training and access to digital tools for underserved communities, empowering individuals with critical skills for the digital economy. Additionally, the Orange Cybersecurity Academy offers specialized training programs aimed at developing cybersecurity expertise, supporting both career development and securing the digital landscape. Furthermore, Orange provides AI training opportunities for its employees through various programs such as the Center of Excellence and Dinootoo, which focuses on the secure professional use of large language models (LLMs).

Telenor - High level forum on AI skills

Telenor is hosting a forum focused on AI skills building, and aimed at fostering a broad dialogue about the future use of AI technologies. The forum will consider the skillsets needed by AI developers and AI users to enable responsible use of AI and to ensure its use benefits wider society. The forum brings together interdisciplinary experts and will review how AI use can ensure fair, non-discriminatory and equal treatment and opportunities for all.

TIM - TLC 4.0 project funded by the Digital Republic Fund under the FUTURA initiative

This program, developed in partnership with Enaip Piemonte, CNOS-FAP, and CIM 4.0, is focused on upskilling women aged 18–35 who are currently inactive or unemployed. Participants undergo 120 hours of intensive digital skills training, complemented by 120 hours of personalised coaching to enhance their confidence and employability. Additionally, the program includes internship placements, ensuring participants gain hands-on experience in professional environments. By combining technical training, career coaching, and practical experience, the initiative not only addresses the ICT skills gap but also promotes workforce diversity and inclusion, empowering women to thrive in the digital economy.

Altice – Digital Academy

Altice Portugal has been tackling the ICT skills gap through its Altice Academy initiative, which offers a wide range of training courses and workshops tailored to professional profiles within the company. Through its Virtual Campus, employees gain access to role-specific programs that enhance skills in key areas such as software development, data analysis, cybersecurity, and customer service excellence. The initiative also emphasizes leadership development to prepare employees for managerial roles and provides technical certifications to validate expertise in critical domains. By fostering continuous learning and adaptability, Altice Academy ensures that employees remain competitive and well-equipped to meet the evolving demands of the telecommunications sector while aligning with Altice's commitment to innovation and excellence.

Deutsche Telekom - Teachtoday

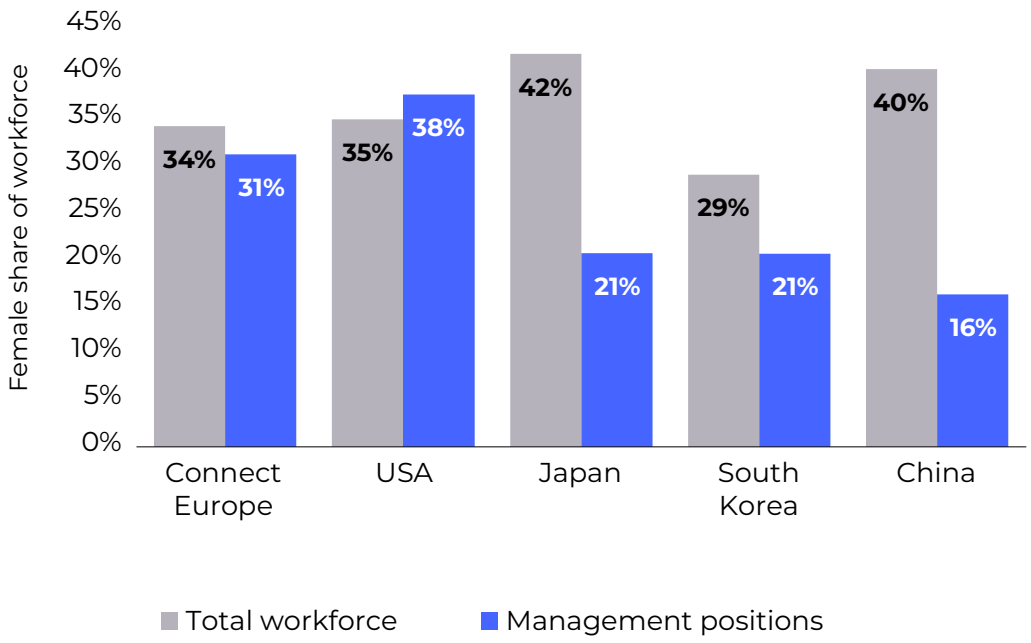
This initiative supports children, young people, parents, and grandparents as well as teaching professionals with hands-on tips and materials about safe, proficient media usage. The digital toolbox comprises over 140 different formats, including product ideas, video tutorials and quizzes.

Collectively, these initiatives show how operators are working to address the ICT skills shortage in Europe, contributing to both workforce development and the region's broader digital transformation goals.

The gender gap is slowly narrowing

Most telcos measure employee gender diversity and the numbers highlight that females remain a minority in operator workforces, particularly in leadership and management roles.

FIG 2.5 : Share of women in the workforce among Connect Europe members and similar leading operators in China, Japan, South Korea and USA, 2023



Source: Analysys Mason, 2024

At the end of 2023, the female share in operator workforces varied between region, and in general, most operators are maintaining a consistent proportion of women in their total workforce year-on-year. Japan and China have the highest female represented workforces (42% and 40%, respectively) but also the lowest female representation at management positions (21% and 16%, respectively). The discrepancy between total female employment and females within management roles is much narrower for Connect Europe members and operators in the US. Several major telecom operators in Europe and the US now have female CEOs, including BT, Telenor, Vodafone, Altice Portugal, and Orange.

Most Connect Europe members are committed to increasing female representation across their workforce by setting targets and implementing organisational and national initiatives to increase the presence of women both at entry level and in senior roles.

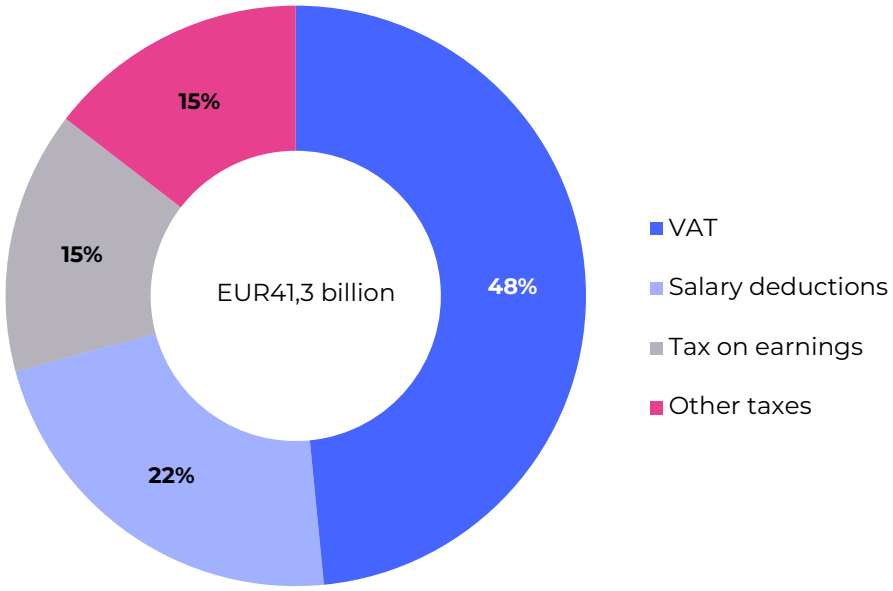
For example, in October 2023, TIM Group launched a Women Plus App, which was created to support women's employability by matching their skills to available jobs, and encouraging the education of women in STEM activities by providing appropriate training courses on finance and entrepreneurship. The app has received the patronage from the European Commission.

Many operators have also launched talent development programs such as those relating to coding or campaigns to attract more women to the sector. For instance, BT commissioned research into gender-neutral language for advertising and its Watch Me campaign successfully attracted 300% more women to engineering roles, and Orange organises Hackathon Women in Tech events.

2.2 CONTRIBUTING VIA GENERAL AND SECTOR-SPECIFIC TAXATION

Connect Europe members paid around EUR41.3 billion in direct taxes (tax on earnings and other direct taxes) and indirect taxes (VAT and salary deductions) for their European operations in 2023; this is equivalent to about 22% of their revenue base.

FIG 2.6 : Total direct and indirect tax, Connect Europe members (Europe only), 2023



Source: Analysys Mason, 2024

The 'other taxes' category includes property taxes and telecoms-specific charges such as recurring spectrum licence fees (but not the prices paid at auction), fees for using numbering resources, specific taxes on telecoms assets (such as pylons and copper), universal service costs, the cost of financing national regulatory authorities and obligations to finance other sectors (such as public TV). The value of sector-specific telecoms taxes can in some jurisdictions actually be higher than tax on earnings: for instance in France these various taxes reached EUR1.6 billion in 2023, a 5% increase compared to 2018, and they represented 64% of the total direct tax paid[12]. The prices paid at auction for spectrum licences are not strictly a tax, but they have a similar function. European operators (Connect Europe and non-Connect Europe) paid a total of EUR32.4 billion at auctions between 2018 and 2023.

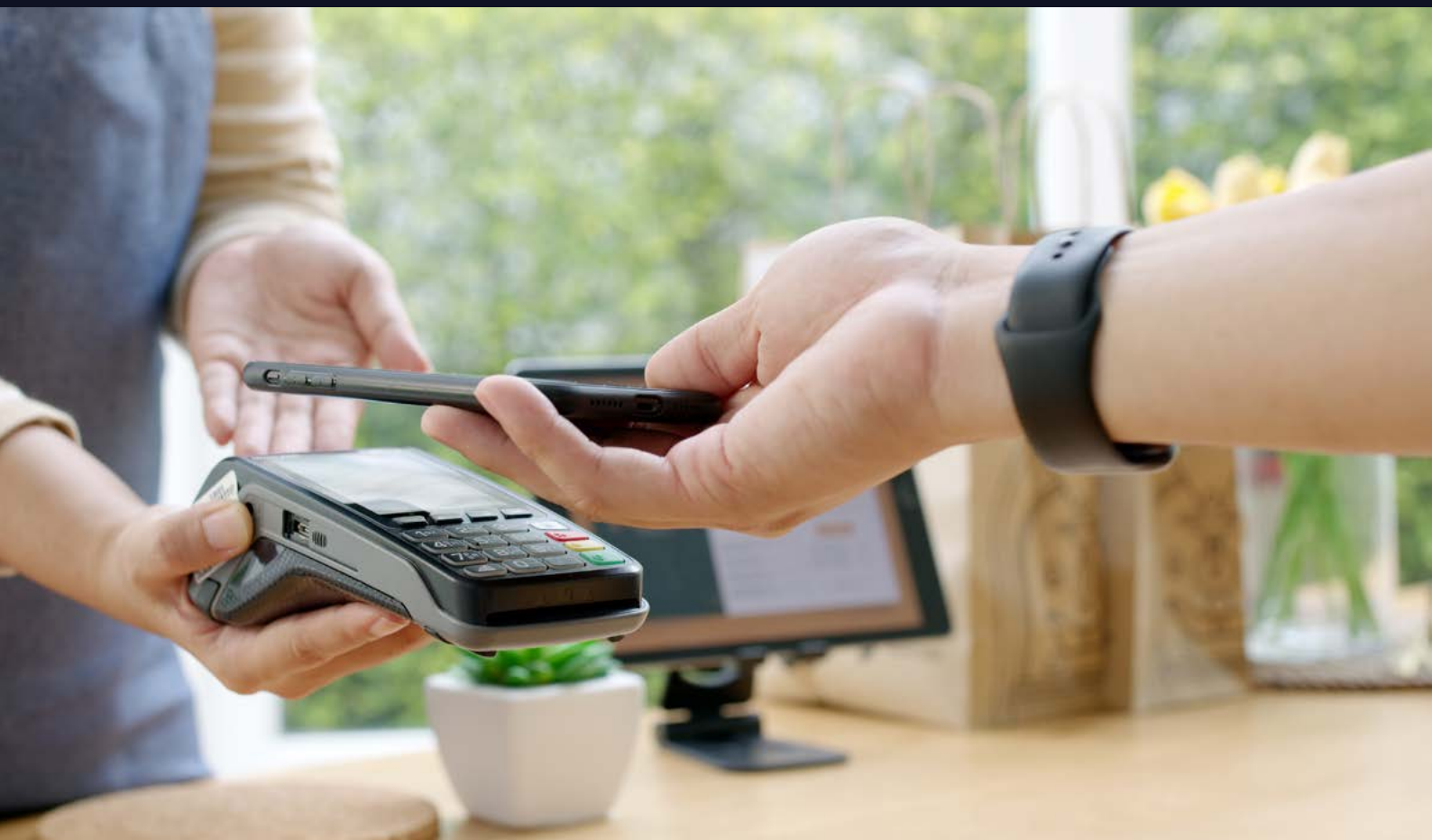
[12] See Etude Economique 2024, FFTélécoms, p14.

2.3 THE DISTRIBUTION OF PROFIT

A high proportion of Connect Europe members' shares are in the hands of institutional investors such as pension funds. Hence the sustained net profitability of the industry has a direct impact on Europeans' well-being. Aggregate net profit for Connect Europe members stood at EUR15.9 billion in 2023, down 22% from 2022. In 2023, Connect Europe members distributed EUR14.2 billion in dividend payments related to 2022 income, a value down only fractionally (2%) over the previous year.

03

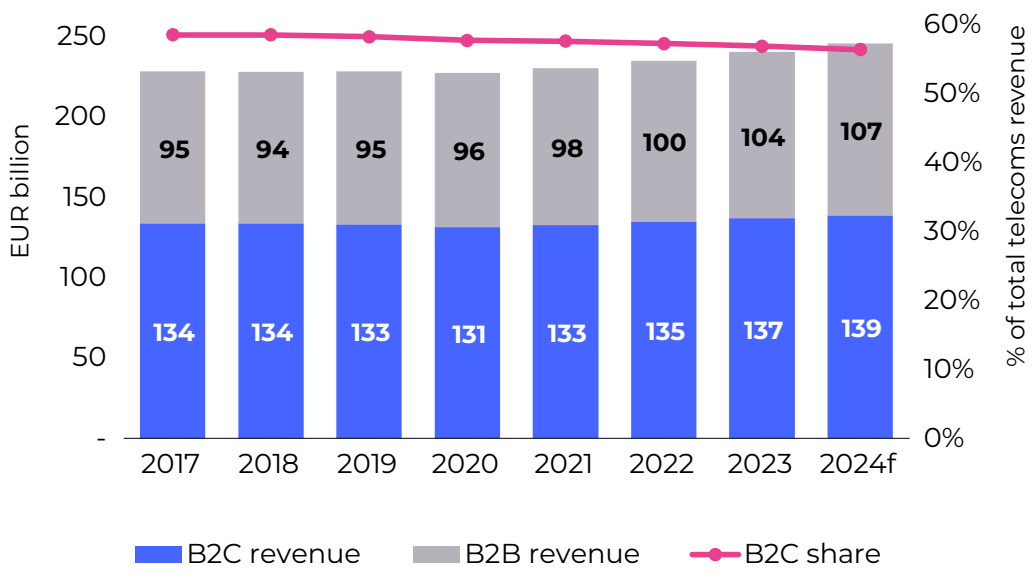
Changing demand for connectivity and digital services



The retail telecoms market comprises both consumer and business-orientated services. The split between these two is very slowly shifting. Tough competition between operators in the European consumer market is suppressing revenue growth, and while operators are facing tough competition in the B2B market too, including from OTT services, they are managing to innovate and this is helping them to sustain a slightly better rate of revenue growth.

Although big business customers spend very substantial sums of money on telecoms services, the consumer telecoms market is larger in revenue terms, simply because there are many more consumer customers than there are business customers. Business-to-consumer (B2C) revenues will represent about 56.4% of all retail revenue at the end of 2024.

FIG 3.1 : Operators' B2B and B2C revenue and the B2C share of the total telecoms revenue, Europe, 2017–2024f



Source: Analysys Mason, 2024

The following sections explore the dynamics of the consumer and business telecoms markets and how they are evolving.

3.1 DEMAND FOR HIGH SPEED CONNECTIVITY

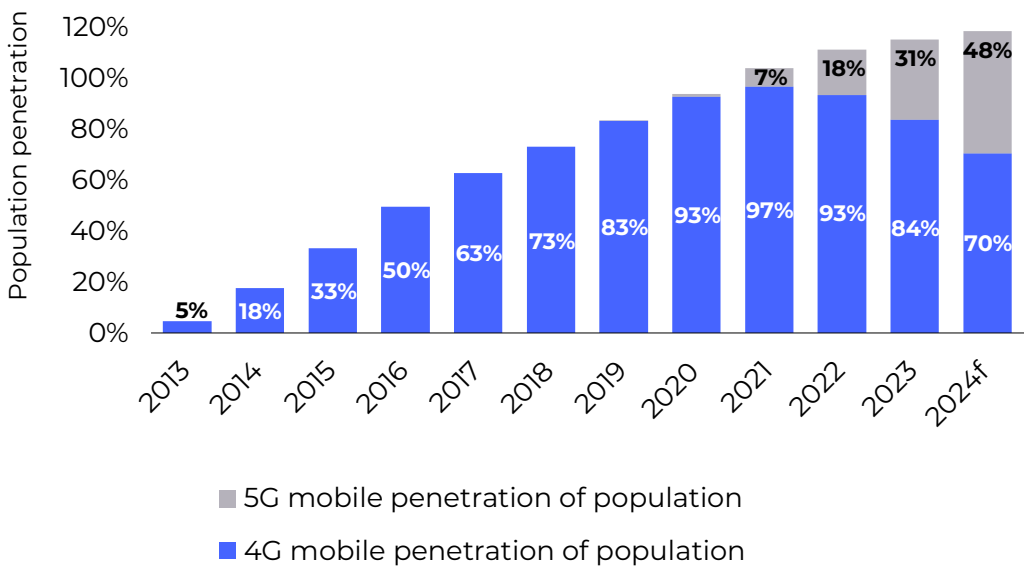
The European telecoms market is increasingly mature. Mobile penetration is well above 100% and high-speed broadband services are available to most of the region's population. This means there is limited opportunity to drive the growth of the market by selling additional connections. Growth needs to come from better monetisation of services, and the introduction of new, additional services.

Mobile connections

5G services are now widely available in most European countries. Western European countries continue to be leaders in terms of 5G adoption in Europe. However, some Central and Eastern European countries like Hungary and Slovakia also have high 5G population penetration.

5G population penetration in Europe as a whole increased from 17.9% in 2022 to 31.3% in 2023. Investments in expanding the coverage of 5G networks, the increased availability of 5G-capable devices and the launch of more service plans that include 5G network access encouraged more customers to upgrade to 5G. 5G population penetration is expected to reach nearly 48% in 2024 (**FIG 3.2**). Nonetheless, Europe will still lag behind countries such as China (105.8% in 2024[13]) and Japan (67.7% in 2024), which were much quicker to invest in the new technology.

FIG 3.2 : Population penetration of 4G and 5G, Europe, 2013–2024f



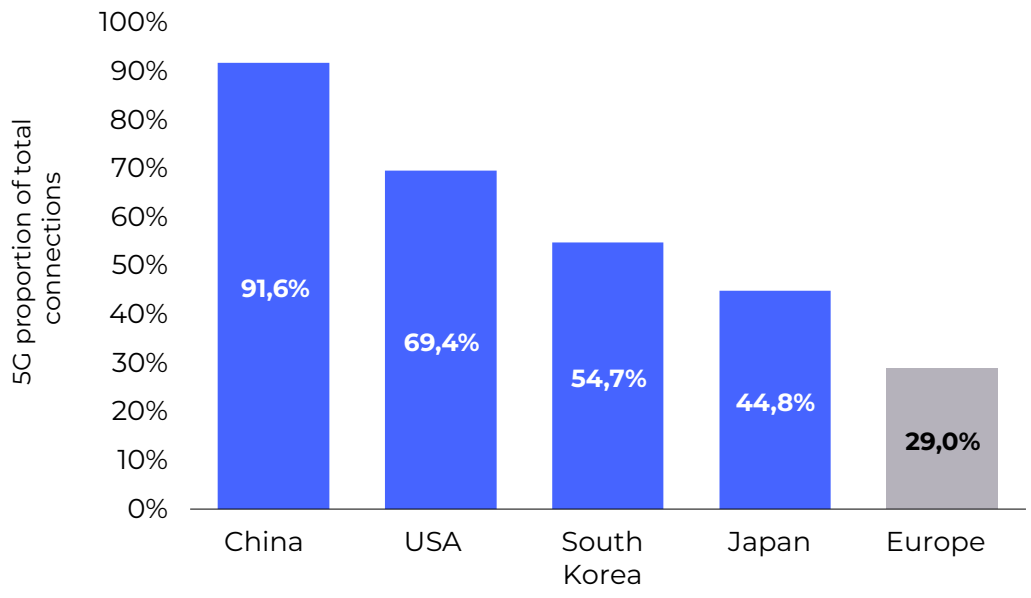
Source: Analysys Mason, 2024

5G share of mobile connections reached 29% in Europe at the end of June 2024.*

5G share of mobile connections remains lower in Europe than in other regions due to factors such as delayed auctions and investment, lower coverage, and also possibly longer device replacement cycles. China remains well ahead of Europe, with a 5G share of connections of 91.6% as of June 2024. USA, South Korea and Japan are also ahead of Europe with a 5G share of mobile connections of 69.4%, 54.7% and 44.8%, respectively (**FIG 3.3**).

5G share of mobile connections (including 5G NSA and 5G SA) grew at a faster rate in the USA and Japan compared to Europe in the twelve months to June 2024. The 5G share of mobile connections increased by 10.1 percentage points in Europe. This is slightly below the 12.2 percentage point growth in the USA and 11.4 percentage point growth in Japan. At the same time, Europe gained ground on China and South Korea, which rose by only 9 and 5.2 percentage points, respectively.

FIG 3.3 : 5G share of all mobile connections, China, Europe, Japan, South Korea and the USA, 2Q 2024



Source: Analysys Mason, 2024

[13] It should be noted that China's figures include all those with subscription packages that theoretically permit use of the 5G network; those subscribers do not necessarily have 5G capable phones. The figure exceeds 100% due to double subscriptions.

* This figure is lower than 5G penetration because overall mobile penetration (connections per 100 people) exceeds 100%.

5G services are expected to continue to gain in popularity in Europe. The number of 5G mobile connections is projected to increase by over 90 million between 2023 and 2024, reaching 267 million in 2024. The share accounted for by LTE services declined for the first time in 2022 due to growth in 5G take-up, and it is expected to decrease further in 2024. Around 75 million connections will be upgraded between 2023 and 2024, leaving LTE with a population penetration of 70%.

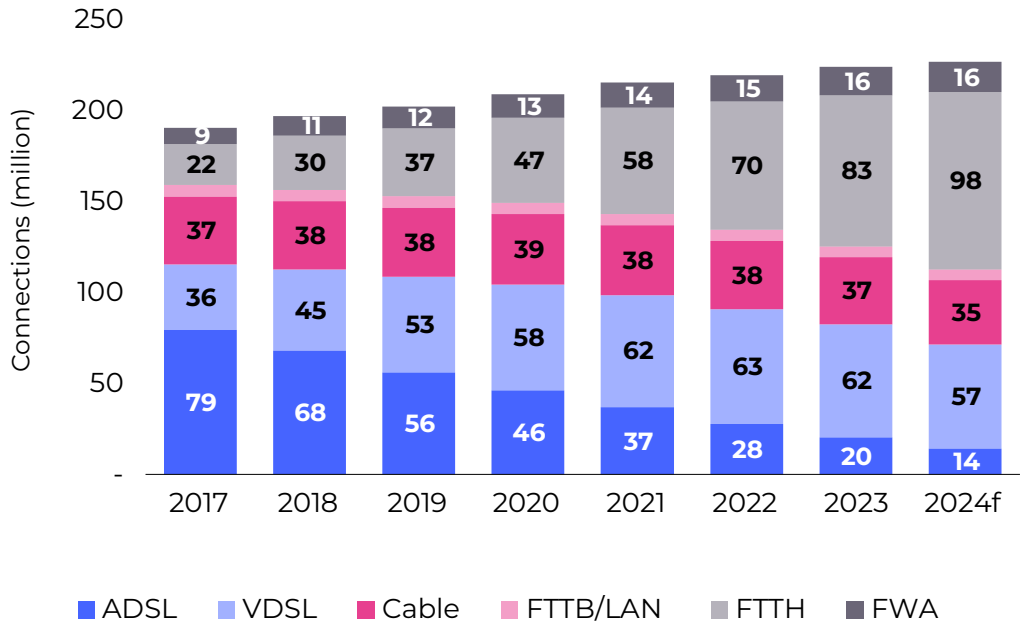
Fixed broadband connections

The fixed broadband market has changed significantly since 2017. Operators in Europe have focused on the transition from copper networks to fibre, which provides a future-proofed, scalable option for broadband network deployment, as well as better quality, higher capacity or lower opex (through reduced maintenance and energy costs) and therefore also lower ongoing environmental impact. The availability of wholesale fibre offers from incumbents and challenger operators also positively impacted the fibre market, simplifying market entry for local ISPs and improving their reach. Furthermore, fibre migration is especially strong in EU member countries because operators have been hugely investing in fibre, which justifies starting to decommission copper. In addition, member states may have implemented national broadband plans in line with the EU's Gigabit society targets. Government and EU funds might provide subsidies to stimulate gigabit-capable infrastructure investment in less-urban areas, which could help accelerate fibre take-up.

The higher focus on fibre broadband led to a significant decline in ADSL-based services between 2017 and 2023, from 79 million to just 20 million (**FIG 3.4**). VDSL-based services started to decline in 2023. In most European countries, fibre will eventually replace cable access as well, with some cable operators expected to overbuild their DOCSIS networks with fibre.

The FWA market will expand too, but this will vary greatly between countries, and take-up is largely a function of supply rather than demand. FWA still only comprises a small proportion of connections, mainly used in areas where it has been challenging or cost-ineffective to deploy fibre or where fibre investment has come late. Austria and Finland, historically mobile-centric markets, will retain a high share of FWA compared to the rest of Europe.

FIG 3.4 : Fixed broadband connections by technology, Europe, 2017–2024f



Source: Analysys Mason, 2024

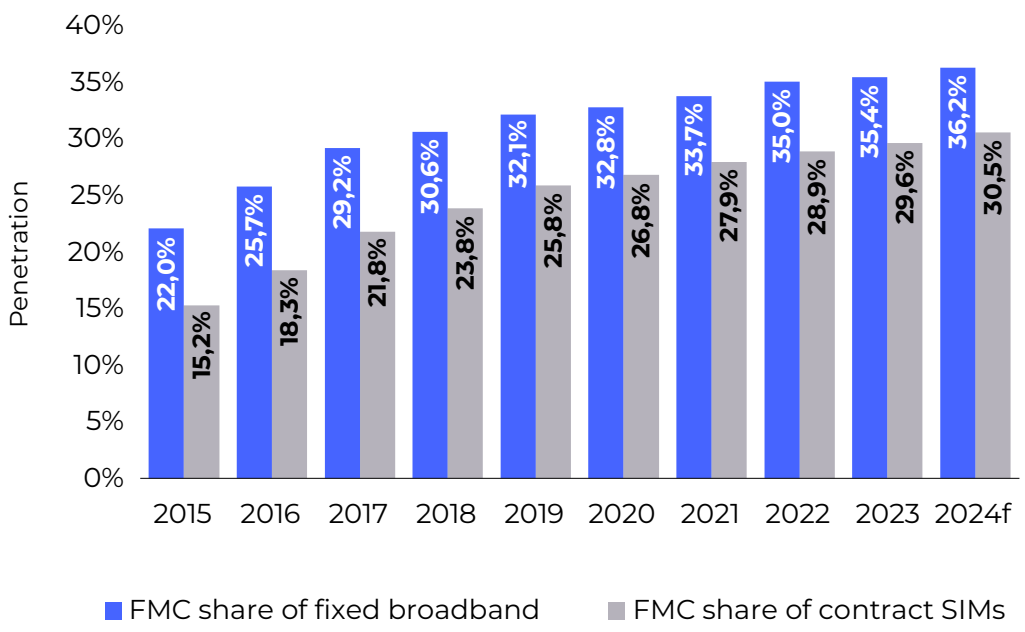
Fixed–mobile convergence

FMC bundling – combining fixed and mobile services within the same customer subscription – has grown significantly in Europe since 2015 and is expected to increase again in 2024. FMC's share of Europe's fixed broadband subscriptions and FMC's share of contract SIMs will account for 36% and 31%, respectively, in 2024 (**FIG 3.5**). FMC bundles are most prevalent in France, Poland, Portugal and Spain.

The adoption of FMC bundles is driven by a range of factors including mergers between MNOs and ISPs, attempts by established players to prevent churn to, or to attract customers from rivals, and wholesale business models that enable operators to enter the market without owning both fixed and mobile network infrastructure.

As the competition from challenger operators is high in most countries, incumbent operators are expanding their FMC service portfolios (by upselling pay-TV services, for example) and offering value-added services (VAS) to defend their market share and increase average spend per user. FMC bundling is not without risk, as it can lead to the erosion of ARPU.

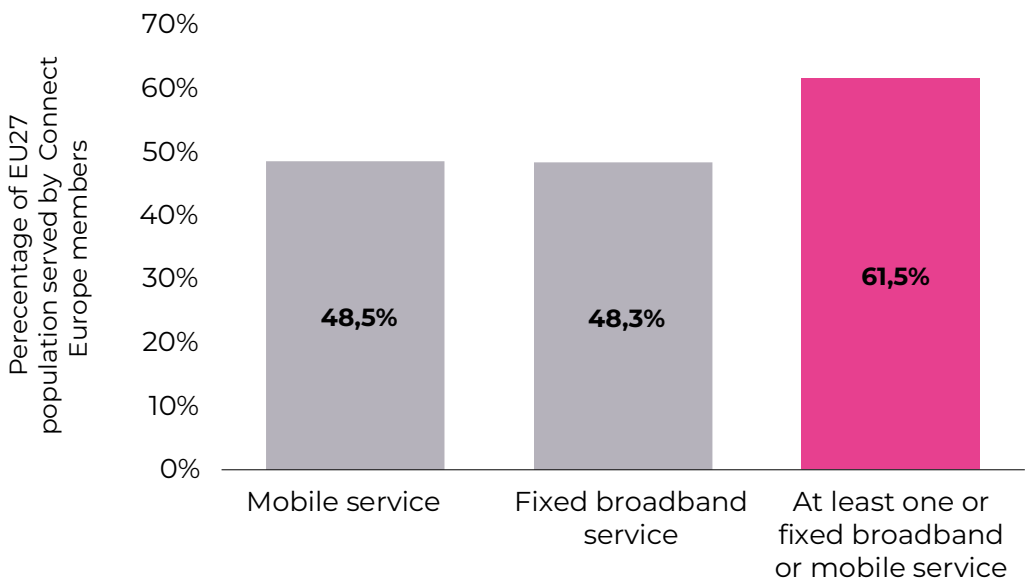
FIG 3.5 : FMC share of fixed broadband subscriptions and contract mobile SIMs, Europe, 2015–2024f



Source: Analysys Mason, 2024

Connect Europe members' services reach 61.5% of Europeans

FIG 3.6 : Percentage of EU population supplied by Connect Europe members for mobile, fixed broadband and either mobile or fixed broadband, December 2023



Source: Analysys Mason, 2024

The members of Connect Europe provide their customers with a combination of fixed and mobile services, and between them they serve a substantial proportion of Europe's population. The Connect Europe members are estimated to serve 45.8% of the region's population with retail mobile services; and 46.5% of them with retail fixed broadband services. Some of those customers are supplied with both fixed and mobile services by the same operator, with the result that retail services provided by Connect Europe members are estimated to reach more than 276 million people (61.5% of all Europeans).

Fixed and mobile data usage trends

The consumption of mobile and fixed data continues to grow in Europe. Fixed internet traffic increased by 16% year-on-year in 2023 (**FIG 3.7**) and is expected to rise by around 12% in 2024. The incremental volume of annual data traffic rose again in 2023 after a disruption to long-term trends caused by the COVID-19 pandemic. Several factors will drive fixed internet traffic growth rates in 2024. The most imminent are increasing rates of FTTH adoption, the decline of DSL, broadcast-to-streaming migration, and the consumption of higher-definition live-streaming sports.

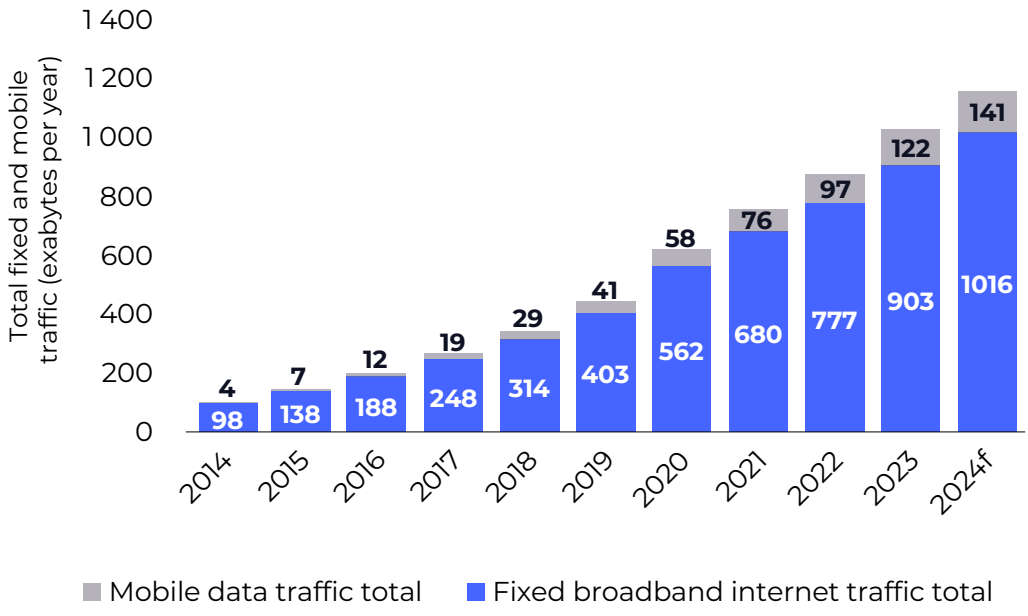
Mobile data usage in Europe continues to grow at a faster rate than fixed. It increased by 26.5% year-on-year in 2023, and is expected to rise a further 15.2% in 2024. We observe that the switching from LTE to 5G tends to lead to an increase of the amount of data used. Mobile still accounts for only a small proportion of traffic generated on mobile and fixed networks in Europe (11.9% for 2023) as fixed broadband networks are used for more “data hungry” activities such as the consumption of large volumes of video and TV services in high-definition.

Growth-rates in European countries still vary widely, especially on mobile networks. There is some evidence from countries that tend to have a large cohort of early adopters of new technologies, or countries where usage is already high, that the kinds of activity that have historically driven consumption levels on mobile and fixed networks are starting to saturate. The number of hours per day that a person will use smartphones is limited; so is the amount of video streaming content that a household will be able to consume. Robust long-term data traffic growth, on fixed and mobile networks, will therefore depend on the emergence of new applications and connected devices. Candidate applications and devices include AI, XR (metaverse/virtual worlds) and C-V2X. Although forecasting their impact is necessarily subject to wide margins of error, these new applications are, we believe, likely to drive an uptick in data traffic growth rates by the end of the decade.

XR/metaverse applications such as 360-degree video, AR/VR gaming and haptic technology have the potential to generate large volumes of data per user but there are a number of factors limiting overall market growth including the cost of devices. In 2023 only 3% of consumers had XR headsets. Impact on access traffic will depend upon where imaging is rendered – on-device or in the cloud. Cloud-based rendering would result in greater access network data traffic. Today, VR services (as opposed to AR services) tend to rely more on fixed networks than mobile networks, and so are likely to impact fixed rather than mobile data traffic, while AR services have potential to be used on mobile devices (including glasses).

C-V2X systems will enable the interaction of connected cars and connected drones with the environment around them. This is not a short-term growth driver due to the cost and time it will take to deploy widespread C-V2X infrastructure.

FIG 3.7 : Fixed and mobile data usage, Europe, 2014–2024f



Source: Analysys Mason, 2024

The likely impact of AI on network traffic levels will vary in different parts of telecoms networks, and will vary according to AI application type. Much remains uncertain but patterns are beginning to emerge.

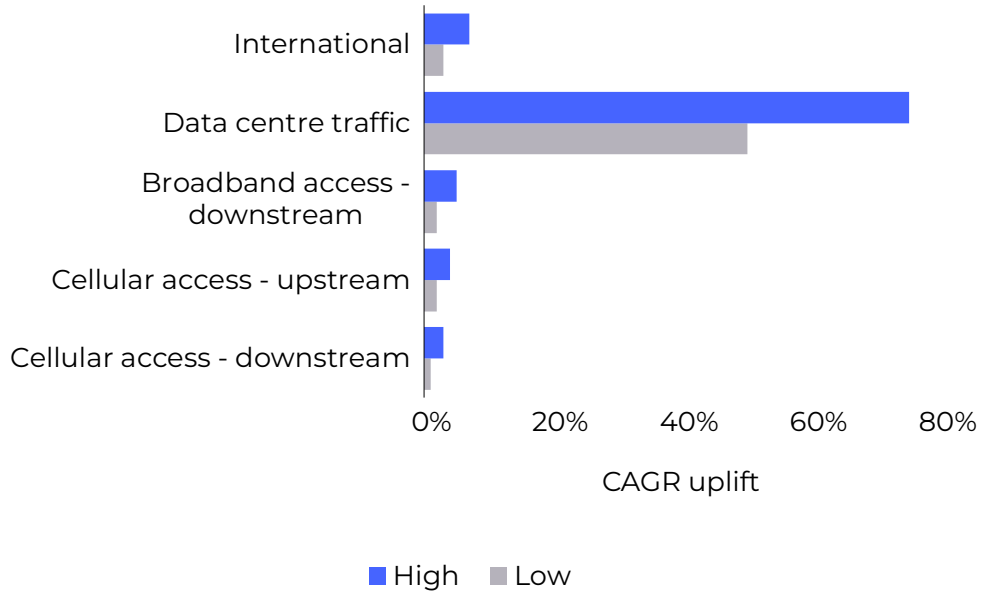
In the access network, AI impact on consumer-related data traffic could be felt in a number of ways:

- **Upload of TV/video/photographic** content could increase due to on-device AI-assisted creation. AI will make it quicker to create content (so more content will be created) and easier to create (resulting in more people creating).
- **Download of TV/video content** is unlikely to increase much beyond current usage growth projections (time constraints, costs and cultural factors act as a limiter), although the choices of content consumed might change due to AI-enhanced recommendations.
- **AI generated game environments and in game avatars** will make services more attractive and more addictive. This could lead to more users and longer usage. Some of this would substitute for online TV/video consumption. The volume of access traffic will depend upon whether the rendering of the graphics happens in the cloud, at the edge, or on a local device.
- **AI personal assistants** could generate a traffic uplift due to continuous background collation of off-device data for on-device processing, and due to delivery of real-world augmentation with visual data overlays – and could be linked to worn devices such as AR glasses, or HUDs in cars.

AI's impact on business-related traffic will revolve around the collection of additional telemetry data from IoT devices. LLMs can improve businesses' ability to analyse the data on devices once they are connected (acting as translation engines for devices' different coding schemes and languages). This could lead to connection of more devices, and more data transfer within the context of digital twin creation and automation. AI can also improve event capture and remote storage for connected video devices. Most data are likely to be analysed centrally. The real impact of AI on business data traffic will be in effective centralised control, rather than any great increase in access network traffic.

Enterprise users will also make use of AI-enabled AR tools to support field engineers, and AI-enabled digital twin solutions to support product and solution designers. These are likely to have centrally-located analytics tools, and much of the digital twin data is likely to stay protected within secure corporate network environments.

FIG 3.8 : Impact of AI on data traffic, potential CAGR uplift attributable to AI, 2023 to 2029



Source: Analysys Mason, 2024

AI will have an impact on international traffic due to increased transfers of data between hyperscaler and corporate data lakes; and in some regions due to the need for access to AI resources located in other countries. A counter-trend will be increased governmental pressure to host critical data locally for security and sovereignty reasons.

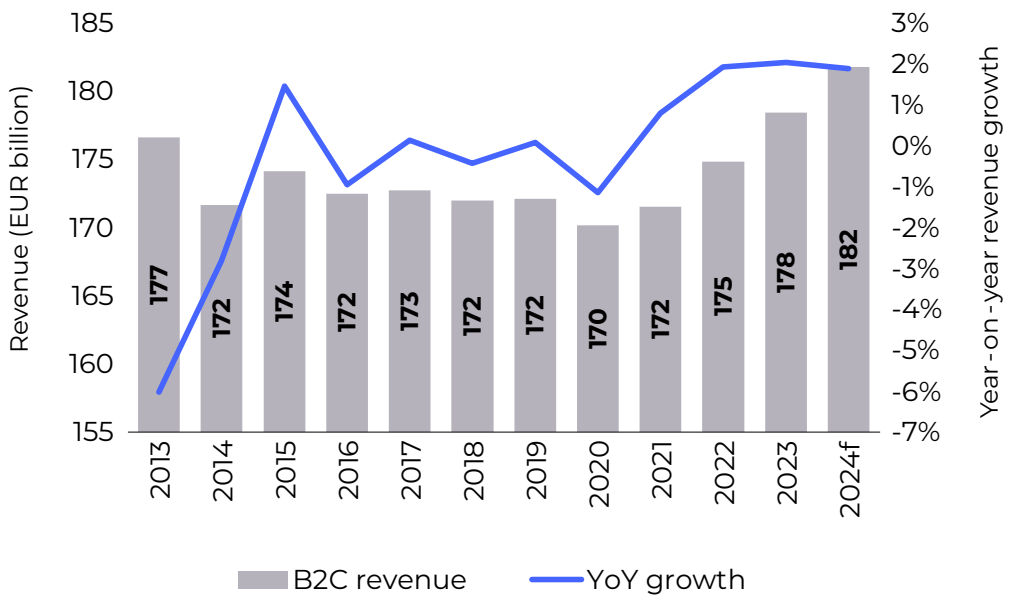
The greatest impact on network traffic will be felt at data centres where traffic volumes related to AI data ingest and AI-related data centre interconnect will rise rapidly (a likely CAGR uplift of 50% or more).

Consumer spending trends

Consumer telecoms service revenue increased by 2% and 1.9% year-on-year in nominal terms in 2022 and 2023, although that represented a real-terms revenue decline. The nominal growth was delivered partly by some inflation-related price increases (although these have been much lower than in some other sectors), partly by a growing contract market share and partly by customers taking larger data allowances. B2C spending will increase by another 1.9% in nominal terms in 2024 although this will reflect another real-terms revenue reduction.

Looking further ahead, growth in consumer telecoms service revenue will not entirely keep pace with inflation. Competitive pressure will work to off-set any inflation-related price rises. Some operators have responded to competitor increases by freezing their own prices or limiting price increases to specific plans.

FIG 3.9 : Consumer telecoms service revenue and year-on-year growth, Europe, 2013–2024f

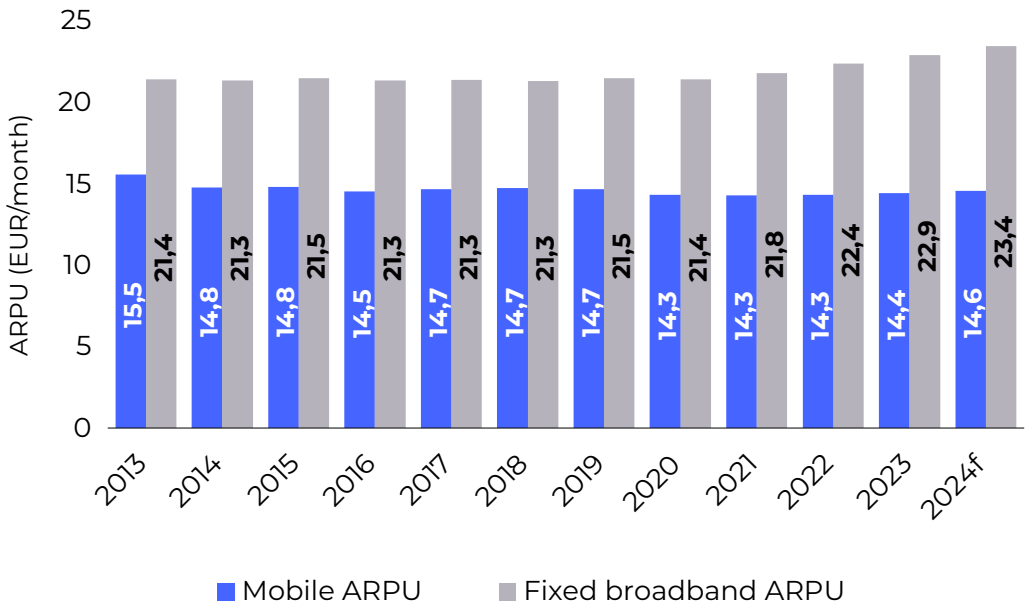


Source: Analysys Mason, 2024

Mobile ARPU is expected to increase in 2024 by 1% year-on-year (**FIG 3.10**), mostly driven by operator efforts to absorb some inflationary costs as opposed to true real terms increases in price. The launch of 5G has not so far led to any significant growth of revenues for operators.

Fixed broadband ARPU is expected to grow more strongly by 2.4% year-on-year in 2024 as a result of both inflation-related price increases and increasing migration of consumers to FTTH-based services.

FIG 3.10 : ARPU for mobile and fixed broadband services, Europe, 2013–2024f



Source: Analysys Mason, 2024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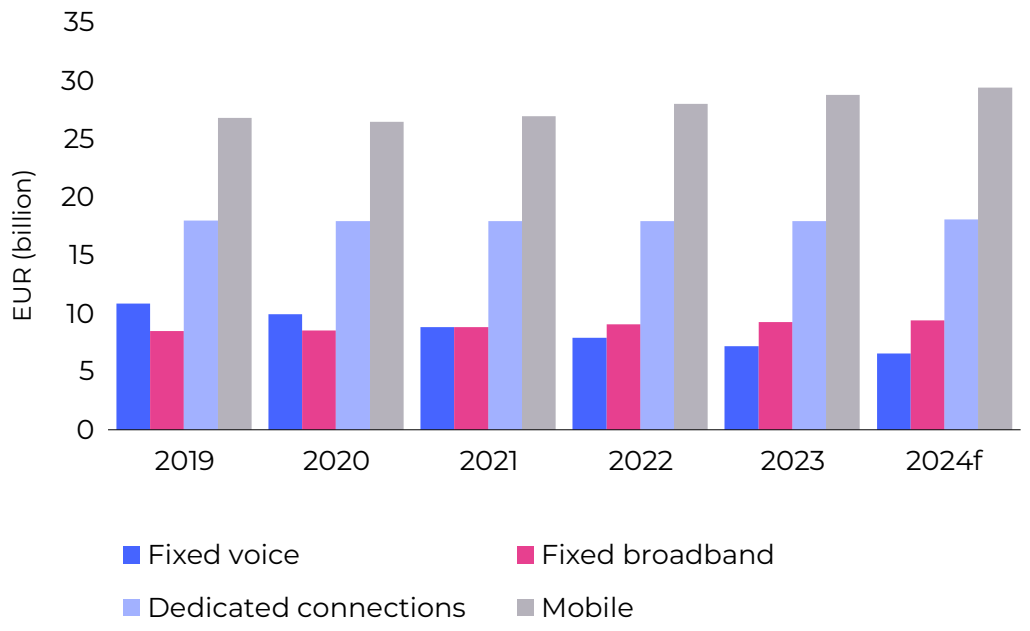
3.2 B2B CONNECTIVITY SERVICES

Retail revenue from B2B connectivity services is derived from four main sources – fixed voice, fixed broadband, dedicated connections and mobile connectivity services. The importance of B2B retail fixed voice revenues has been declining rapidly as a consequence of increased use of voice services supplied by content and application providers (CAPs) and increased bundling of voice within contracts. The market for dedicated connections remained largely flat between 2019 and 2024. Steady growth was achieved in the B2B mobile and B2B broadband segments with CAGRs of 1.9% and 2.2% respectively.

FIG 3.11 : Operators' B2B retail services revenue, Europe, 2019–2024f



Source: Analysys Mason, 2024

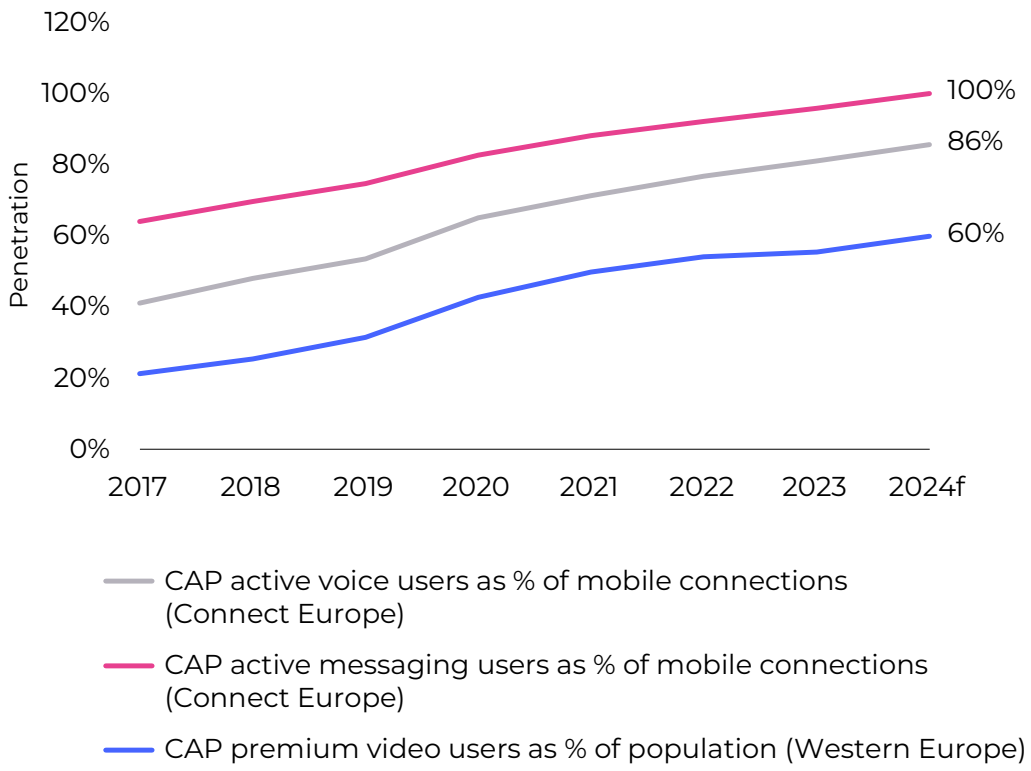
3.3 TRENDS IN DIGITAL SERVICE DEMAND

Digital services encompass the wide range of applications and services that run over IP networks. As the natural expansion of the fixed and mobile connectivity markets has slowed, operators have looked to digital services for revenue growth in both the consumer and business markets. At the same time, however, competition from content and application providers targeting their traditional voice and messaging markets has grown increasingly strong.

B2C digital services: operators and content and application providers (CAPs)

CAPs have been targeting parts of the communications market with web applications for telephony and messaging for years, and they have had significant success. Their market presence has grown as communications applications have been integrated within social media platforms and business applications, so that users have multiple means of connecting with friends, family and work colleagues. Well known examples of voice and messaging applications include business-focused applications such as Teams, or Slack; Zoom which appeals in both the business and consumer market; as well as a host of consumer focused applications such as WhatsApp, Viber, Facebook Messenger, Snapchat, and Discord. Voice and messaging applications are typically regional, reflecting language and political influence. For instance Tencent QQ and WeChat dominate in China but are not leading messaging apps in Europe or the United States.

FIG 3.12 : Penetration of CAPs' services, active users[14], Connect Europe regions and Western Europe, 2017–2024f



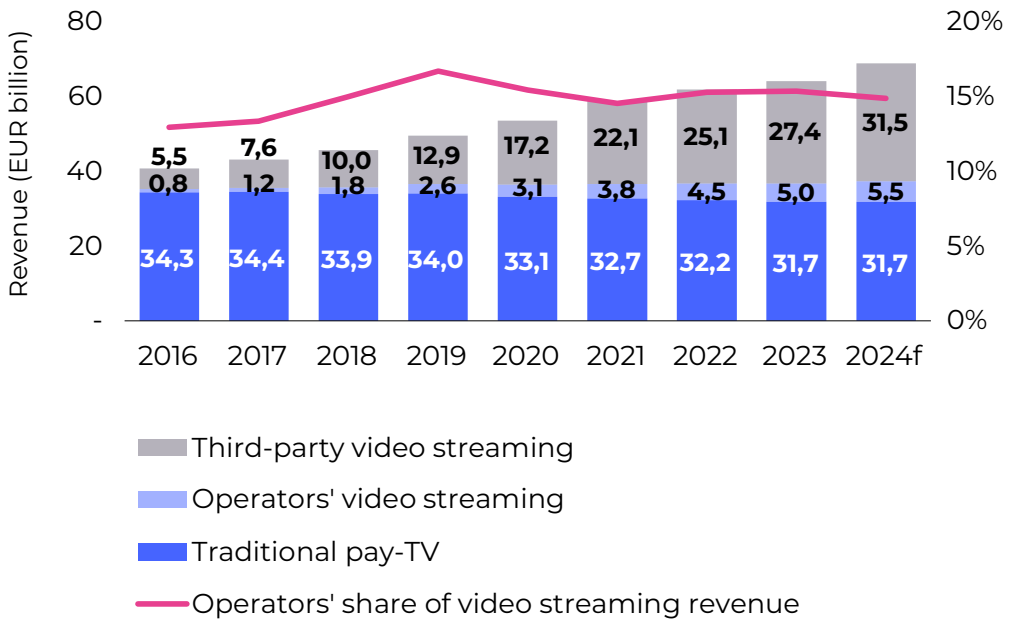
Source: Analysys Mason, 2024

Messaging applications have achieved the widest acceptance, with active user penetration expected to reach 100% mobile device penetration in Europe in 2025. Many users have multiple accounts on different platforms resulting in potentially penetration of over 100%. Meanwhile the number of SMS messages sent over mobile networks has been falling steadily. In Europe the total number of sent SMS messages declined by 60% between 2013 to 2023. CAP voice penetration is also increasing and is expected to reach 86% of mobile connections by 2024. This is having an impact on operator telephony services. Although mobile outgoing voice minutes in Europe grew by 30% between 2013 and 2023 fixed call minutes fell by 68% over the same period.

The percentage of users of premium (non-ad-supported) video applications is also rising quickly, and customers are more valuable. With continued success of services from companies such as Amazon, DAZN and Netflix, premium video user population penetration is expected to reach 60% in Western Europe by the end of 2024.

[14] Active user is defined as someone that has used an application within the past month.

FIG 3.13 : Revenue from traditional pay TV, operator video streaming and third-party video streaming services, Europe, 2016–2024f, plus operators' market share (as %)



Source: Analysys Mason, 2024

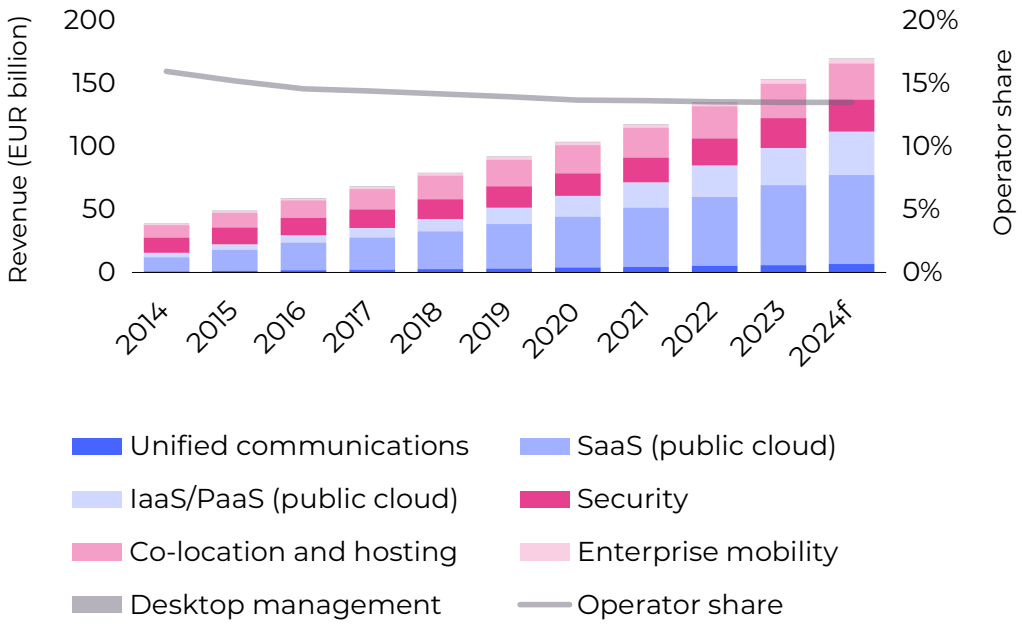
Operators in Europe continue to lose revenue generated from traditional pay-TV services due to cord-cutting. The decline comes from cable TV and satellite pay-TV services and is partially offset by growth in IPTV. Operators joined the video streaming market to combat market losses. The revenue generated from operators' video streaming services continues to grow, and they have maintained a stable share of the video streaming market's revenue of around 15%. As a result, the revenue generated by operators from pay-TV services is expected to grow by 1.5% in 2024.

B2B digital services

The revenue generated by operators from non-connectivity B2B services continues to rise. It increased at a CAGR of 16.5% between 2014 and 2023, and a further growth of 10.7% is expected in 2024. SaaS continues to grow in proportion to the overall market, and it will remain the most significant component in 2024, accounting for over 41% of B2B digital services revenue. The next largest segment, IaaS, will account for 20.3% in 2024, up from 19.3% in 2023. Security, and co-location and hosting also account for a substantial share of revenue and will continue to grow, albeit at a slower rate than other segments.

This growth, though, should be put into the context of declining market share for European cloud providers in the face of strong competition from US providers. In fact operators' share of non-connectivity B2B services revenue in general has been declining historically, but it flattened out in 2022 and will remain at around 13.5% in 2024. Operators are increasingly bundling core connectivity services with non-connectivity and ICT services to increase the value they offer to, and revenue they gain from enterprise customers; and also to make core services stickier (i.e. making it less attractive for their customers to change supplier).

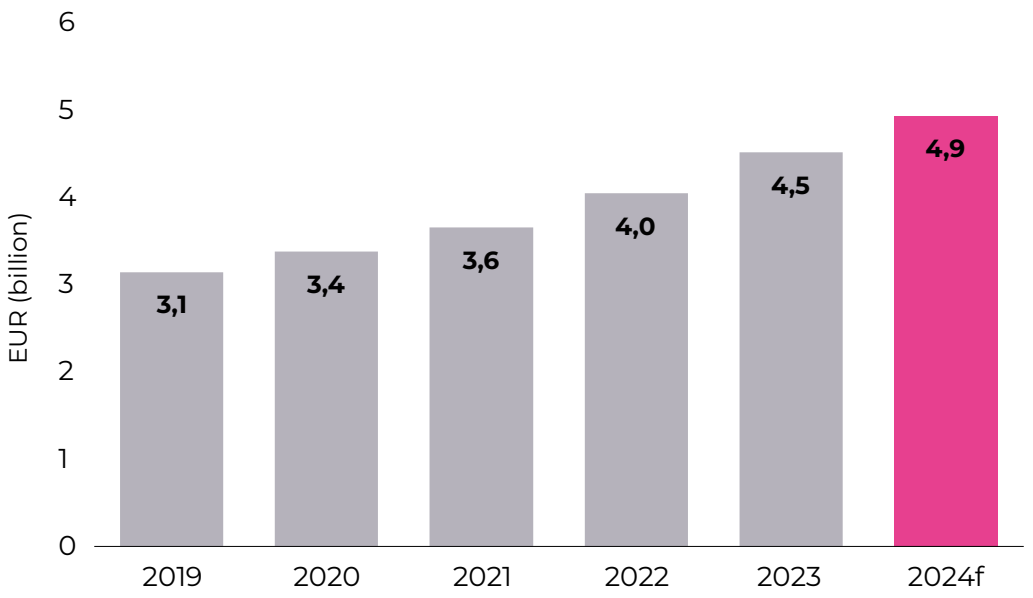
FIG 3.14 : Non-connectivity-related B2B services revenue and operators' market share, 2014–2024f



Source: Analysys Mason, 2024

Operator revenue from cybersecurity services has also been rising. Although operators only capture a share of the market, with much more going to systems integrators, channel resellers and security solution specialists, they are benefitting from increased spending generally as enterprises attempt to protect their systems and their data from malicious attackers – both criminal and state-led.

FIG 3.15 : Operators' cybersecurity retail revenue, Europe, 2019–2024f



Source: Analysys Mason, 2024

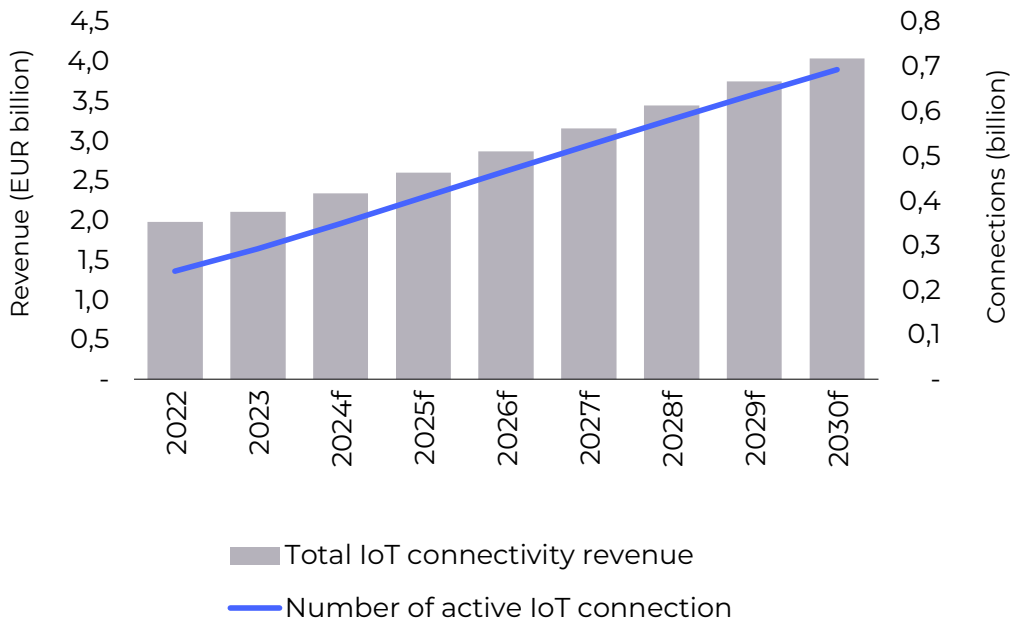
European operators' retail revenue from cybersecurity services is expected to rise by more than 9% to EUR4.9 billion in 2024.

The Internet of Things

Internet of Things (IoT) connectivity has long been viewed as a potential area of growth for operators. While it is difficult to differentiate on connectivity, some providers are able to do so by providing ultra-high availability or localisation solutions. Other providers are focusing on adjacent areas of the value chain and offering platforms to manage large numbers of devices, international connectivity and roaming support, by developing AI or cloud integration tools on their platforms, or by investing in acquiring vertical expertise.

Operators' IoT connectivity revenue is growing, and is projected to reach around EUR4 billion in Europe by 2030 (**FIG 3.16**). Growth in IoT connectivity revenue has been somewhat slower than expected due to pricing pressures within the connectivity market, which are eroding the average revenue per connection. However, the pricing pressure is expected to ease towards the end of this decade and to be mitigated somewhat by rising data usage in applications such as connected cars.

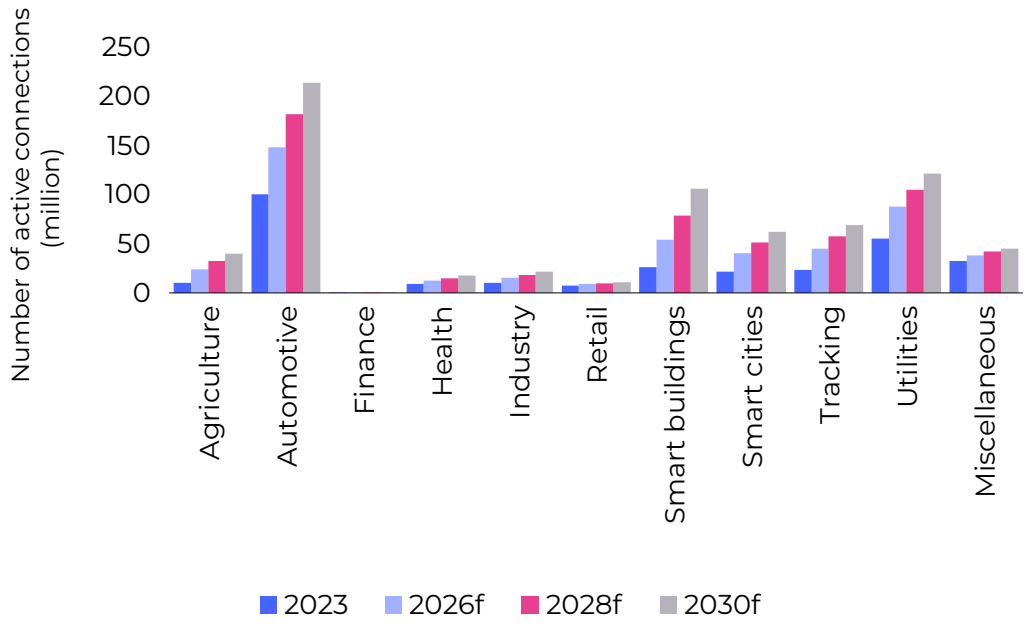
FIG 3.16 : Number of active IoT connections and IoT connectivity revenue, Europe, 2022–2030f



Source: Analysys Mason, 2024

The number of IoT connections in Europe will be around 707 million in 2030 having risen at a CAGR of 6.5% between 2022 and 2023. As operators shut down 2G and 3G networks the share of connections accounted for by NB-IoT and LTE-M technologies will increase.

FIG 3.17 : Number of active IoT connections by vertical industry, Europe, 2023–2030f



Source: Analysys Mason, 2024

Vertical industry	2023	2026f	2028f	2030f
Agriculture	10.2	23.8	32.5	39.8
Automotive	100.6	148.2	182.0	213.6
Finance	0.1	0.1	0.1	0.1
Health	9.1	12.3	14.8	17.5
Industry	10.1	15.2	18.5	21.7
Retail	7.4	9.0	9.9	10.9
Smart buildings	26.5	54.2	78.4	106.2
Smart cities	21.7	40.3	51.5	61.9
Tracking	23.5	45.1	57.6	69.2
Utilities	55.3	87.9	104.7	121.2
Miscellaneous	32.2	38.3	41.9	45.0
Total	**296.7**	**474.4**	**592.0**	**707.2**

The automotive and utilities sectors will account for the highest numbers of IoT connections in Europe between 2023 and the end of the decade. The number of connected cars is rising rapidly, with 5G connections now appearing in new models. The majority of connected cars currently in use have LTE SIMs. Electric vehicles (including battery EVs and plug-in hybrid EVs) are reliant on connectivity for operating system updates, and alongside non-electric cars they also make use of connections for telematics and in-car infotainment services.

The high number of utility IoT connections can be attributed to industry efforts to move to smart metering. For example deployments in Spain and Germany are using funds from the EU Recovery and Resilience Facility to accelerate smart meter adoption. Telefónica has been particularly active in this space; it won contracts to connect water meters using NB-IoT for two of its major utilities; Canal de Isabel II (130 000 meters) and EMASESA (300 000 meters) in 2022 and 2023, respectively.

04

Optimising networks for the future

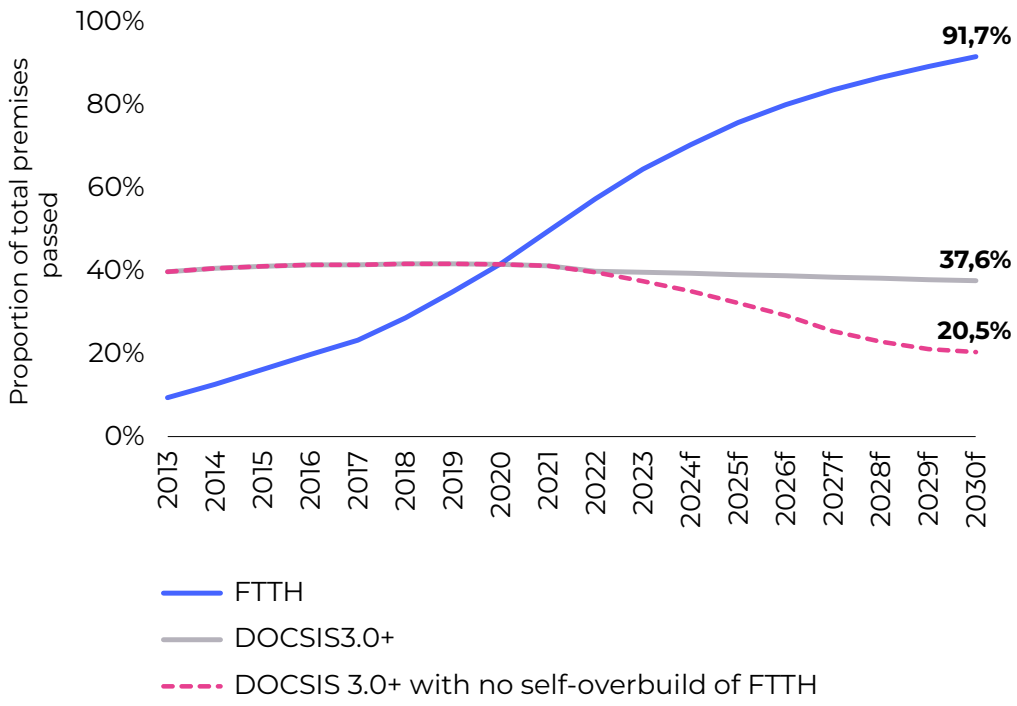
Future networks will have to meet certain connectivity targets, but they will also have to be lean and green.

4.1 ADDITIONAL INVESTMENT TO REACH GIGABIT TARGET

The EU Digital Decade infrastructure targets – full population gigabit and 5G coverage – are ambitious and exceed the ambitions of many other liberal economies. Few other non-European advanced economy licensing authorities are demanding such 5G coverage. These ambitions are costly. In this section, we outline what work there is still to do and describe the barriers to achieving this goal. As things stand, the risk is that the EU will fall short of its "gigabit for everyone by 2030" objective.

Based on a combination of factors, including operators' plans, we now project that FTTH coverage, in terms of unique premises passed, will reach about 91.7% of premises in Europe by the end of 2030. This means that 23.4 million addresses or 45.4 million people in Europe will be unserved.

FIG 4.1 : Premises passed by FTTH and DOCSIS3.0+, Europe, 2013–2030f



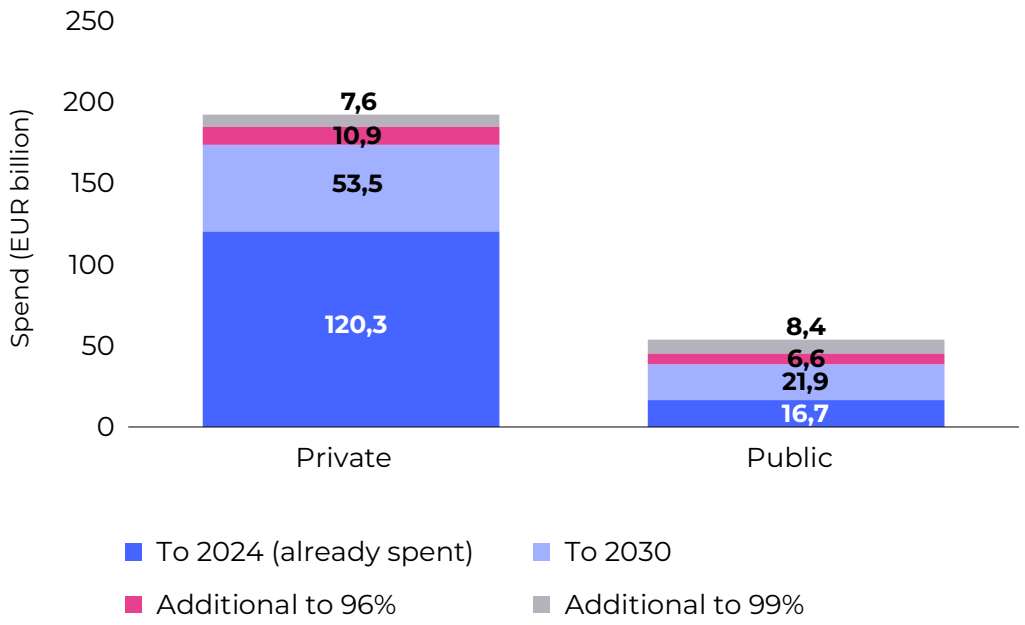
Source: Analysys Mason, 2024

Cable broadband (DOCSIS 3.0 and above) will cover 37.6% of premises in the same timeframe, but most cable network footprints will have undergone some level of overbuilding with FTTH, and the decline by 2030 reflects the fact that some cable networks will have been decommissioned. Whether cable operators do choose to self-overbuild with FTTH, or switch to buying wholesale FTTH, depends to a large extent on the intensity of FTTH infrastructure competition in the market. Faced with strong FTTH competition, continuing to operate complex and costly HFC networks may become commercially unsustainable. Some will prioritise footprint expansion (which will invariably mean FTTH) over fibre upgrades to their existing footprint. The transition of cable operators to FTTH not only intensifies infrastructure competition at the retail level, but may extend to the wholesale level if cable operators opt to compete on wholesale services.

The 256 million premises passed by FTTH in Europe will be covered by an average of about 1.5 FTTH networks by 2030. These projections of FTTH deployment are based on a several overlapping factors: operator plans and in some countries regulatory obligations, unit capex trends, competition levels and expected take-up levels. A substantial degree of consolidation, where buy replaces build, is also to be expected to avoid overbuild.

FIG 4.2 shows a projection of the total spend in Europe to the end of 2024, the costs out to the 91.7% projection, and the costs of coverage required to cover out to 96% and further out to 99% of premises with FTTH. These projections also include an estimate of what would have to be covered by public money. The total capex excludes any overbuild so far and any projected overbuild: in other words, it is the minimum required to reach a particular level of coverage.

FIG 4.2 : Cost of deploying future single network FTTH to forecast 2030 coverage, and additionally to 96% and 99% coverage, Europe

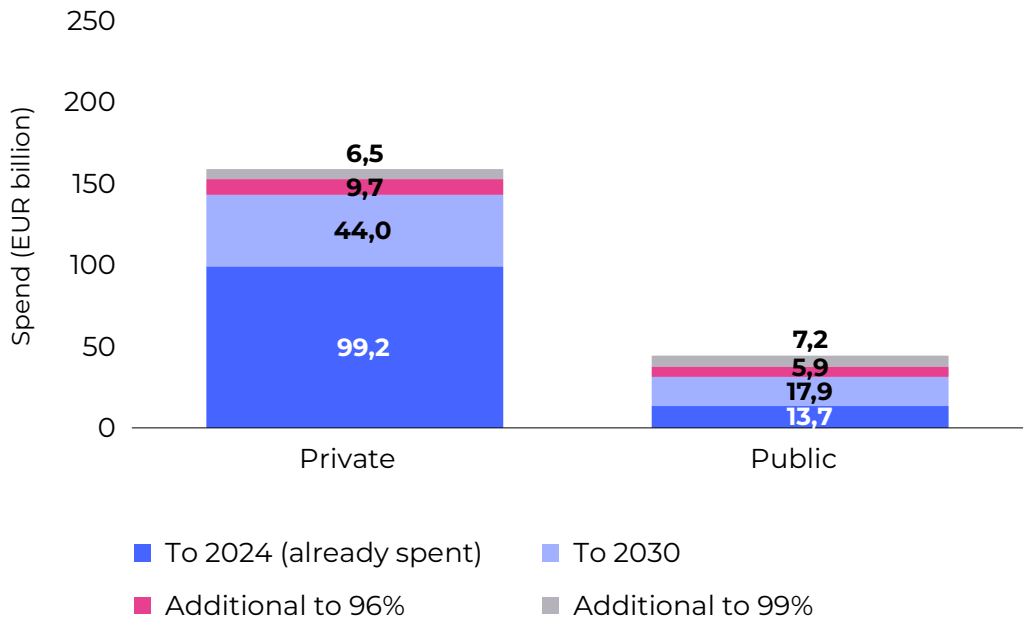


Source: Analysys Mason, 2024

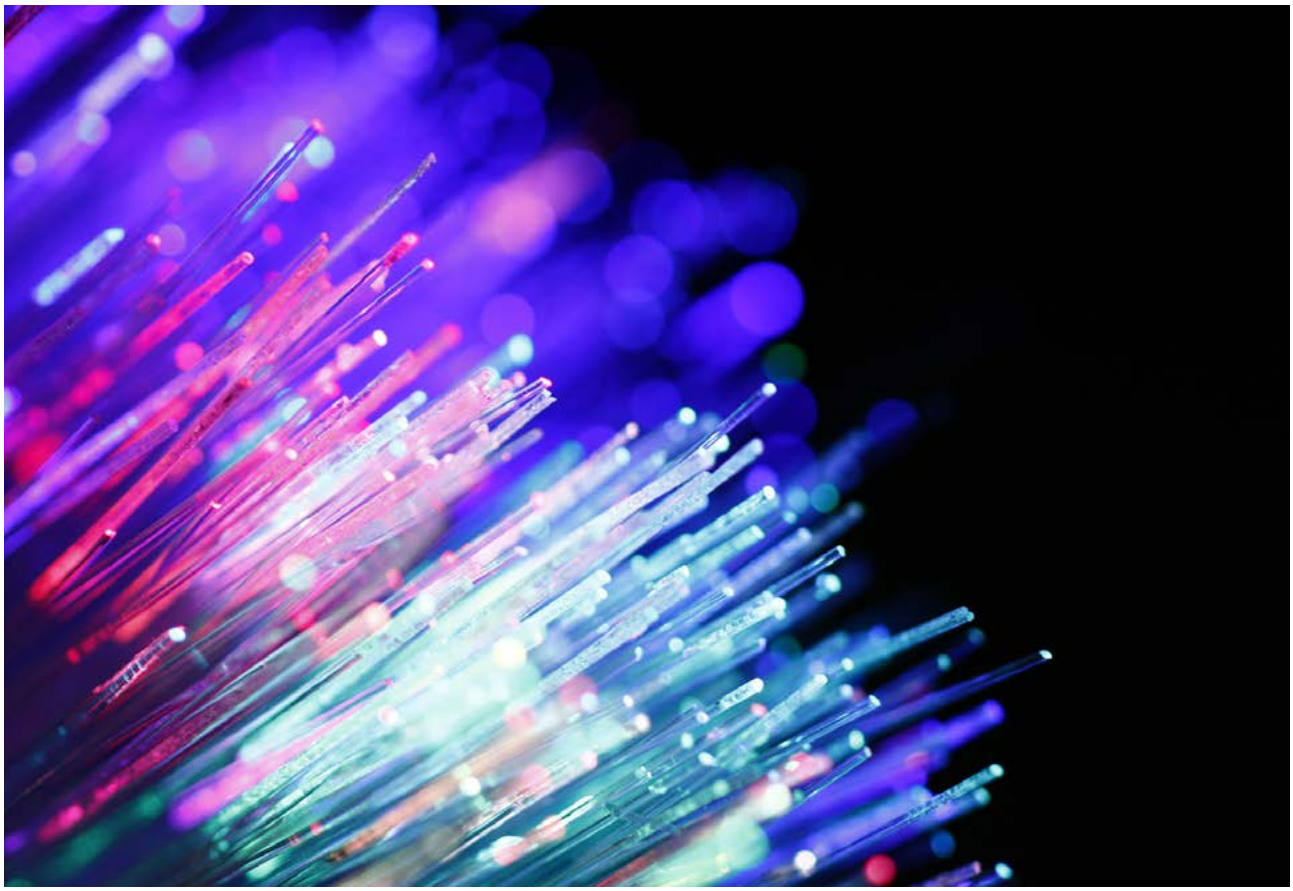
For Europe as a whole, there is still EUR75.4 billion to be spent between the end of 2024 and the 91.7% FTTH coverage projection for 2030. The additional cost from that coverage out to 99% will amount a further EUR33.5 billion, of which about 45% would have to come from the public purse.

For the EU27 alone, the additional cost to the very similar coverage projection (91.5%) by 2030 amounts to EUR61.9billion and the additional cost to reach 99% is EUR29.2 billion.

FIG 4.3 : Cost of deploying future single network FTTH to forecast 2030 coverage, and additionally to 96% and 99% coverage, EU27



Source: Analysys Mason, 2024



4.2 ADDITIONAL INVESTMENT TO REACH 5G TARGET

The Digital Decade strategy by the European Commission aims to raise the level of 5G deployment, with full 5G coverage of all populated areas by 2030. In mid 2023, around 89% of the EU's population was covered by 5G in populated areas[15]. However, 5G coverage of midband stood at only 59%. The difference between the two coverage figures is coverage based on either low-band only, or on dynamic spectrum sharing with 4G, neither of which provide substantial performance uplifts. The additional cost to achieve overall 5G coverage targets, using e.g. DSS or lowband, is likely to be well under EUR10 billion.[16] However, to achieve full coverage using midband spectrum additional investment and funding to the tune of around EUR25-30 billion would be required. This would involve spend on additional cell-sites and small cells. As with the FTTH investment gap calculations, these figures are for a single network to fill the gap to full coverage, and as with the FTTH calculations, the real investment will involve a great deal of overlapping coverage, and hence the financial figures will be substantially higher.

Spectrum assignment is uneven and annualised licence costs are high

Radio spectrum is a limited resource essential for wireless communication networks, utilised by a number of sectors such as mobile and fixed network operators, satellite communications, broadcasters, and government agencies. The wireless landscape is rapidly evolving, driven by advancements in 5G, new spectrum-sharing models, and rising demand for high-bandwidth applications. This evolution has intensified competition for spectrum resources among stakeholders. As global mobile usage continues to grow regulators face the challenge of balancing diverse spectrum needs and ensuring its efficient use.

The amount of spectrum assigned varies considerably between countries in Europe but there are only a handful of countries that have not yet assigned spectrum in any of the 5G bands. The Draghi report highlights the inconsistencies of spectrum assignment in the EU. It recommends increasing EU-level control of spectrum harmonisation and spectrum auctions, and recommends longer duration of licences plus fewer restrictions to encourage growth and cross-border investment opportunities across EU member states.

[15] Digital Decade 2024: 5G Observatory Report, European Commission, 2024, https://digital-strategy.ec.europa.eu/en/library/digital-decade-2024-5g-observatory-report

[16] The March 2023 report Investment and funding needs for the Digital Decade connectivity targets indicated that full 'basic 5G coverage' in the EU27 could be achieved with additional spend of EUR11.5 billion, mostly without public funding.

Regulators in most European countries have now assigned spectrum (via auctions in nearly all cases) in the 3.4 GHz–3.8 GHz band (the most important band for 5G mobile). The other principle 5G band is the 700 MHz band. mmWave spectrum has also been assigned in some countries. **FIG 4.4** shows the allocation of spectrum in the 5G bands as of November 2024.

FIG 4.4 : Assignment of spectrum in the main 5G bands for nationwide public mobile service, Europe, November 2024

Country	Spectrum assigned in the 700 MHz band (MHz)	Spectrum assigned in the 3.4 GHz–3.8 GHz band (MHz)	Spectrum assigned in the mmWave band (MHz)
Albania	0	240	0
Austria	60	300	1400
Belgium	60	410	0
Bosnia	0	0	0
Bulgaria	0	300	1600
Croatia	60	320	1000
Cyprus	60	400	0
Czech Republic	60	400	0
Denmark	80	390	2850
Estonia	60	390	2400
Finland	60	390	2400
France	60	310	0
Germany	60	300	0
Greece	60	390	1000
Hungary	50	390	0
Iceland	40	300	0
Ireland	60	340	0
Italy	75	363	1000
Latvia	80	400	0
Lithuania	40	300	0
Luxembourg	60	330	0
Malta	0	300	0
Montenegro	60	380	0
Netherlands	60	300	0

Norway	60	400	0
Poland	0	400	0
Portugal	60	400	0
Romania	30	655	0
Serbia	0	0	0
Slovakia	60	390	0
Slovenia	75	380	1000
Spain	60	380	2000
Sweden	40	320	0
Switzerland	70	300	0
UK	80	400	0

The 700 MHz band has been awarded in many countries in Europe, with just 2 of EU member states left to assign spectrum in the band. There has been lacklustre interest in mmWave spectrum across Europe, following initial enthusiasm in other markets like the U.S., Japan, and South Korea. 10 countries in Europe have now assigned mmWave spectrum, and Austria was the last to be added to this list in March 2024. There are several reasons for this slower interest in mmWave spectrum including propagation challenges, the lack of maturity in the mmWave device ecosystem and the difficulty of charging more for quality of experience improvements.

While there are still a small number of assignments to be made in smaller European countries, it looks clear that the total spend will be about EUR30 billion, about three quarters of the total spent on spectrum intended for 4G/LTE, and a little over a quarter of what got spent on 2.1 GHz for 3G/UMTS in the early 2000s.

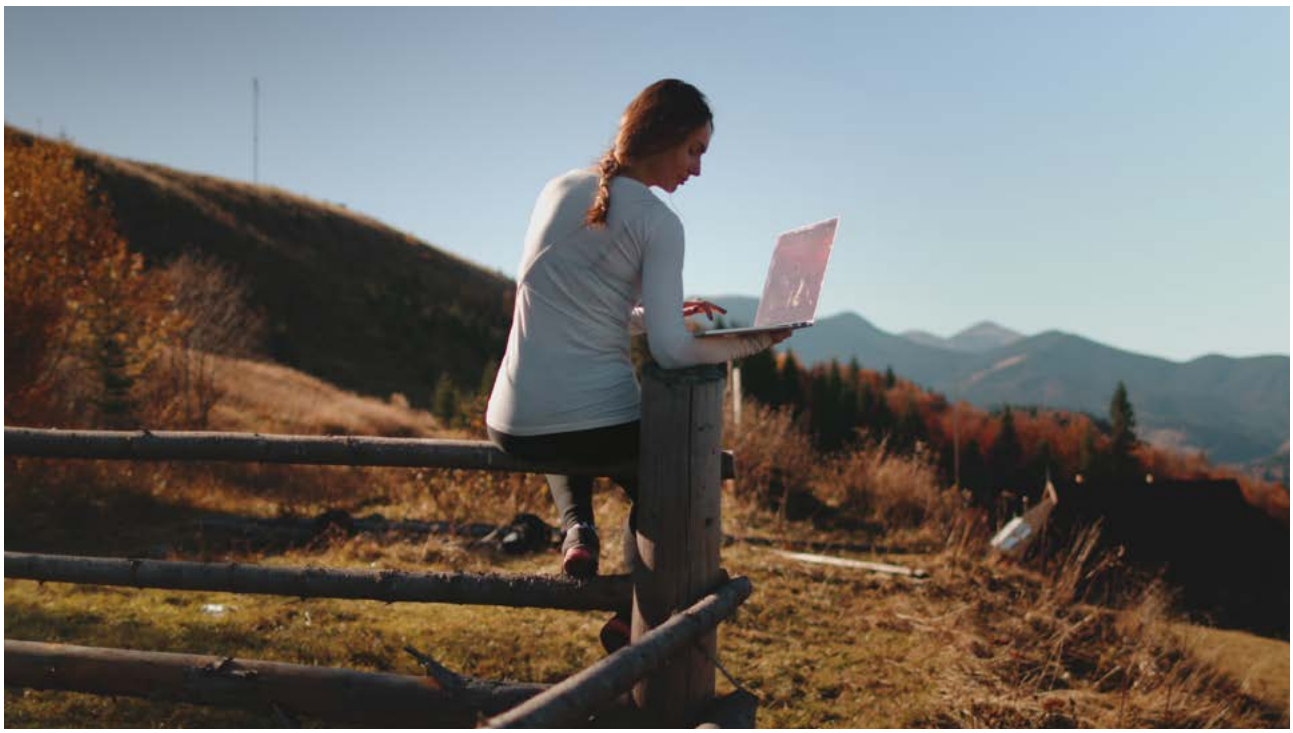
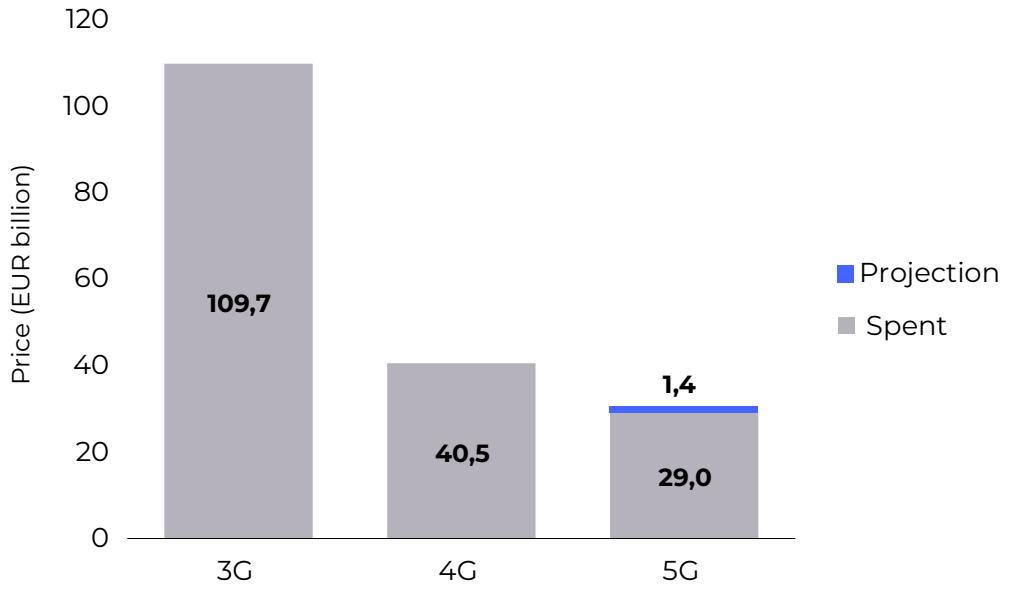


FIG 4.5 : Total prices paid at auction for the main 3G, 4G and 5G licences, Europe, 2000–October 2024

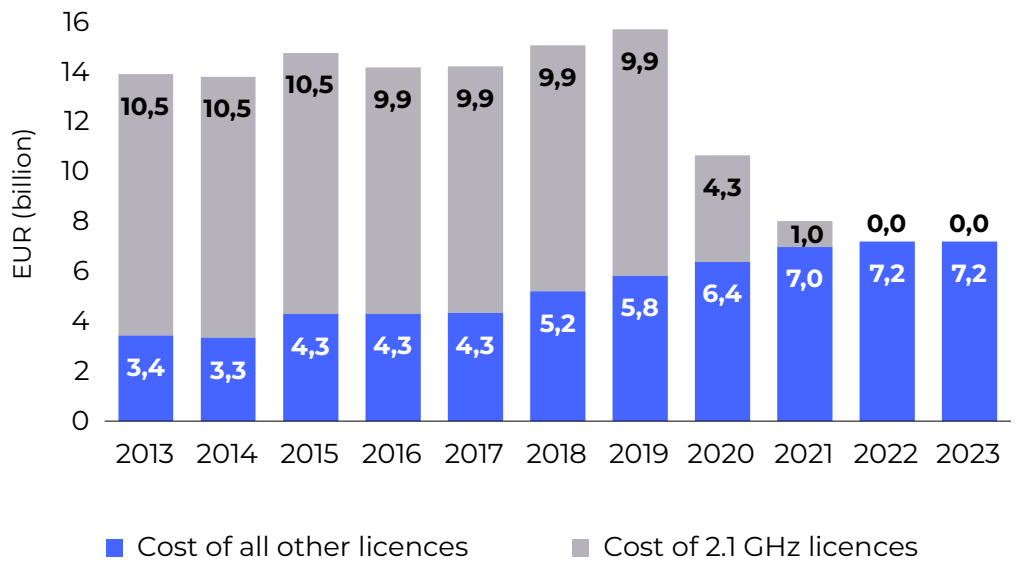


Source: Analysys Mason, 2024

Auctions for 2.1GHz (used for 3G) held in the early 2000s commanded very high prices, as a result of overvaluation, competitive pressure and market growth expectations. In recent years nearly all of these high-priced 2100 MHz licences have expired. Re-auctioning licences or imposing annual licence fees in place of auctions will not typically generate

as much revenue for governments as the annualised cost of the original licences. **FIG 4.6** shows an estimate (with 6% discount rates applied) of the total annualised spectrum burden for European mobile operators since 2013 with and without the impact (of very high priced) 2100 MHz awards in the early 2000s. These figures include annual licence fees.

FIG 4.6 : Annualised spectrum costs, European mobile operators, 2013-2024



Source: Analysys Mason, 2024

While annualised costs have fallen, the EUR7.2 billion for 2023 still amounts to around 6.5% of mobile revenue. The trajectory of annualised licence costs (excluding 2.1 GHz licences that were primarily for 3G) has been trending upwards for several years.

Future spectrum needs

Depending on when more bandwidth is required, bands between 3.8 GHz and 7 GHz are more practical for the mobile industry than mmWave. Hence a number of CEOs of leading European operators, including many Connect Europe members, asked, in a joint open letter in October 2024, for the European Commission to allocate the upper 6 GHz band (6425 MHz – 7125 MHz) exclusively for mobile networks, instead of either a hybrid regime that allows low-power usage for Wi-Fi, (stating that would be detrimental to the mobile sector), or assigning the whole of the upper 6 GHz to licence-exempt status, as has happened in for example the USA.[17]

[17] See https://www.telefonica.com/en/communication-room/blog/european-telecoms-ceos-call-6-ghz-band-allocation-mobile-networks/

4.3 LEANER AND GREENER NETWORKS

Operators worldwide face continued investor and competitor pressure to become more efficient, and to drive cost out of their operations. At the same time they also face mounting pressures from governments, regulators, investors, employees and customers to reduce the environmental impact of their activities. These demands, together with their own social commitments, are incentivising operators to develop leaner and greener networks. Europe's operators have been proactive in terms of tackling their environmental impact, and in communication their plans.

Decommissioning legacy networks

Operating legacy fixed (PSTN copper, local exchanges, FTTC and HFC) and legacy mobile (2G and 3G) networks with rapidly rising energy costs and high operating costs per subscriber is something that operators are trying to avoid, especially if they are being run alongside new networks. Additional motivations for decommissioning 2G and 3G include helping to free up finite spectrum resource for 4G/5G networks.

Most operators plan to decommission their 3G networks before their 2G networks, particularly in Europe. 3G networks are often replaced by 4G and 5G and it is expected that 3G networks will be decommissioned in Europe by 2030. Many Connect Europe members that are planning to shut off their 3G networks are already doing so; they are all expected to complete this process by the end of 2028. 2G networks are also being deactivated. A few operators plan to leave their 2G networks running but many will decommission them over the next ten years.

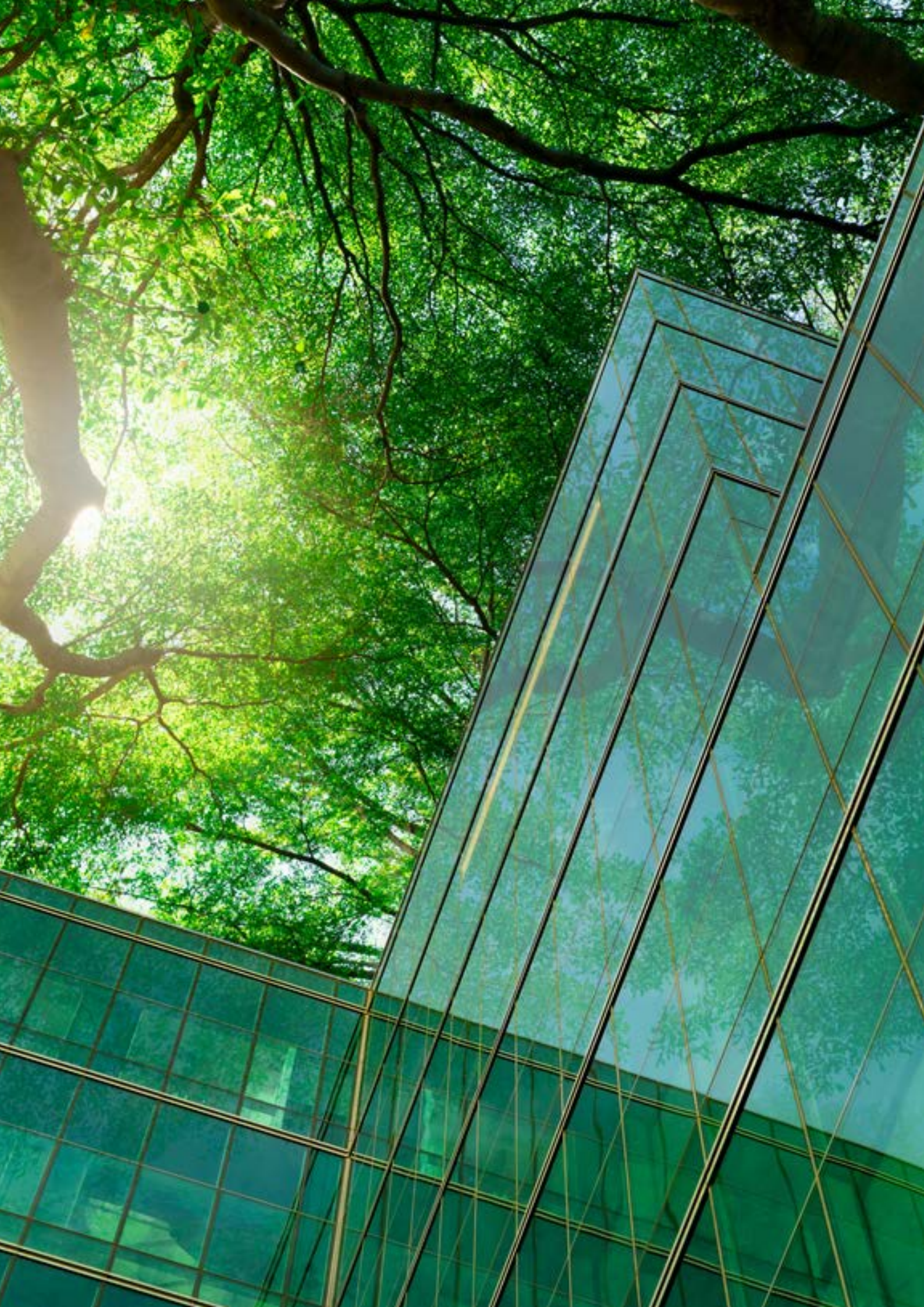
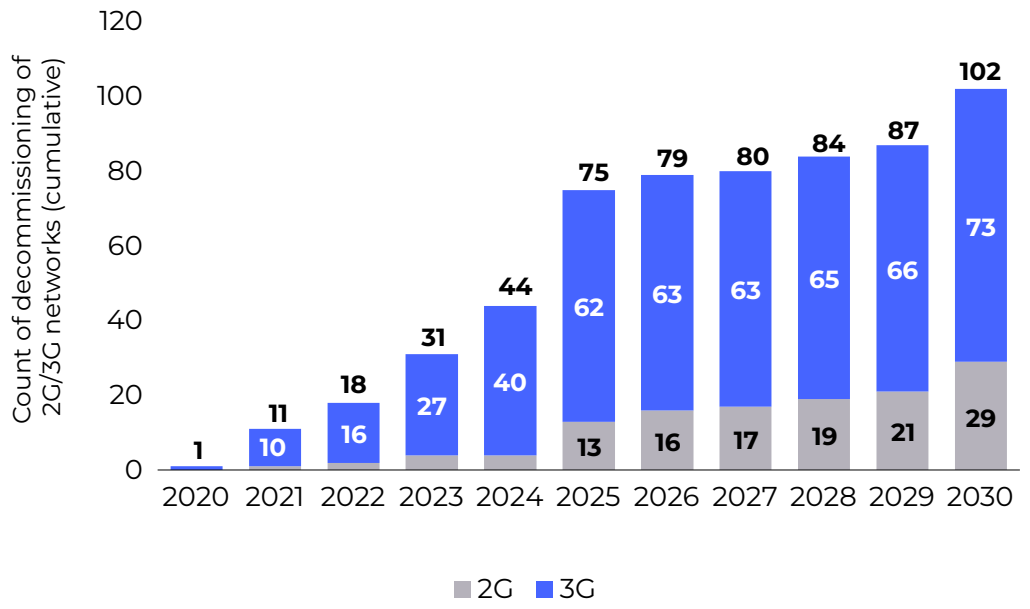


FIG 4.7 : Cumulative number of decommissioned 2G and 3G networks, Europe, 2020–2030 and later



Source: Analysys Mason, 2024

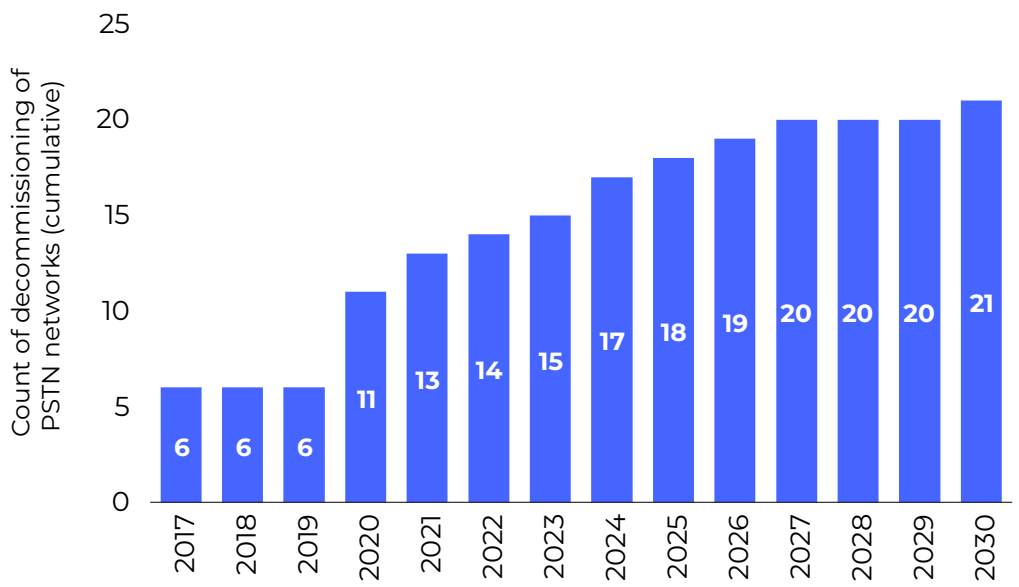
Fibre roll-out is almost complete in an increasing number of countries, which is making copper decommissioning an attractive economic and environmental opportunity for operators. FTTP networks have substantially lower operating costs than copper networks, mostly because they have fewer active parts, they are more resilient, and use about 90% less power per line. Overall opex per line on FTTP is about 50% that on copper and decreases with higher utilisation.

The transition from copper to fibre networks involves three major components. First operators must signal their planned stop-sell and technical decommissioning dates. Then comes the stop-sell of copper-based services, which refers to the commercial withdrawal of services such as PSTN or PSTN-emulation, ADSL, and VDSL (including FTTC). PSTN decommissioning often happens many years ahead of copper decommissioning. Lastly, is the technical decommissioning of copper which involves the physical removal of copper infrastructure at local exchanges, which may be followed by scrapping the copper lines altogether.

The whole process is generally mired in regulatory complexity due to the need to deliver alternatives to competitors, preserve infrastructure competition, sustain services for vulnerable members of society and for critical infrastructure systems relying on the legacy infrastructure. For these reasons it takes years. It is expected that 21 PSTN networks in Europe will have been decommissioned by 2030.

It should be noted that the varying conditions in different countries mean that timescales vary widely. Countries with less FTTH coverage will not be able to decommission as quickly; and in some countries - especially where the copper infrastructure has been upgraded to offer very high speeds, such as in Germany - copper-based broadband still forms an important part of the service mix.

FIG 4.8 : Cumulative number of decommissioned PSTNs, Europe, 2017–2030



Source: Analysys Mason, 2024

In the first quarter of 2023 Telenor became the first operator Connect Europe member to shut down its copper network activities (although in principle copper LLU will be maintained until early 2025). Telenor has reported that it expects to save up to 100GWh of electricity per year after the switch-off, which is about one eighth of its total energy consumption across all parts of its Norwegian fixed and mobile networks. Telenor also has begun the process of dismantling its network and recovering the copper.

Other operators in Europe are also using the shutdown of their copper networks to support wider circularity agendas. For example, BT has secured a EUR105 million prepayment with global recycler EMR for the sale of some of its redundant copper cables. BT said that it had extracted 3300 tonnes of copper from cables that it had already removed as part of its network upgrade to FTTH, and also that it expected eventually to be able to recover 200 000 tonnes of copper.

After Telenor, Telefónica and Telia Company will be the next to complete the shutdown of their copper networks in 2025 and 2026, respectively. Some operators have announced plans aiming for a complete shut-off before or by the early 2030s. Exact timelines have yet to be announced in many countries, especially where copper-based broadband is likely to remain important into the 2030s.

Open RAN

Open RAN remains a topic of interest for operators around the world and large-scale deployment is already underway by a few operators, which will help to validate the platform and drive it into global deployment from 2028. Open RAN attracts operators because, through common specifications such as those defined by the O-RAN Alliance, it allows the network to be cloudified in a standard way. 3GPP standards include many options for moving some or all RAN baseband functions to the cloud, but Open RAN defines a single approach that can be supported by a wide range of vendors. For operators considering the significant challenges of implementing the baseband in the cloud, Open RAN offers a simplified blueprint and access to a broad base of innovation and suppliers, and allows RAN network functions to be deployed on any cloud platform.

Even for operators that are not yet considering a virtualised RAN, Open RAN has defined a common fronthaul interface between the radio unit and baseband unit, which enables equipment and software from multiple vendors to interoperate in a standard way, reducing the risk of vendor lock-in.

However, it is now widely recognised, even by Open RAN early movers, that there are significant challenges in this migration - which they are working on addressing. These include complexity of system integration for multivendor networks, and crucially for many European operators, of coexistence with conventional RAN. Analysys Mason's annual survey of operators, which has tracked Open RAN deployment intentions for five years, shows that the level of commitment to deploy Open RAN has stayed fairly stable among European operators since 2019, with 64% planning to deploy during the life of their 5G networks. However, the timescale for large-scale commercial deployment in the macro network has been at times extended while a number of the operators wait for the ecosystem to address some of the technical and performance challenges, and for emerging vendors and their solutions to mature. The average start date for a commercial macro Open RAN deployment is now 2028 in Europe, compared to 2025 in the 2020 survey. Nevertheless, we do see the first macro-deployments in Europe taking place.

European operators have been at the forefront of trialling Open RAN and Vodafone's roll-outs are particularly advanced, and have expanded the operator's supply chain in key markets such as the UK. Deutsche Telekom, Orange, TIM and Telefónica also continue to be active in trialling and deploying the technology while contributing to efforts to build a European ecosystem, e.g. through publishing a series of technical and commercial requirements to help guide the industry in a common, operator-centric approach. In October 2024, Spain's MasOrange agreed a five-year contract to introduce Open RAN across much of the newly merged operator's 5G footprint; while in November, DT announced the next stage of its Open RAN deployment in Germany, rolling out Open

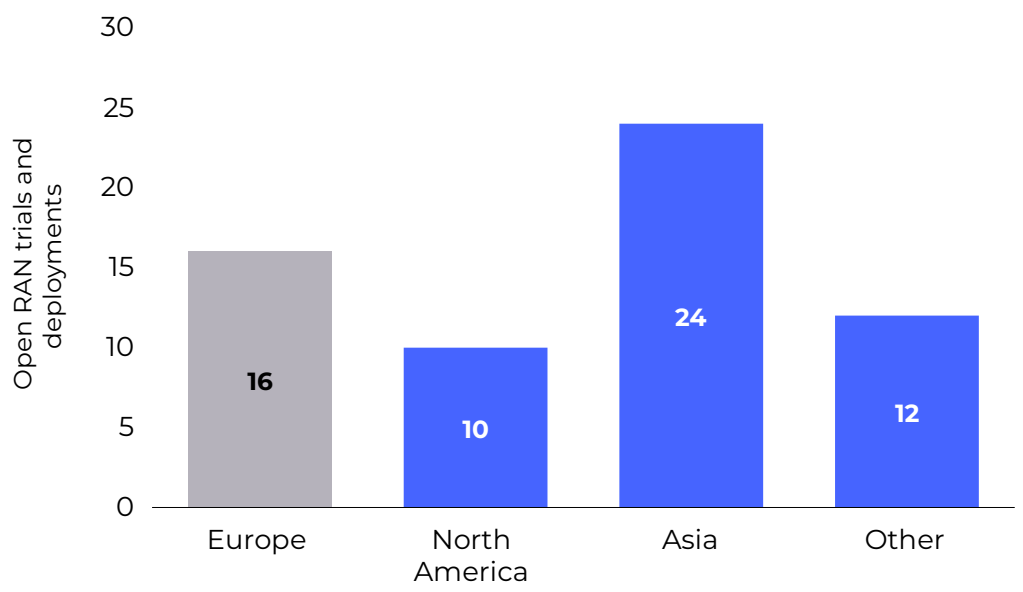
RAN compatible equipment to about 3,000 sites in partnership with Nokia and Fujitsu. On the vendor side, a commitment by Ericsson to support Open RAN from 2025 - notably with its Open RAN fronthaul and non-real time RAN Intelligent Controller – is significant in driving scale and R&D budget into the market, though it may also intensify the trend for operators to deploy 'single-vendor Open RAN', in which the network functions and radio units are procured from a single supplier, but with the interfaces left open so that new suppliers can be introduced in future. Our survey indicates that almost 70% of operators starting commercial Open RAN roll-out before 2029 will initially work with a single vendor, and in most cases an established NEP. This pattern is seen at AT&T, which awarded a USD14 billion Open RAN contract to Ericsson, but will introduce additional vendors, including Fujitsu for radio units.

Operators are starting to set targets for open networks. AT&T says 70% of its mobile traffic should flow across 'open-capable' networks by the end of 2026, while Vodafone has committed to 30% of its European macro sites supporting Open RAN by 2030. Orange has pledged to mandate Open RAN compliance for any new procurements from 2025.

The increased number of brownfield operators that are setting ambitious objectives should drive confidence in the platform and therefore adoption of Open RAN in the second half of the decade. This will be typically aligned to at least one of three deployment trends – virtualisation and disaggregation of the RAN; a new cycle of 5G deployment or densification, often with 5G-Advanced; and rural expansion, an environment that is commonly targeted by non-traditional Open RAN radio suppliers, with low-cost or simple models that suit rural economics.

As **FIG 4.9** shows, there were 16 commercial deployments or large-scale field trials of Open RAN in Europe as of September 2024, but we expect this number to almost double by the end of 2025, to 30. Asia-Pacific remains the largest Open RAN region in terms of trials and deployments, with significant market-leading initiatives in Japan and India, in particular.

FIG 4.9 : Open RAN trials and deployments in Europe, Asia-Pacific, North America and other geographies, 2024



Source: Analysys Mason, 2024

Cloudification, automation and AI in networks

As outlined above, adoption of Open RAN, and open network platforms more broadly, is often driven by cloudification. Migration of telecoms networks to the cloud has progressed more slowly than was expected at the end of the last decade. The most common domain for cloudification is the mobile packet core, since the 5G Standalone core was designed from scratch for cloud-native implementation. However, adoption of 5G SA has also been far slower than previously anticipated, and most European operators are still supporting the majority of 5G traffic on Non-Standalone networks, which use the 4G core. In nearly all cases, moving the RAN baseband functions to the cloud will follow several years after deployment of a cloud-native core, and in Europe, the timeframe to virtualise transport networks or fixed access routers is similar to, or longer than, the roadmap for the RAN. In Europe, some initiatives may help to facilitate the migration to the cloud, particularly by helping to address concerns about data sovereignty, security and federation. For instance, the EC has announced that its first Important Project of Common European Interest (IPCEI) will apply to next generation cloud infrastructure

and services (CIS), and will enable a federated and fully cloud-native network from end to end. A total of 19 companies from seven member states (France, Germany, Hungary, Italy, the Netherlands, Poland, and Spain) including 4iG, Deutsche Telekom, Orange, Telefonica, TIM are participating directly in the project. Many dozens of other companies are indirect partners. The project - which is underpinned by up to EUR1.2 billion in Member State funding - revolves around the creation of an interoperable and openly accessible European data processing ecosystem. This includes the development of data processing capabilities, and software and data sharing tools for federated, energy-efficient and trustworthy cloud and edge distributed data processing technologies and related services. The research, development and first industrial deployment phases will run between 2023 and 2031.

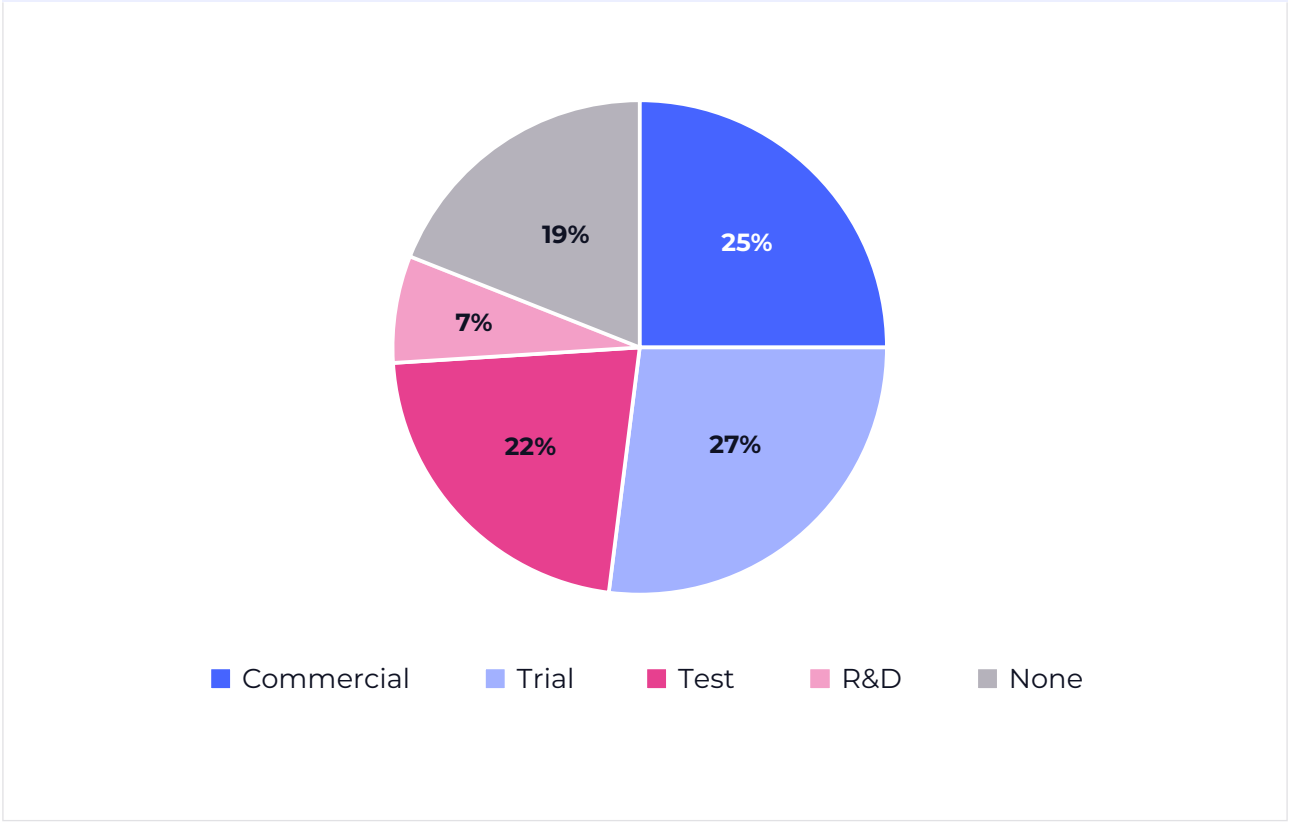
The cautious progress does not signify a lack of interest among operators. Many already run IT applications in the cloud and offer services to customers. They have also started to work together on innovative telco cloud within the Sylva project developed under the Linux Foundation and supported by the IPCEI CIS. The cloudification of the networks presents a far higher degree of complexity, migration effort and risk, and needs to be aligned with a new cycle of network performance and investment, to avoid wasting investment in traditional systems, especially 5G RAN. But according to Analysys Mason surveys, over two-thirds of European operators do have a roadmap to move the RAN, fixed and transport networks to the cloud, even though this may span a full decade.

The reasons to cloudify networks are to increase the agility to design, deploy and provision new services rapidly, driving improved revenue and customer experience, and reaping the full benefits of 5G SA characteristics including slicing; as well as to achieve significant opex reduction and quality of experience enhancement, through automation. These potential benefits are sufficiently compelling for many operators to have embarked on their cloud journeys, targeting cost and revenue upsides at each stage of the multi-phase migration in order to improve the 5G business case cumulatively over the rest of the decade.

The vision is to combine extreme automation with a network that adapts itself constantly in response to the needs of individual applications or users. This will leverage several key capabilities that are only deployable on the cloud, notably 5G or converged core that supports multi-domain slicing, and dynamic RAN control functions such as adaptive spectrum selection. Capabilities of this kind are enabled by cloud and 5G, but can be greatly enhanced by the addition of AI/ML.

The evolution of mobile standards, in the 5G-Advanced and future 6G specifications, is heavily focused on the integration of RAN and AI, initially for automation use cases such as self-organising network (SON) or automated beamforming, but looking ahead to an AI-native platform with AI embedded in the network itself as far as the digital front end. As **FIG 4.10** illustrates, Analysys Mason's survey shows that 25% of European operators have already deployed some AI functionality for RAN automation and optimisation, either enhancing an existing OSS use case, or implementing new functions, often related to beamforming in Massive MIMO sites. Another 27% said they have reached large-scale lab or field trials for their most advanced use cases and over 80% have RAN AI activity of some kind.

FIG 4.10 : Status of operator deployment of AI for RAN automation and optimisation, European operators (36 respondents)



Source: Analysys Mason, 2024

Although the wait for mature AI-native technologies and tools for the RAN may lengthen the process of network cloudification, the implementation of AI-native systems should amplify the impact of the cloud on efficiency, automation and user-defined QoE. Operators are working closely with AI technology leaders such as Nvidia to accelerate the availability of key enablers such as large language models for Generative AI that are optimised for telecom requirements and data. This is a focus of the Global Telco AI Alliance, founded earlier this year by Deutsche Telekom and four other operators (E&, SingTel, SK Telecom and Softbank). Another group, the RAN AI Alliance, is working on AI-native technologies for RAN automation and intelligence, with an eye on 6G. Founding members include T-Mobile USA, Softbank, Nvidia and ARM.

Decoupling energy consumption from greenhouse gas emissions

Telecoms operators in Europe are making strong progress in terms of reducing their energy consumption and decoupling energy consumption from carbon emissions by moving to the use of renewable energy sources, and many Connect Europe members have now set externally validated net-zero targets for both their direct (Scope 1 and 2) and indirect (Scope 3) carbon emissions[18]. The Science Based Targets Initiative is an independent organisation established to validate companies' carbon reduction targets against scientific principles. The table below shows members of Connect Europe that have validated short-term targets (designed to meet requirements to limit global warming to a specific temperature increase - in the case of all these companies, 1.5C) and longer-term targets to achieve net zero across the value chain (encompassing scopes 1, 2 and 3). Some European operators have announced net zero targets but are not working within the SBTi initiative.

FIG 4.11 : SBTi-based emission reduction targets, Connect Europe members at the group level

Operator	Near-term science-based target date (scope 1 and 2)	Target date for net-zero emissions (value chain)
A1	2030	2040
BT	2030	
Deutsche Telekom	2030	2040
Elisa	2030	2040
GO	2030	2050
KPN	2030	2040
Liberty Global	2030	
Magyar Telecom	2030	
Orange	2030	2040
Proximus	2030	2040
TDC	2028	2030
Telefónica	2030	2040
Telenor	2030	2045[20]
Telia Company	2030	2040
TIM Group	2030	
Swisscom	2030	2035
Virgin Media O2	2030	2040

Source: Science Based Targets Initiative[19], 2024

FIG 4.11 only shows targets that have been validated against the Science Based Targets initiative (SBTi) Net-Zero Standard. To check progress in SBTi, click here : https://sciencebasedtargets.org/companies-taking-action

Energy usage is a primary driver of carbon emissions in the telecoms sector. The energy usage of the Connect Europe members' European operations steadily fell between 2020 and 2022 and the use of renewable energy is growing. 84% of their energy was reported to come from renewable sources in 2023 (calculated using the market definition of scope 2).[21]

Many of the Connect Europe members are investing in renewable energy and moving away from the use of fossil fuels. Examples include TIM, which has invested in around 80 photovoltaic plants already in operation in Europe (and an additional 100 in Brazil), and KPN which will purchase more than 50% of its electricity on an annual basis from a new wind farm that will be located more than 50 km off the coast of the Netherlands.

In addition to investment in their own facilities, operators are signing power purchase agreements (PPAs) contracts. The considerable reductions made in Scope 2 emissions by some of the Connect Europe members have been enabled through the use of long-term PPAs. For example, between 2020 and 2023, Deutsche Telekom decreased its Scope 2 (market-based) emissions by 99%, in part due to its widespread use of PPAs across its European operations[22].

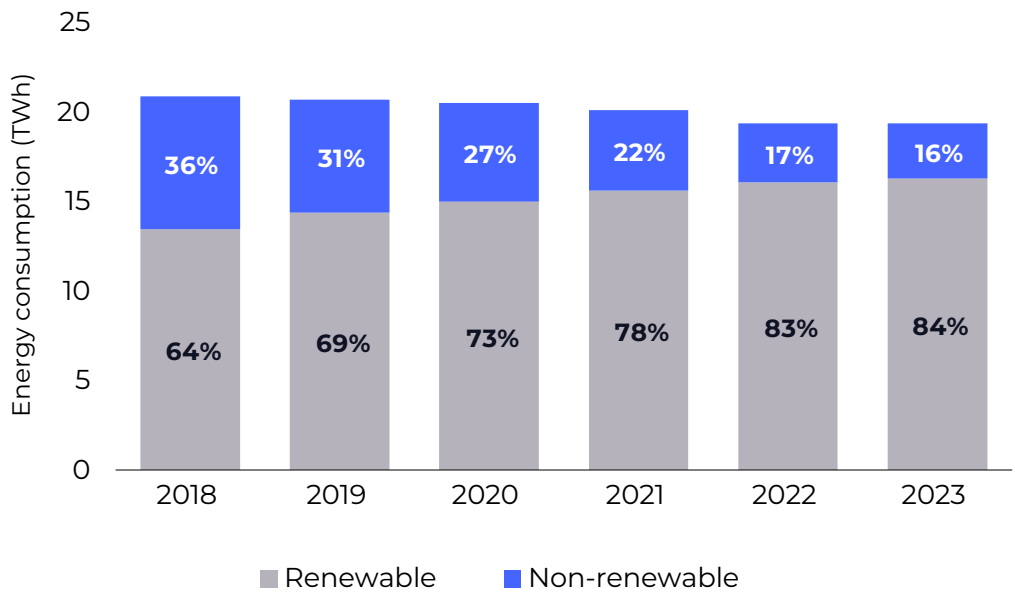
Several Connect Europe members have also been early participants of climate initiatives such as RE100[23] designed to encourage 100% migration to renewable electricity sources. The ability of operators to migrate to renewable electricity sources will depend however on the energy mix in their corresponding Member States, as operators' access to renewable energy in their home markets will vary.

[18] Scope 1 : direct emissions from an operator's own activities as a result of the combustion of fuels on site; Scope 2 : indirect emissions from the purchase of energy including electricity); Scope 3 = all other indirect emissions from an operator's upstream and downstream activities.
[19] https://sciencebasedtargets.org/target-dashboard
[20] 2040 target for Nordic operations; 2045 target for Asian operations.
[21] There are two different ways of defining scope 2 emissions: the location method and the market method. The location method involves looking at the overall emissions of the grid of the country that operations are located in, while the market method focuses on the specific supply mixture that an operator buys. Most operators use the market method for reporting their scope 2 emissions.
[22] https://www.cr-report.telekom.com/2023/management-facts/environment/co2e-emissions#atn-19711-19716
[23] RE100 (there100.org)

To enhance the use of renewable and sustainable energy sources while addressing the intermittency challenges of wind and solar power, some telecoms companies have implemented advanced energy storage solutions. A notable example is Elisa's Distributed Energy Storage (DES) project, which serves two primary functions: demand management and grid support; and revenue generation. The system allows load shifting to optimise energy use during periods of higher renewable energy availability, while allowing Elisa to sell excess stored power back to the grid.[24]

Another example is Deutsche Telekom which – in collaboration with partners - has integrated two large-scale battery storage systems into the power grid, each with a capacity of 6 megawatt hours (MWh). These are designed to help stabilize the power supply, balance grid fluctuations, and facilitate the integration of renewable energies.

FIG 4.12 : Energy consumption from renewable and non-renewable sources, Connect Europe members, Europe only, 2018–2023



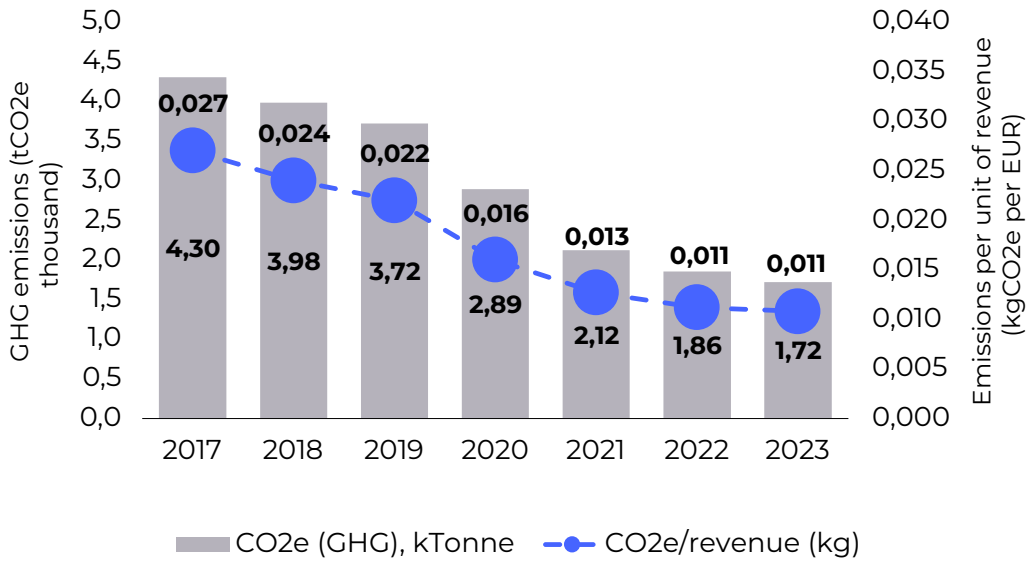
Source: Analysys Mason, 2024

[24] Distributed Energy Storage - Elisa

Connect Europe members' Scope 1 and 2 emissions within Europe are decreasing year-on-year. Consequently, the carbon intensity of revenue generated by their businesses is following a similar decline; emissions per unit of revenue fell by around 60% between 2017 and 2023 (**FIG 4.13**).

To achieve these reductions, operators have been implementing a range of measures, alongside the adoption of renewable energy. These include decommissioning legacy fixed and mobile networks (as discussed previously), improving the energy efficiency of their network infrastructure, as well as sharing passive network infrastructure. The physical sites are the biggest consumers of energy and emissions in telecom networks, and after shutting down their legacy networks, one of the changes that an operator can make to reduce energy and emissions is also to engage in network sharing.

FIG 4.13 : Scope 1 and 2 GHG emissions and emissions per unit of revenue generated, Connect Europe members, Europe only, market-based calculation method, 2017–2023



Source: Analysys Mason, 2024

Scope 3 emissions produced across the entire value chain are the most difficult and complex to assess, and the absence of emission transparency through multiple tiers of the supply chain is a concern. Scope 3 emissions represent around 80% of a telecoms operator's total carbon emissions, and 80-90% of a typical operator's Scope 3 emissions come from upstream activities in their supply chain – mainly from the purchase of their goods and services (category 1) and capital goods (category 2)[25].

Connect Europe members have been working to tackle the complexities of Scope 3 by implementing the necessary governance and reporting structures to enable them to begin to measure their supply chain emissions, to encourage their suppliers to reduce emissions, and implement measures that reduce customer emissions. From this perspective, circular economy principles are important for telecom operators seeking to tackle Scope 3 emissions. Circular economy programs - for instance for network equipment - enable operators to avoid ICT overproduction. For example, Orange is managing the circular economy program OSCAR which favours the reuse of network equipment between its subsidiaries[26]. Similar principles apply to the reuse of devices supplied to end customers.

Reducing and managing waste, and reducing resource usage

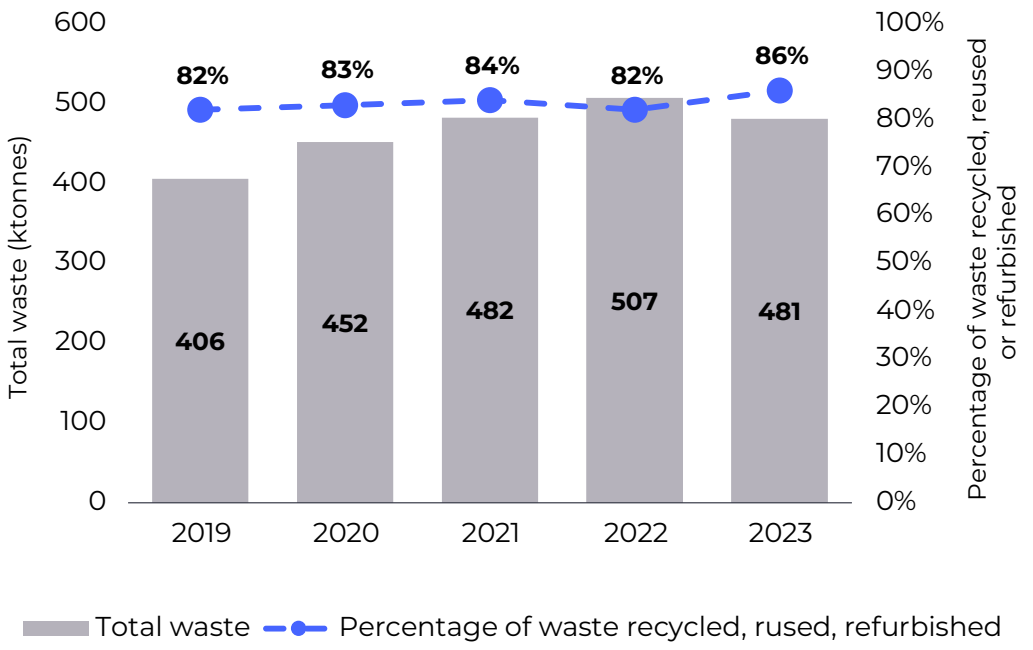
Reducing and managing waste, including ongoing operational waste, the waste generated when old networks are decommissioned, and consumer electronic waste (e-waste) such as mobile phones, computers and tablets, is a challenge for the telecoms industry. Many players express the importance of resource management in their sustainability reports.

Despite this, levels of waste production and disposal are often unreported or disclosures are limited. In 2023, only 58% of the top 50 global operators published any official figure on their total waste production and less than half of them reported on how much of their waste had been recycled, recovered or sent to landfill. Definitions of waste are often vague and varying methodologies are used to account for volumes of waste and to report on the extent of material recycling or reuse.

Although the global picture on the reporting of waste is limited, Connect Europe members are taking proactive measures to help curb the growth of waste (**FIG 4.14**). In 2023, the levels of waste recorded by Connect Europe members dropped, after a period of growth between 2019 and 2023; and the proportion of waste recycled, reused or refurbished rose to 86% - the highest level recorded over the last 5 years. This has been achieved thanks to programmes such as the WEEE Clean programme, managed by Orange. The guidelines set out in WEEE Clean provide a framework for the Orange Group's WEEE and battery waste policy, helping Orange subsidiaries to efficiently managing waste generated from IT and network infrastructure, as well as from customer equipment distributed by Orange.

[25] ARCEP, https://www.arcep.fr/nos-sujets/numerique-et-environnement.html
[26] https://www.orange.com/en/newsroom/news/2021/net-zero-carbon-commitment-circular-economy-heart-our-network-infrastructure

FIG 4.14 : Total waste generated, and percentage of waste recycled, reused, or refurbished, Connect Europe members, group level, 2019–2023



Source: Analysys Mason, 2024

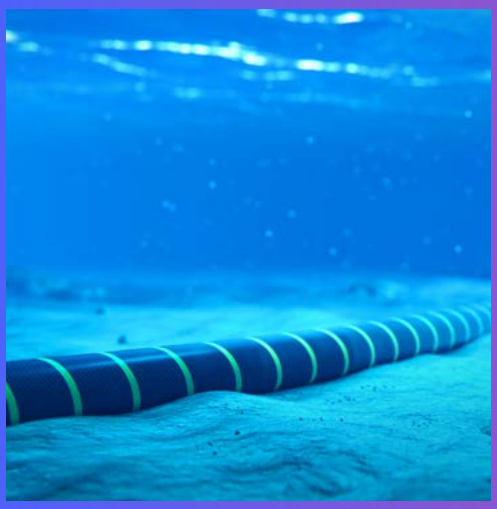
Operators are also looking at wider resource (non-electronic) resource usage. For example, Deutsche Telekom's *Digital Delivery Note* replaces physical documents, significantly reducing environmental impact by saving 7.7 tons of CO2 and nearly 6,000 cubic meters of water per 1 million sheets of paper. As well as minimizing resource consumption this approach has the additional benefit of helping to optimize supply chain processes and reduce delays.

Ensuring security and resilience

Changes in global geopolitics have led to increased focus within Europe on the security and resilience of its telecoms networks. As critical infrastructure, telecoms networks underpin all of the region's business activity, financial and healthcare systems, and governmental operations and play a key part in its military security operations. Recent events such as the severing of cables in the Baltic Sea in November 2024 have ensured heightened focus on identifying and mitigating weaknesses in telecoms infrastructure. Malicious threats to telecoms infrastructure include physical threats (such as damage to submarine cables, attacks on cell towers or supporting power infrastructure) as well as cyber attacks (including espionage, sabotage and data theft). As mobile networks also play a key role in assuring the validity of online transactions, the integrity of the telecoms infrastructure is also crucial to prevent theft from businesses and consumers and fraud (see section below). There are also increased physical threats to infrastructure from climate change-induced weather (wildfires, flooding events, landslips, and storm winds).

Europe's governments and operators are looking hard at remedies to increase the security and resilience of the region's telecoms networks. There are too many potential activities to cover them all in this report, but significant areas of recent focus include:

Ensuring submarine cable integrity and resilience



In February 2024 the European Commission passed a Recommendation on the security and resilience of submarine cable infrastructure[27]. The recommendation set out a series of actions including improved coordination across Member States, improved governance to assure security and resilience, and provision of funding to enable submarine infrastructure (anything related to cable construction, operation, maintenance and repair) to be safeguarded. In addition at a United Nations General Assembly event in September 2024, the EU endorsed a Joint Statement on the security and resilience of undersea cables. This recommended use of low-risk subsea cable providers, enhancement of route diversity, protection of cable networks from unauthorised access to data in transit, and implementation of cybersecurity best practices.

AI security

The EU's horizontal regulation on Artificial Intelligence[28] introduced in 2024 sets out a framework to govern use of AI, with higher safeguards required for higher-risk activities. Telecoms operators will have to ensure they comply with the governance requirements. Europe's operators are already experimenting with the use of AI to improve the security and resilience of their systems.

Vendor embargos

The EC advised Member States to restrict or exclude high-risk suppliers from their 5G networks in 2020. Since then many European countries have taken measures to minimise the use of telecoms equipment supplied by Chinese vendors. This has involved billions of Euros of investment on the part of operators to rip out and replace the technologies concerned.

Quantum encryption

As quantum computers become more capable and sophisticated concern has grown about the potential for the technology to be used to compromise security systems. In anticipation of this eventuality, in April 2024 the European Commission published a Recommendation on post quantum cryptography[29]. This encouraged Member States to develop strategies for the adoption of Post-Quantum Cryptography, to coordinate their approaches and plan transition strategies for the post-quantum era. A number of operators, including Connect Europe members BT, Proximus, Orange and TIM have been involved in technology trials of quantum encryption and quantum communications over fibre networks.

[27] Brussels, 26.2.2024 C(2024) 1181 final.
[28] https://eur-lex.europa.eu/eli/reg/2024/1689/oj
[29] https://digital-strategy.ec.europa.eu/en/library/recommendation-coordinated-implementation-roadmap-transition-post-quantum-cryptography

6G security

6G networks will need to be able deal with an ever expanding range of threat vectors including the emergence of new threats such as quantum computing-enabled key decryption and AI-enabled attack mechanisms. European operators, vendors, and academic institutions are involved in a range of EU-funded projects to work on embedding security into 6G standards by design. Key consortium-led EU projects include: ROBUST-6G, SAFE-6G, ITRUST6G, RIGOROUS, and CONFIDENTIAL6G.

All of these frameworks, rules, decisions and projects represent costs for operators, require substantial investment on the part of operators, and demonstrate the critical role of operators in ensuring that future networks remain secure, resilient and fit for purpose.

Collaborating with other industries to protect customers

Fraudulent caller line identification (CLI) spoofing poses a major issue across Europe, and fraudsters are continuously coming up with new ways to scam people. Combatting this form of fraud can be challenging, particularly because there are typically several different actors involved in the process, with differing levels of oversight. Connect Europe members have responded to this issue by collaborating with other sectors on a national level, in order to protect customers from being defrauded.

The Netherlands

In the Netherlands there is a successful cooperation between banks (the Dutch Banking Association) and the telecom sector (COIN – the Dutch Telecommunications Association) with pilot projects underway to:

- mitigate spoofing of phone numbers used by banks in the Netherlands
- mitigate smishing with alphanumeric SMS Sender IDs of NL banks.

These pilot projects are examples of very effective, voluntary collaboration between the telecoms and banking industries, whereby relatively simple measures can effectively counter spoofing. These solutions target the cases whereby it may be most easy to mislead customers (with the use of actual phone numbers and IDs from the bank). No content monitoring is required.

Finland

Finnish authorities, telecommunications operators and the financial sector are working closely together to prevent fraud. The National Regulatory Authority (Traficom) set up a task force to address the problem. Its recommendation was the introduction of mobile telephone CLI validation for an international incoming roaming call.

Cooperation between the various stakeholders has now led to implementation of a technical solution to stop scam calls. Mobile telephone CLI (calling line identity) validation processes are used to check whether traffic using Finnish numbers actually originates from abroad, or if a Finnish mobile subscription is currently abroad. This makes it possible to block traffic originating from abroad using Finnish numbers. In addition to this, during spring 2024 Traficom started the registration of protected SMS Sender IDs, which can be used by organisations such as banks and financial institutions. This allows them to send out text messages to Finnish citizens and be sure that no one else can use the same SMS Sender ID.

Belgium

Belgian operators introduced a full operational blacklist - including the public bank telephone numbers. This blacklist stopped CLI spoofing fraud for bank telephone numbers while all parties await a generic solution to stop CLI spoofing for all Belgian numbers. The regulator organises regular meetings (at least 2 times per year) between the telecom and bank sector to monitor the evolution of the fraud and to analyse new fraud scenarios.

05

Connect Europe members play a key role in determining the pace of European technology innovation

The Draghi report envisages tech innovation driving future accelerated growth in the European economy. Innovation also relies on telecoms operators to turn their networks into platforms for innovation. This means embracing cloud native architectures, adaptive business processes, high levels of automation and programmability, and the development of new network-as-a-service applications. The following section explores developments in a number of these areas.

5.1 5G STANDALONE NETWORKS

5G standalone (SA) is the next phase of 5G deployment for many operators. It marks the transition from 5G non-standalone (NSA) architecture, which uses the existing 4G evolved packet core (EPC), towards a self- supporting and flexible 5G core. As well as no longer relying on a 4G anchor for control, the transition to 5G SA also opens the door to a range of network benefits, especially when leveraging a cloud-native core. These benefits include the cost, scalability and agility advantages of a cloud environment, but also a range of unique network capabilities, such as ultra reliable low-latency communication (URLLC), massive IoT, improved edge support and network slicing.

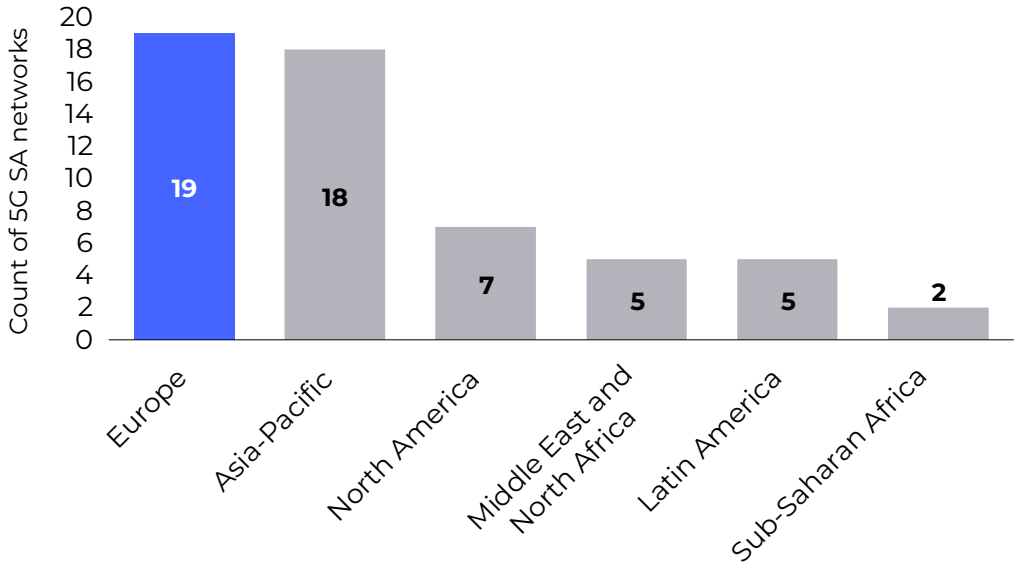
The advanced capabilities of 5G SA can bring a range of cost savings and performance advantages to an operator network, and most importantly, the 5G core could enable new use cases for operators. Network slicing is a flagship capability of 5G SA and allows operators to create customised virtual slices of their networks with guaranteed performance and unique service level agreements (SLAs) to support specific customers' or applications' requirements. However, the progress towards 5G SA has been generally sluggish globally, due to uncertainties about demand and monetisation.

To date, there have been 56 operational 5G SA networks worldwide (**FIG 5.1**). The number of 5G SA launches worldwide slowed in 2023 but has since gained some momentum in 2024. There have been 9 commercial launches of 5G SA networks so far in 2024. This is compared to a total of 10 launches throughout the whole of 2023. Adoption of 5G SA has been slow largely due to operator concerns that the return on investment is unclear, the technology is immature and the migration from 5G to 5G SA is disruptive. There is also limited information available about the extent of operators' rollout of 5G SA.

The adoption of 5G SA networks in Europe has been growing, despite a slower global uptake. In 2023, Europe witnessed a record number of 5G SA launches, and this trend has

continued into 2024, with European operators accounting for seven out of nine global 5G SA deployments so far this year. The UK market has seen notable activity in 2024: BT's (EE) network introduced its 5G SA service in September 2024 and Virgin Media O2 launched its 5G SA network earlier, in February 2024. Several other European countries have also made strides in 5G SA deployment including France, Germany, Greece and Finland.

FIG 5.1 : 5G SA commercial networks by geography, 3Q 2024

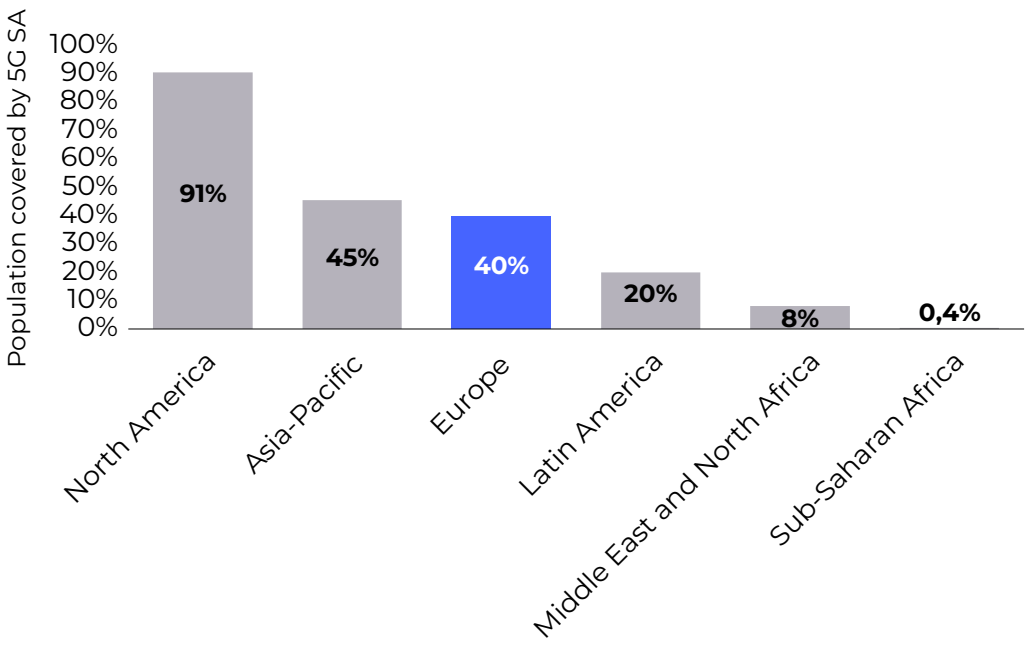


Source: Analysys Mason, 2024

North America leads in terms of 5G SA coverage, with 91% of the region's population able to access 5G SA services (**FIG 5.2**). This is followed by Asia-Pacific with 45% 5G SA coverage and then Europe at 40%. The high coverage rate reported in North America is largely attributable to the early launch of services using 600MHz. (T-Mobile USA launched its 5G SA network over 600MHz spectrum in August 2020 and later launched a faster 5G SA service using the 2.5GHz band in November 2022). By September 2024, the U.S. operators reported 95% 5G SA coverage across the country. Many operators use NSA as a stepping stone towards SA but some operators such as DISH in the US and Jio in India have opted for direct SA deployment from the beginning.

Europe, Finland, Germany and France have reported high 5G SA coverage. In September 2024, Free in France reported it had launched 5G SA in the 3.5GHz band, with its 3.5GHz infrastructure covering close to 50% of the French population. In 2024 Vodafone also announced it had expanded its 5G SA coverage to 92% of the German population using the 700MHz, 1.8GHz and 3.5GHz bands, after launching in April 2021.

FIG 5.2 : 5G SA coverage, by region, 3Q 2024



Source: Analysys Mason, 2024

In regions where 5G SA has been launched, coverage has been expanding beyond just urban centres. However, many mobile subscribers in most of Africa, the Middle East and Latin America have yet to experience 5G SA, with regional coverage of 0.4%, 8% and 20% in those areas, respectively. Many operators in these regions are focusing on existing 5G deployments using the NSA model.

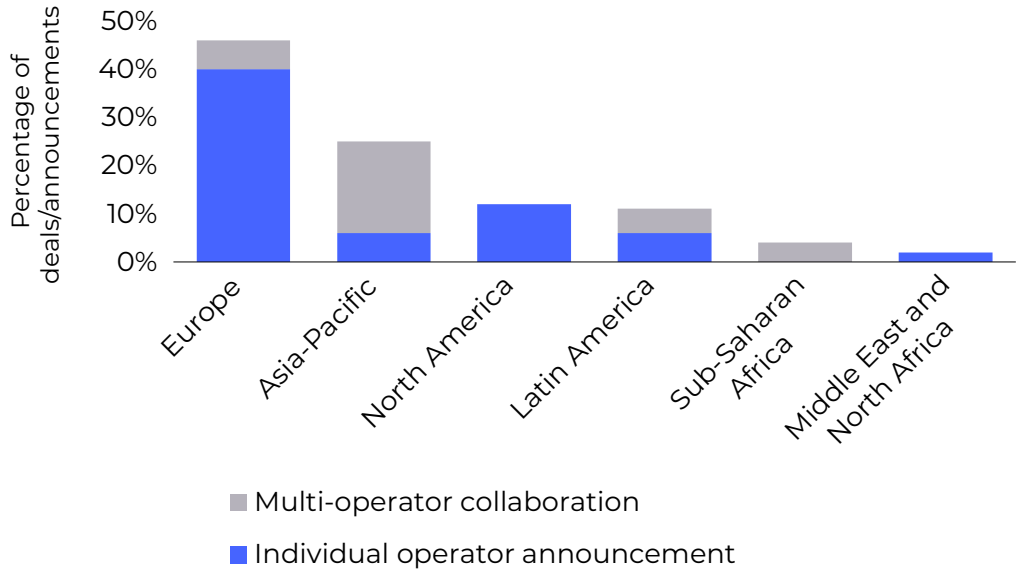
5.2 OPEN GATEWAY AND NETWORK-AS-A-SERVICE

Network-as-a-service (NaaS) is a significant development in supporting potential new business models for operators. It involves operators providing network capabilities and related services from a single platform to customers, particularly enterprises, which can then deploy their own use cases and services for internal or customer use. The customers are shielded from the complexity of running their own mobile connectivity and services and can access a wide range of applications that take advantage of network capabilities such as charging and enhanced security.

The main features of NaaS are any-to-any connectivity, a self-service portal, 'single pane of glass' management, consumption-based pricing, a value-added services marketplace, and exposure of network and platform capabilities to developers through open APIs. The last of these features is an important enabler of NaaS, and several related initiatives, including MEF, CAMARA and GSMA's Open Gateway, are all working on industry-standard APIs. These allow developers to incorporate network functionality into applications in a standard way, so that their apps can run on the network of any supporting operator, greatly expanding the apps base.

As **FIG 5.3** shows, Western European operators have dominated this market in its early stages, accounting for over 40% of publicly announced network API initiatives to date. Companies such as Deutsche Telekom and Orange have been strong supporters of the Open Gateway initiative and have released initial open APIs, as well as roadmaps for future additions. In some cases, two or more operators have co-developed APIs or NaaS services based on the open specs, in order to offer a common set of functions to customers in all their respective markets.

FIG 5.3 : Network API platform-related announcements by region, and by individual or multi-operator announcement



Source: Analysys Mason, 2024

However, this market is at an early stage of development and there are barriers to overcome. Most of the first open APIs to be commercialised support simple network functions such as SIM swap, which do not add significant value for enterprise applications. Advanced APIs (such as those that enable network quality and insights) are essential to realise the NaaS opportunity, but these advanced APIs are not straightforward to implement. They require deep access to network data, sophisticated orchestration and OSS/BSS capabilities and integration across multiple network domains. There have been challenges such as lack of support from the major device operating system providers for opening up access to their OS capabilities.

However, there is significant momentum behind efforts to address these problems. In November 2024, for example, 12 major operators, including DT, Orange, Telefonica and Vodafone, announced a venture with Ericsson to sell their combined base of network APIs from a single platform, an initiative that will increase scale and confidence in open APIs and the NaaS models they facilitate.

The ecosystem, with European operators in the vanguard, is working to address further challenges and also to enhance the NaaS business case with additional functionality, particularly network slicing. Commercial and technical challenges have prevented significant deployment of 5G or multi-network slicing, but the technology has the potential to enrich NaaS propositions by allowing enterprises and developers to create multiple virtual networks on a single physical infrastructure, with each slice tailored to specific application requirements such as security or reliability levels. In the medium term the use of APIs for programmatic slicing could greatly improve the NaaS model, providing on-demand, application-based network provisioning with the granular control and flexibility that enterprises want.

5.3 INTEGRATION OF SPACE AND 5G TERRESTRIAL COMMUNICATIONS NETWORKS

Partnerships between satellite and terrestrial communications providers constitute a very small part of the European telecoms landscape, but they are becoming more strategic to telecoms operators as a rising number of use cases rely on the ubiquitous coverage that a combination of satellite and terrestrial broadband can deliver. Such use cases can drive new revenue opportunities for telco/satco partnerships, in addition to traditional services such as mobile backhaul or connectivity for transportation or very remote areas. There is increased demand for connectivity in every location, such as in aeroplanes or trains; and potential growth in IoT or logistics applications that require truly ubiquitous coverage.

The drive to meet these demands has been facilitated by two developments: the emergence of low earth orbit (LEO) satellites, which can blanket large areas with coverage at a fraction of the cost and latency of traditional geostationary (GEO) satellites; and the publication of 3GPP standards for integrating 5G with non-terrestrial networking (NTN). The 5G NTN specifications are part of 3GPP Release 18 standards and enable greatly improved interoperability between the two networks, and will help telecoms operators to add 5G satellite services to their portfolios seamlessly.

The upcoming 3GPP Release 19 will enhance the use cases and performance for 5G NTN, improving coverage and capacity, extending support to the new 5G RedCap IoT standard, and adding multicast and broadcast services. In addition to 3GPP standards, other industry bodies such as TM Forum and MEF are working on common APIs to simplify integration and support an at-scale platform for apps developers.

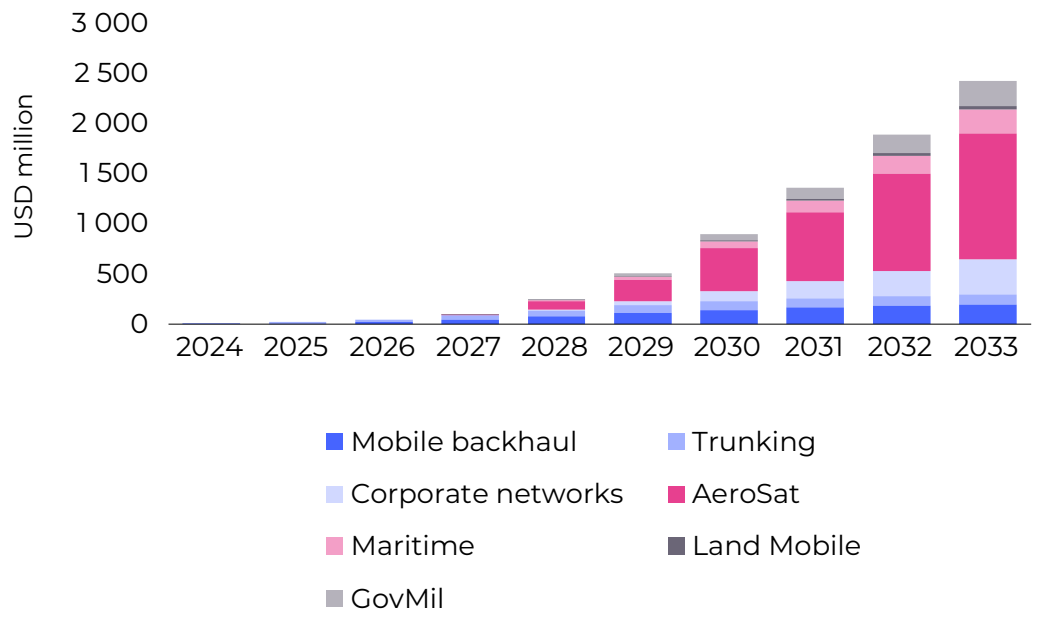
Many large European operators are forming NTN partnerships. Examples include Vodafone and Intelsat, which in 2024 expanded the range of use cases they address for remote locations or emergency response. Deutsche Telekom has long-standing alliances with GEO operators Intelsat and Viasat and with LEO venture OQ, as well as with satellite IoT service providers such as Sateliot. Telefonica has a variety of satellite partnerships including one with Starlink, the largest of the LEOsat operators, which spans Europe and Latin America, and was recently extended to the UK joint venture VMO2. VMO2 will use Starlink services primarily for rural backhaul.

An important development in the European satellite landscape was announced in October 2024 when the European Commission chose a team led by satellite firms Eutelsat, Hispasat and SES to build its long-planned IRIS2 multi-orbit constellation. The three companies will lead a consortium called SpaceRISE, which will rely on a Core Team

of European subcontractors: Deutsche Telekom, Orange, Airbus, Thales, OHB, Telespazio and Hisdesat. IRIS2 is Europe's third space programme after Galileo and Copernicus and plans a constellation of 290 satellites in both medium-earth orbit (MEO) and LEO to provide secure connectivity services to the EU and its member states, along with broadband connectivity. It will be a 12-year contract for a public-private partnership to acquire the satellites and ground segment to provide government services by 2030 and enable commercial services. The EC has expressed interest in incorporating 3GPP standards and other emerging technologies such as regenerative payload, to help IRIS2 differentiate from other constellations.

All these developments should help to increase the revenues from 5G satellite services in Europe by over 130 times between 2025 and 2033, from a tiny base of USD17 million at the start of that period to USD2.4 billion by the end (see **FIG 5.4**). Still a very small sum compared to total European telecoms services, these revenues will also help operators to attract new enterprise businesses and offer value-added services for additional monetisation. According to Analysys Mason forecasts, the biggest 5G satellite market will be commercial aeronautical mobile connectivity (aeroSat), followed by corporate networks and mobile backhaul. AeroSat and backhaul are not new revenue streams, but demand for them is increased by the need for ubiquitous connectivity. Many corporate network revenues are supporting new use cases such as IoT and these will experience the highest compound annual growth rate, at 150% between 2027 and 2033.

FIG 5.4 : 5G Satellite revenues in Europe 2024-2033 by market segment



Source: Analysys Mason, 2024

The ecosystem and value chain for converged telecom/satellite services is likely to change significantly as a result of new players and new use cases. The commercial relationship may be well-established between long-term partners such as Inmarsat and Vodafone, which are expanding existing cooperation into new use cases. But the entry of LEOsat operators, particularly Starlink, introduces powerful new stakeholders, mainly from the USA, which will expand the market but may also reset the relationship with operators. Major device players such as Apple are also likely to take a greater share of the value of new services than traditional satellite device makers, because of their market power and ability to work with both telcos and satcos.

5.4 OPERATORS' ROLE IN THE DEFINING AND DEVELOPING 6G

As the expansion of 5G coverage and 5G SA continues, the industry is already starting to consider what 6G will look like. Analysys Mason currently tracks over 200 R&D projects that address some aspect of 6G. The ITU has begun the process of defining the characteristics of 6G, under its IMT-2030 framework, and will confirm the compliant standards by 2030. 3GPP has said that Release 20 of its standards, which should be completed in 2027, will be a crossover release between 5G and 6G, while Release 21 will be a full 6G release and should be completed by early 2029, allowing for commercial equipment in 2030.

The decision to have a crossover release indicates that 3GPP, guided by the cellular operator and vendor community, will aim to build on 5G foundations rather than creating 6G from scratch. That aligns with the attitude of many large operators, especially in Europe, which have publicly stated that they will not sustain another big-bang upgrade that entails a major capex spike. Capex levels at most major operators have fallen in the past 2-3 years and are not expected to return to pre-2021 levels, and so there is considerable pressure on the technology ecosystem to devise 6G as a series of incremental improvements that can be introduced when required without having to replace 5G systems.

This approach will be facilitated by the cloudification of mobile networks, which would enable a stream of software updates to deliver many new functions, as in the cloud world. That 6G networks will be cloud-native and AI-native are two of the few areas of consensus at this early stage, and operators hope those characteristics will support a significant increase in automation, network adaptability, resource efficiency and therefore reduced TCO. Arguably, if this vision is realised, 6G will deliver many of the promises that 5G was originally designed to fulfil.

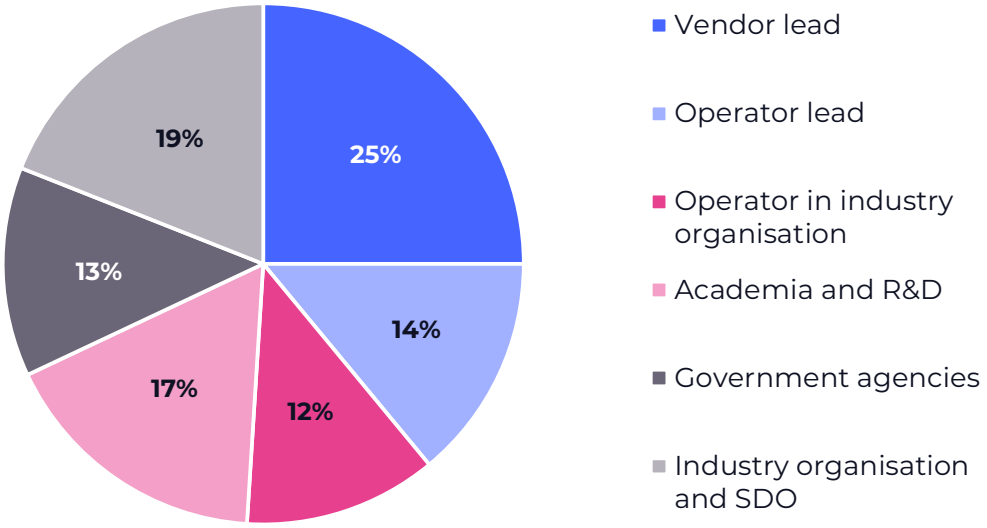
For most operators, however, the priority for the rest of this decade will be to maximise the return on investment in 5G. But it is still important for large operators to be active in 6G R&D and standards-setting, to ensure that the development of the next-generation mobile network remains aligned to their interests, such as radical TCO reduction and a

cloud-native platform that is optimised to enable new telecom business models.

FIG 5.5 shows that 14% of the 6G R&D projects that are currently underway are led by one or more operators, and a further 12% are run under the auspices of an industry alliance, but with an operator in the lead role. However, that leaves almost three-quarters in which no operator plays a lead role, while the largest category of projects is vendor-led. Some major European operators, such as Telefonica and Orange, are active in multiple 6G-related projects, some of them under the auspices of the European Union, and have significant inhouse R&D labs, though the biggest R&D spenders come from Asia.

Many more operators will exert their influence on 6G at a slightly later stage, through participation in standards bodies or early test labs. However, it is important for Europe's future position in 6G intellectual property and deployments that its operators are supported to take the most proactive role possible in the shaping of future platforms.

FIG 5.5 : 6G R&D projects by type of organisation taking the lead role



Source: Analysys Mason, 2024

5.5 CLOUD AND EDGE COMPUTING

In the context of telecoms networks, cloud infrastructure enables the re-design of network infrastructure to reduce latency, and to increase versatility and adaptability. Operators have been migrating to cloud-based systems for their own internal purposes for years. Many have migrated IT and back office systems to the cloud, and some have started to implement network functions, including the 5G core and even the RAN baseband, on cloud infrastructure.

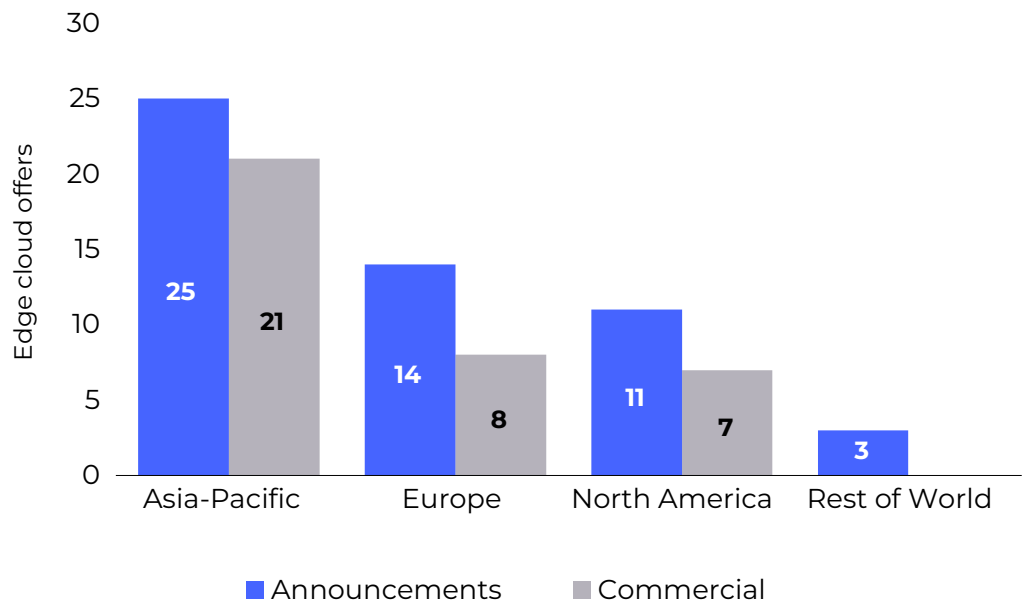
Project Sylva was launched in September 2023 by Deutsche Telekom, Orange, Telefonica and Vodafone, together with leading vendors and digital infrastructure providers. It has been conceived to address the various challenges associated with deploying telco and edge use cases including costs, time market and compatibility across telco implementations. The work under Project Sylva includes the creation of:

- **a common cloud layer and reference architecture** for cloud as a service (CaaS) among telcos to help reduce costs
- **a guarantee of compatibility** among operators in the MEC Federation initiative
- **a reference network function validation process** that decreases the time to market of new services.

Operators already offer cloud-based services to their customers – often in partnership with a public cloud provider.

The European Commission envisages substantial economic benefit from the wider use of cloud computing by businesses, and so is keen to encourage the deployment of cloud infrastructure much closer to end users, in 'edge' locations. Edge computing distributes the cloud infrastructure to locations much closer to the user than in a centralised cloud. This supports faster response times, local control of data and security and other benefits. Under the EU's Digital Decade programme, it is targeting 10 000 climate-neutral, secure edge nodes across the EU by 2030 in order to support a wide range of new or enhanced digital services. In this context, operators have a potentially significant role to play in delivering the edge cloud infrastructure that the EU expects will underpin future industrial innovation.

FIG 5.6 : Operators that have announced projects or commercialised edge cloud offers, by global region, to 1H 2024

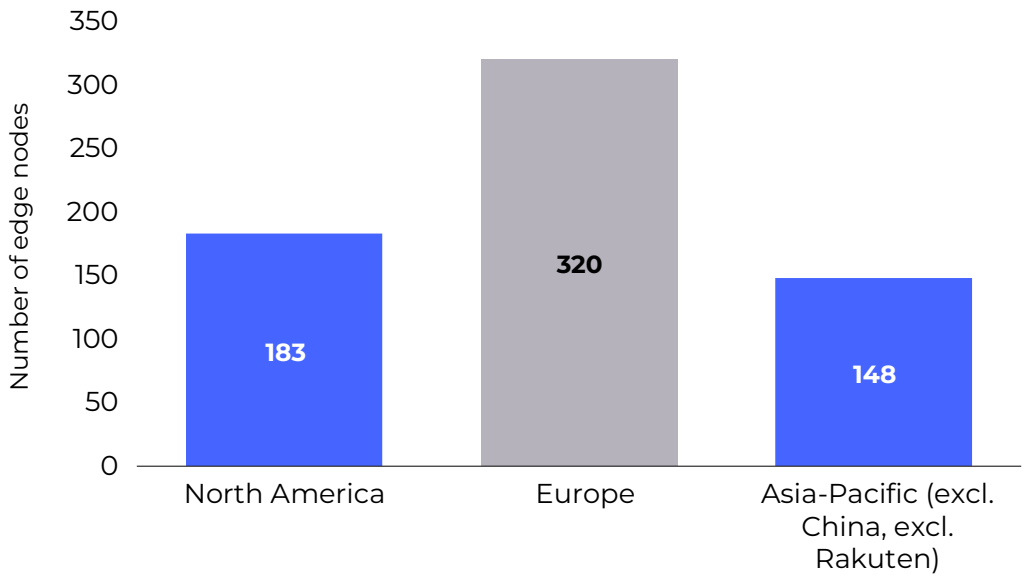


Source: Analysys Mason, 2024

An increasing number of operators are announcing edge cloud projects, or launching commercial edge cloud services. By end September 2024, 43 operators had announced projects, and 36 of those had launched commercial services. Operators in the Asia-Pacific have been early investors. The number of announced and launched services is higher than the figures shown in **FIG 5.6**, with a number of operators offering multiple variants of edge cloud service. In Europe more than half of the operators that have announced or launched edge cloud offers are Connect Europe members.

There is wide variation in terms of where operators are choosing to deploy edge infrastructure. The edge computing market is segmented according to where the computing capability is deployed. Unlike traditional cloud infrastructure which is typically deployed at a few centralised locations within a country, edge cloud infrastructure can be deployed at the local edge (for instance at cell sites), at aggregation locations within networks, and within larger metro locations. Compute capability can also be deployed on devices at the industrial edge (effectively at enterprise sites). This is similar to the model used by KPN in a mobile edge trial with its customer KLG. KPN placed local 5G gateway on KLG's site; as such, part of KPN's mobile 5G network runs locally giving the benefit of high reliability, low latency and 'near-real-time' response times, but the data all stays on site meeting stringent security requirements.

FIG 5.7 : Live operator edge nodes by region, to date (publicly disclosed)



Source: Analysys Mason, 2024[30]

Although the number of edge nodes is rising in Europe, it is clear that there is a long way to go before the EC's target of 10 000 nodes will be reached. According to the EC's own estimates Europe (EU27) had over 1100 edge nodes[31] (deployed by all company types, including enterprises themselves) by the end of 2023. Operators are estimated to have deployed around 320 edge nodes in Europe.

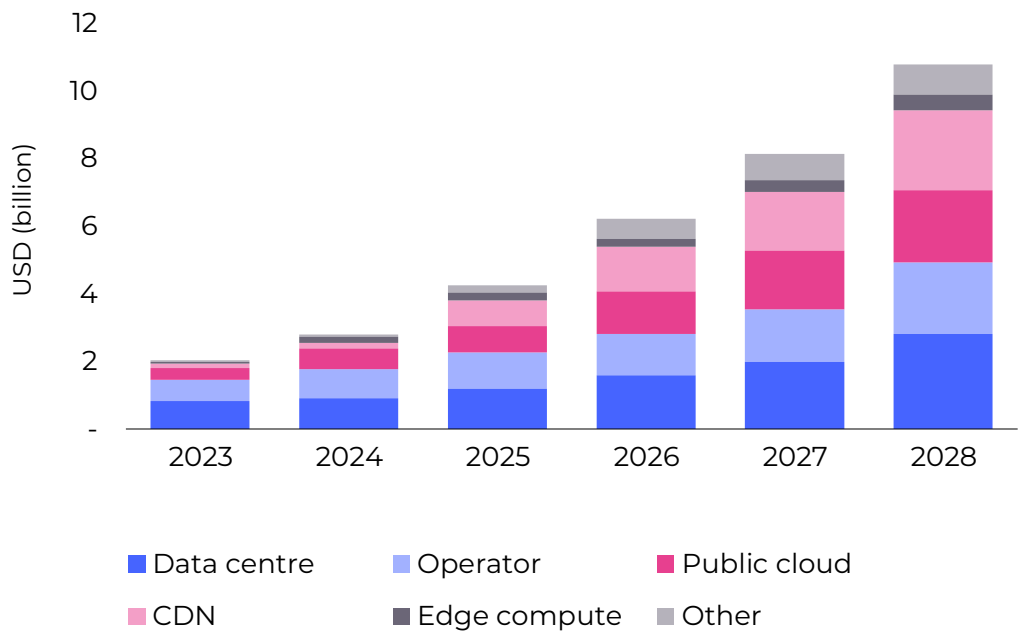
In Japan, Rakuten has deployed very small edge appliances at cell sites, with the result that it is now able to claim tens of thousands of edge nodes on its network. These were deployed initially to support network functions in Rakuten's virtualised architecture – there is a future aspiration to host third party tenants and to deliver B2B services. Indeed many other operators are also reviewing possible uses cases and business models for very distributed edge architectures for RAN GPU-as-a-service or RAN AI-as-a-service type applications.

[30] China and Rakuten excluded from chart to prevent counting of edge nodes not used to host third-party workloads.
[31] State of the Digital Decade report, 2024

Currently the use and business cases are not clear, and demand for services is nascent. For this reason there is substantial public investment designed to promote the evolution of the market. For instance in December 2023 the European Commission approved the Important Project of Common European Interest (IPCEI) on Next Generation Cloud Infrastructure and Services (CIS) (see section on Cloudification, automation and AI in networks, above).

Globally, operator deployment of edge nodes to run customer workloads is expected to increase sharply in 2025 and beyond. Excluding Rakuten (and 1&1 for which Rakuten is deploying a similar architecture), there will be more than 16 000 by 2028.

FIG 5.8 : Spending on public edge node infrastructure, by company type, worldwide, 2023–2028



Source: Analysys Mason, 2024

Global investment in public edge infrastructure will increase from USD2.0 billion in 2023 to USD10.8 billion in 2028, at a CAGR of 39%. Spend by data-centre providers accounted for 48% in 2023, with operators accounting for 31% share of investment, and public cloud providers for 17%.

Operators accounted for 50% of metro edge spend in 2023 but this will decline to 33% by 2028, as operators migrate their spending to edge nodes closer to end users, while cloud providers increase their investments in metro locations.


Smart Industrial Control System
Dashboard
Overview
Product report
Performance
Product Quality
Machine State
Machine 1
Machine 2
Machine 3
Monthly Summary
32.04%
Product Quality
99%
Performance
25%
Power consumption
67%
Machine State
Fine

5.6 FOSTERING THE EMERGENCE OF A SUSTAINABLE ECONOMY

Operators have a significant role to play in supporting the emergence of a sustainable economy. As section 4 above shows, Europe's operators are already making progress in terms of reducing their scope 1 and scope 2 emissions by migrating to renewable energy sources. They are also beginning to tackle their scope 3 emissions – which requires reductions of emissions through the telecoms supply chain and of emissions caused by customers' use of products and services. As they do this, operators will be able to leverage the expertise they are gaining through their internal sustainability improvement efforts - for instance by commercialising the platforms and solutions they develop for their own internal purposes.

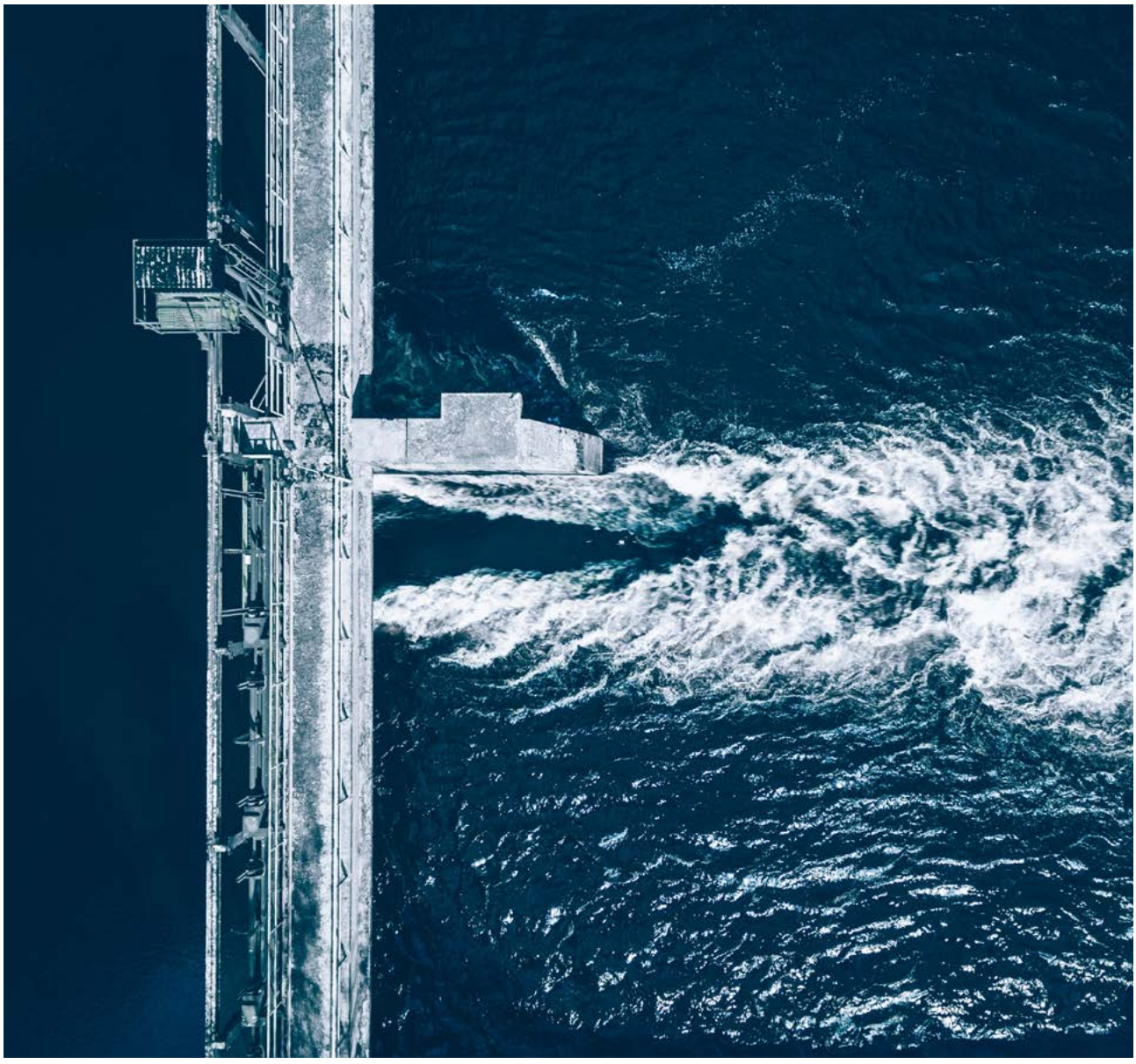
Operators also have a significant role to play in nurturing the emergence of a wider sustainable economy. Sustainable (low carbon) network and compute services and solutions can often be used to re-engineer industrial, governmental and business processes, and to create more efficient operational models - for instance by reducing the time, energy, or volume of materials needed to create assets; or reducing the energy or carbon cost of maintaining assets. In this way, telecoms operators can enable their customers to reduce emissions. Scope 4 (avoided) emissions are not formally enshrined in the GHG Protocols yet, but will be increasingly reported in the coming years.

Examples of initiatives by Connect Europe members that are helping customers to be more sustainable include:

- **Telenor has been working with Skagerak Energi hydropower generation.** It provides IoT connections that enable more efficient monitoring of reservoir hydro power plants. Optimisation based on the data provided means that the plants can generate an estimated 0.8% to 1.2% more electricity.
- **Deutsche Telekom's Smart Groundwater Monitoring project** aims to improve the analysis of water consumption through simplified data acquisition and monitoring. Control trips to the withdrawal points are avoided, saving CO2. Optimal plant watering also contributes to groundwater savings of up to 30%.
- In line with its commitment to digital transformation and decarbonisation, **Orange has partnered with ArcelorMittal France** to launch the country's largest private 5G network at ArcelorMittal's Dunkerque steel production facility. This initiative is set to enhance operational efficiency by improving team mobility, integrating autonomous vehicles, and optimising energy performance. The 5G infrastructure will enable real-time data exchange, providing greater visibility into production processes and fostering the adoption of innovative solutions that support the decarbonisation of industrial operations.

Operators additionally have a big opportunity to help other companies avoid emissions through effective waste management and recycling – especially of their copper assets. The carbon cost of producing a tonne of pure copper from ore is estimated to be 4 tonnes of CO2 equivalent (tCO2e). The total global copper mine production in 2023 is estimated to be 22 million tonnes, and production has steadily increased since 2010.

Estimates of the carbon cost of recycling copper from removed cables vary considerably. However, they all show that the carbon cost is a fraction of the carbon cost of producing copper from ore, with figures ranging from 0.62tCO2e to 1.54tCO2e per tonne of copper recovered depending in part upon whether or not the carbon cost of removal is included. An operator could sell into the market resulting in that volume of copper not needing to be produced from ore. It could thereby enable a net 'saving' of between 2.5tCO2e and 3.4tCO2e per tonne of copper extracted, minus whatever the removal costs turn out to be.[32]



[32] See Analysys Mason, Recovering copper leads to potentially huge volumes of avoided emissions, November 2024.

06

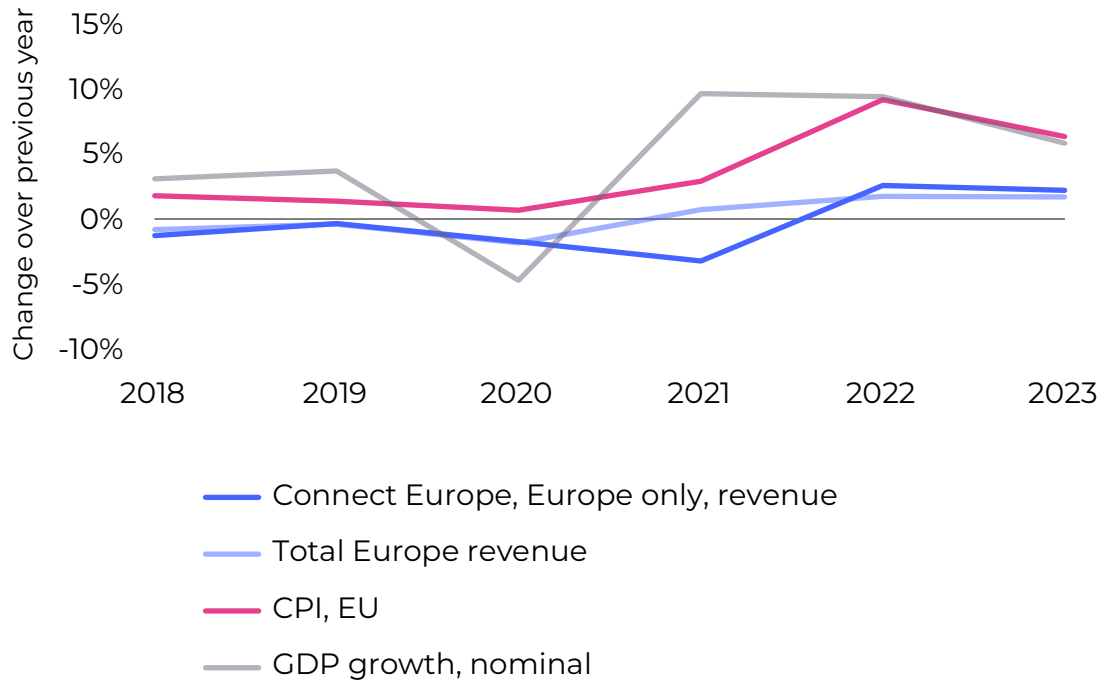
Strengthening telecoms operators as a force in the European digital economy

There are opportunities for European operators to scale up and reestablish themselves as drivers of prosperity through investment and innovation, but there are sector-specific challenges and obstacles to achieving this.

6.1 THE UNDERLYING FINANCIALS FOR THE SECTOR REMAIN DIFFICULT

For European operators as a whole, and for Connect Europe members, basic revenue growth has failed to keep pace with inflation.

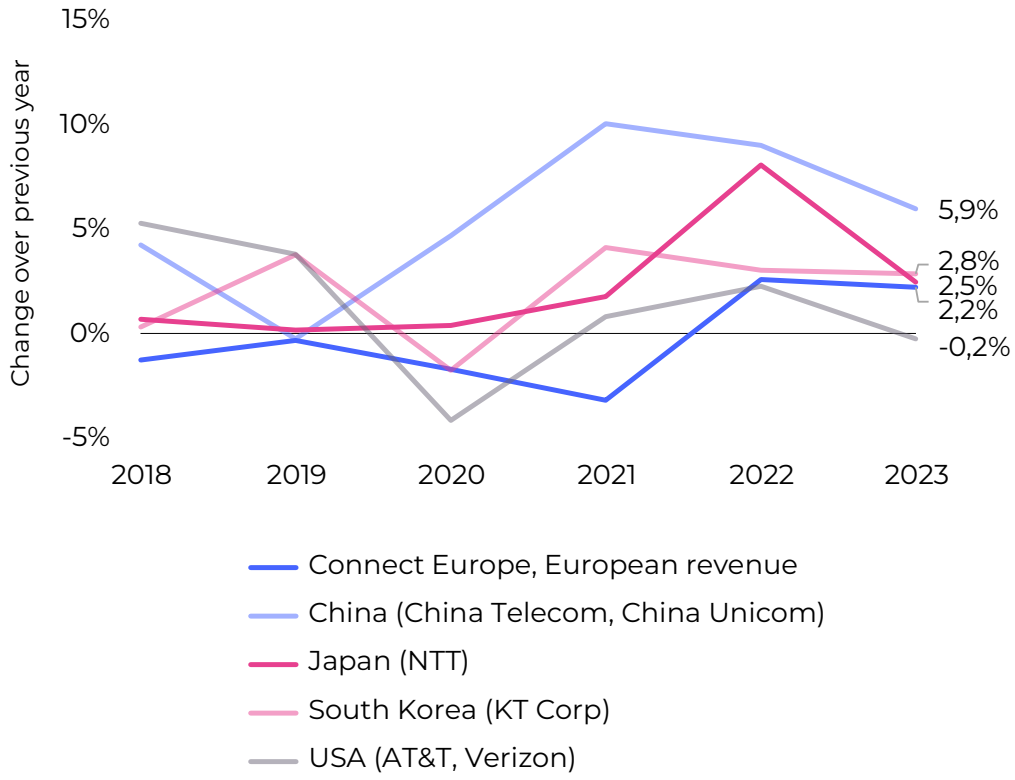
FIG 6.1 : Connect Europe members' European revenue growth, total Europe telecoms revenue growth, CPI, and nominal GDP growth, Europe, 2018-2023



Source: Analysys Mason, 2024

Low growth among leading telecoms operators is not confined to Europe, but European operators (Europe revenue only) have generally underperformed their peers.

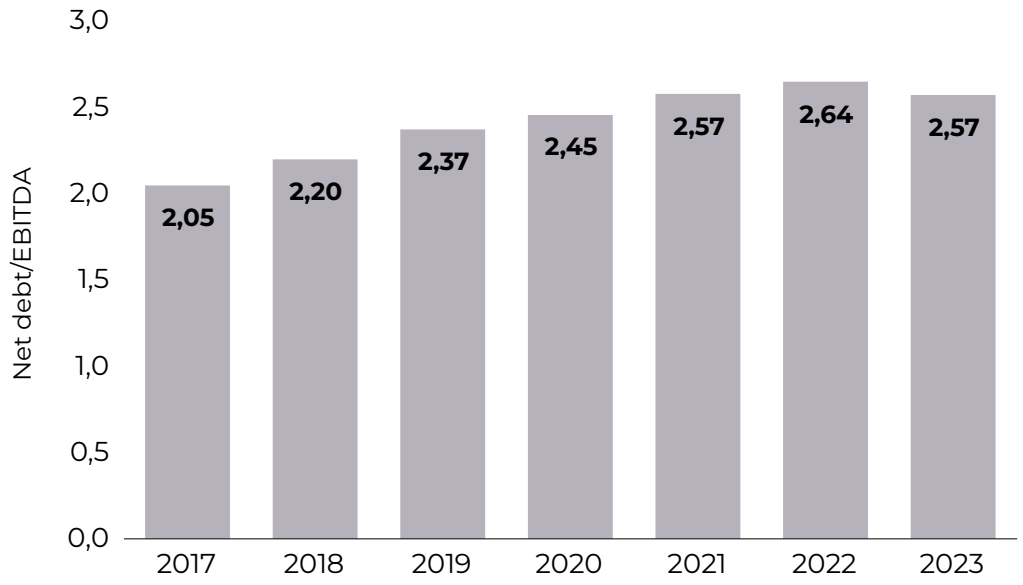
FIG 6.2 : Connect Europe member European revenue growth and comparator operator revenue growth, 2018-2023



Source: Analysys Mason, 2024

The level of debt of European operators has been a long-term concern. There was a slight decrease in the aggregate net debt/EBITDA ratio for Connect Europe members in 2023, but despite various debt reducing measures (sale of assets, including key assets like towers and partial stakes in FTTH), and slow, hard-won margin improvements in the face of stagnant revenue, the level remains high.

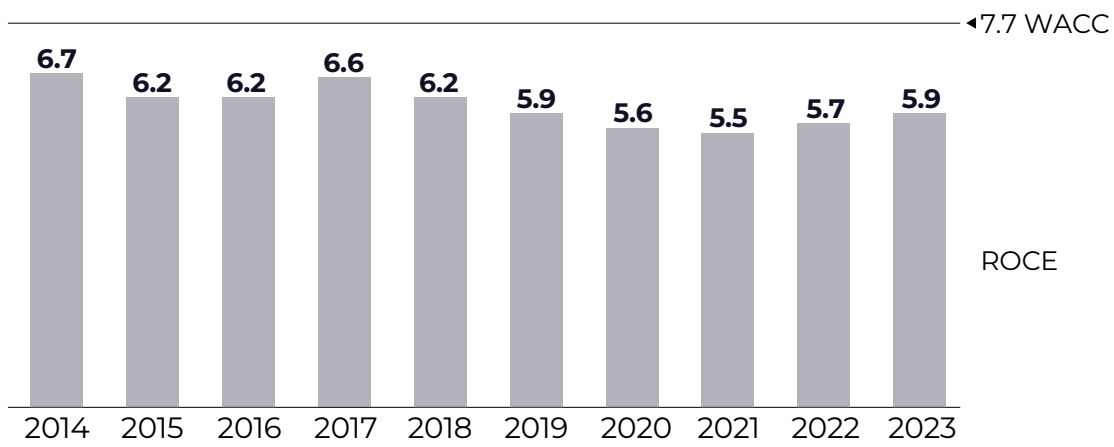
FIG 6.3 : Net debt/EBITDA, Connect Europe members at group level, 2017–2023



Source: Analysys Mason, 2024

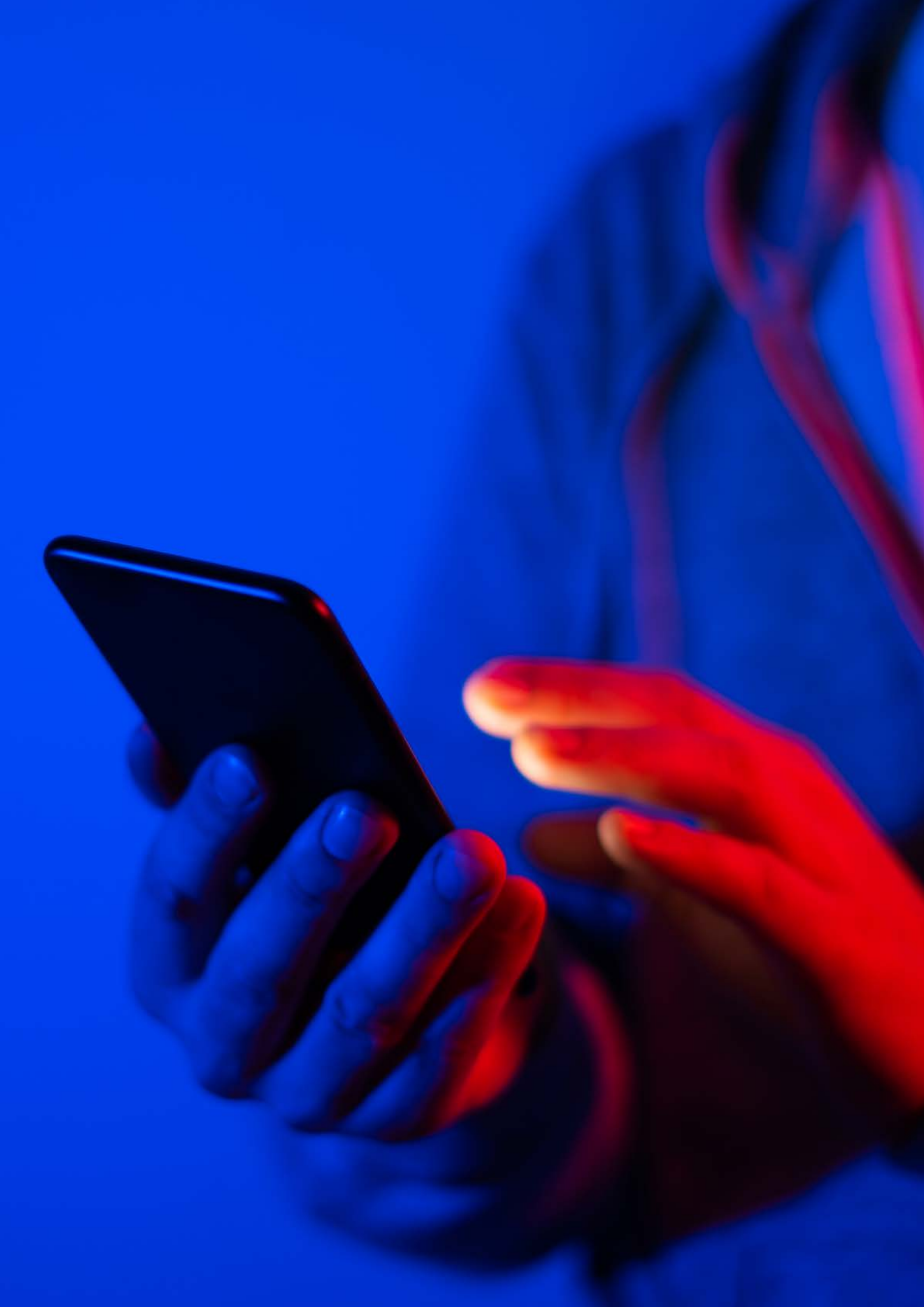
FIG 6.4 shows return on capital employed from 2014 to 2023. While ROCE has improved since 2021 (to a large extent because of some large impairment charges in 2021), the aggregate returns the industry makes on its investment is below the cost of capital it faces, an issue that is also noted in the Draghi report..[33]

FIG 6.4 : Comparison ROCE/WACC, in %, 2014-2023



Source: The future of European competitiveness, Draghi Report, 2024

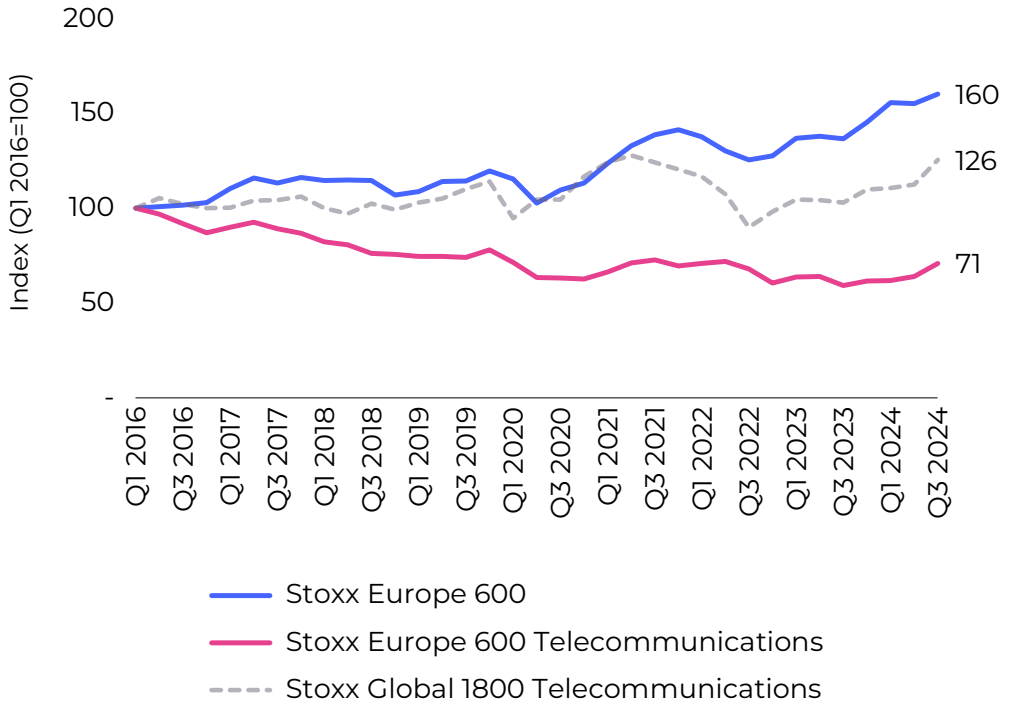
[33] See also European Telecom Crossroads, HSBC Global Research, November 2024, which shows the difficulty covering cost of capital by sub-scale European operators, and argues that shift in policy could alter the outlook for the sector for the better.



6.2 THE MARKETS ARE STILL UNRECEPTIVE TO THE EUROPEAN TELECOMS SECTOR

In the face of difficult financial fundamentals, it is perhaps unsurprising that capital markets are somewhat unreceptive. During 2024 European communications stocks picked up in value, to a large extent reflecting the broader European stock markets and mirroring gains in communications stock worldwide. Nevertheless, European communications stock has underperformed on markets relative to global communications and relative to European stock, and at 3Q 2024 had lost 58% of its value relative to the start of 2016.

FIG 6.5 : STOXX Europe 600 index, STOXX Europe 600 index for telecoms and STOXX Global 1800 index for telecoms, Q1 2016-Q3 2024



Source: STOXX

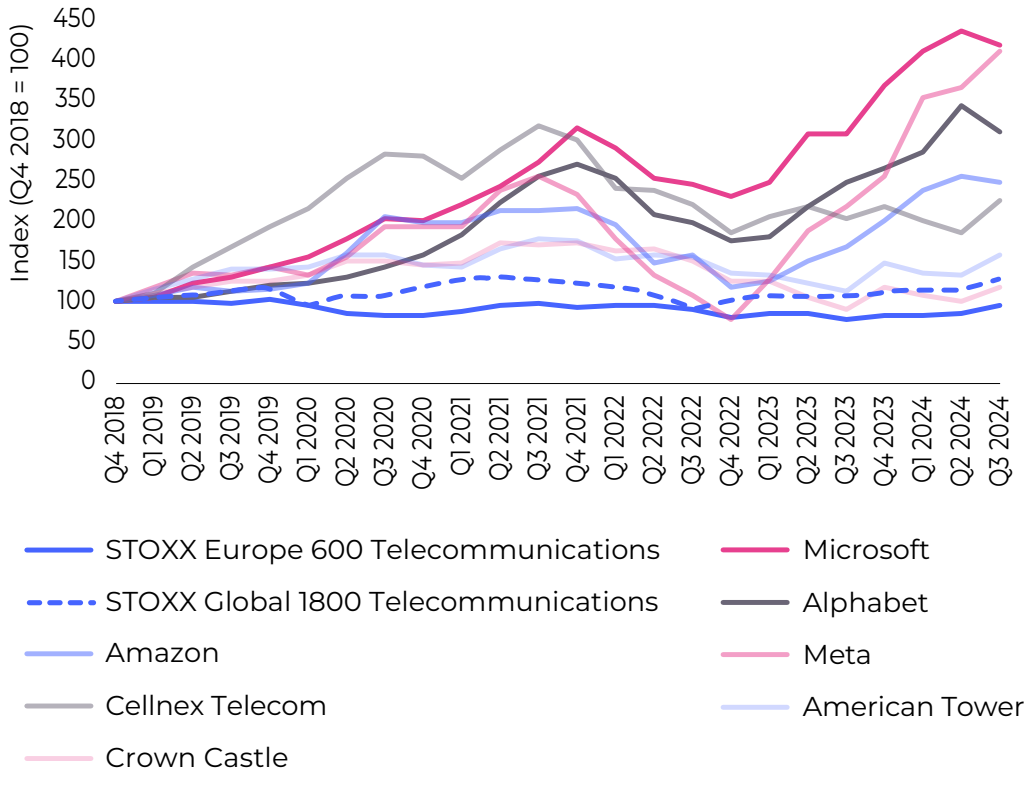
The market capitalisation of the largest 5 European operating groups by revenue (Deutsche Telekom, Orange, Vodafone, BT) decreased by EUR78.5 billion (-29%) to EUR189.3 billion between 2015 and 2023, whereas the market capitalisation of the largest 5 US operating groups by revenue (Verizon, AT&T, Comcast, T-Mobile, Charter Communications) rose by 17% (EUR89.0 billion) over the same period. The European figure is actually substantially boosted by the rising value of T-Mobile USA, controlled by Deutsche Telekom.

Excluding that equity stake in T-Mobile USA, the market capitalisation of the largest 5 European operating groups fell an estimated EUR144.5 billion (-58%) over that period.

The Draghi report states that the total market capitalisation of the EU's telecom sector fell by 41% from 2015 to 2023 to reach around EUR270 billion, compared to over EUR650 billion for US telecom operators.

Operators have long been concerned that part of their historical value as service providers is being ceded to hyperscale content and applications providers (CAPs). At the same time, they have come under pressure to improve their balance sheets, and have consequently taken decisions to sell various assets, including stakes in towers and FTTH. This has resulted in the ceding of large parts of their mainly physical asset-base to infrastructure-focused businesses, for example towercos and wholesale-focused fibrecos, in which an interest has been shown by non-European stakeholders. **FIG 6.6** compares European and global telecoms stock performance against these other types of business in the digital communications chain: four hyperscale businesses, and three large communications infrastructure businesses.

FIG 6.6 : STOXX Europe 600 index for telecoms, STOXX Global 1800 index for telecoms and stock values for hyperscalers and towercos, Q4 2018–Q3 2024

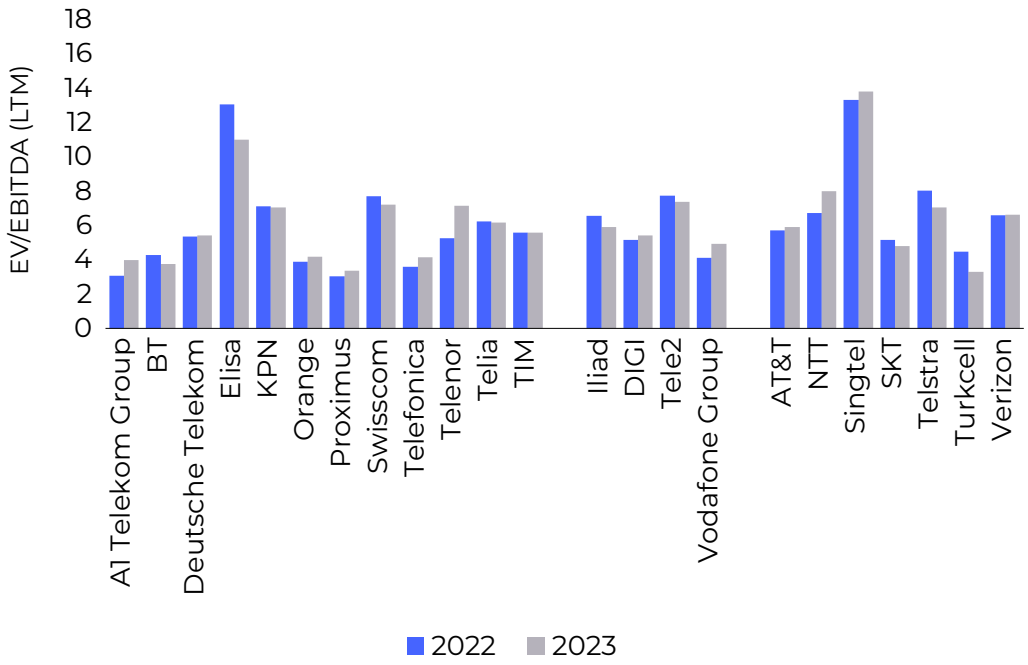


Source: STOXX and Analysys Mason

While the CAPs all went through a period of negative market sentiment in the second half of 2022, they have all bounced back. They have all had the scale and agility to re-invent themselves and focus investment on newer and promising areas. The infrastructure businesses gained strongly during a boom period for telecoms infrastructure M&A between 2019 and 2021, fell away as enthusiasm waned and they had to focus on organic growth; they have nevertheless mostly outperformed operators in this respect.

In previous years we saw slides in enterprise value relative to EBITDA, but 2023 was more of a mixed picture.

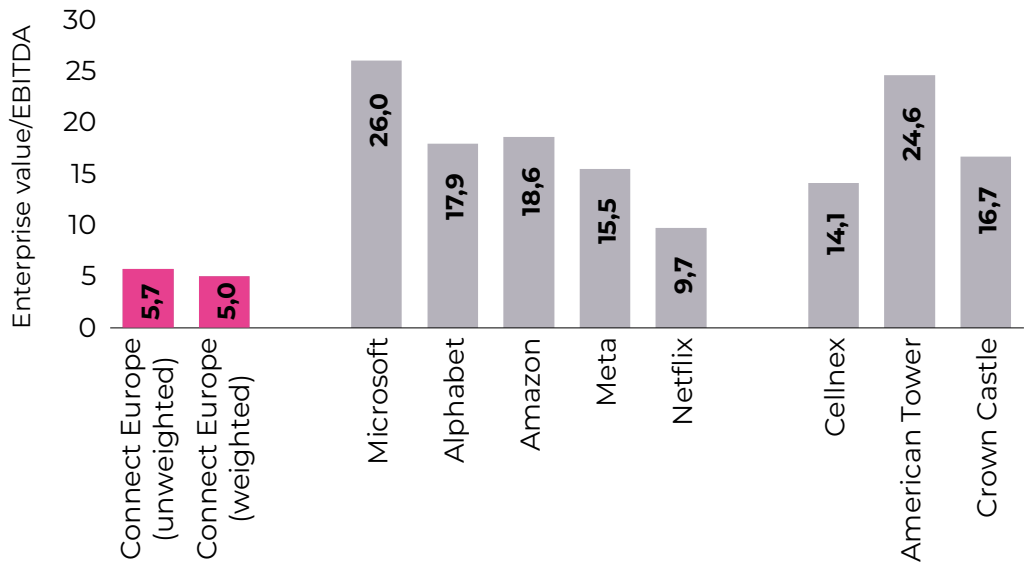
FIG 6.7 : Enterprise value/EBITDA, larger Connect Europe members and other operators, worldwide, end of the last full financial year



Source: Analysys Mason, 2024

Relative to hyperscale CAPs and infrastructure businesses, telecoms operators have lower valuations relative to EBITDA than either players principally at the service end of the value-chain (the US hyperscalers) and relative to infrastructure businesses.

FIG 6.8 : EV/EBITDA multiples, Connect Europe members, selected hyperscale CAPs and major telecoms infracos, worldwide, 2023



Source: Analysys Mason, 2024

The business model used by most operators globally seeks to benefit from tying the provision of physical connectivity to the service layer. While the physical layer mostly consists of geographically distributed passive and active network assets, the service layer increasingly resides in software. There are economies of scale that mean the cost to add an incremental customer for connectivity generally declines with utilisation of networks, but these are offset by periodic spikes as more capacity is introduced due to needs. The cost, however, to add an incremental customer for a software-based service invariably falls more rapidly, even though the service is critically dependent on connectivity. Markets appear to regard telecoms operators' vertically-integrated approach as an inefficient means to maximise the value of the physical assets; this is a problem for telecoms operators anywhere where there is a competitive market.

The problem for this model is compounded in Europe because pro-entrant regulation can have the effect of neutralising whatever advantage investment in those physical assets confers. Hence, markets tend to regard European telecom operators as even more hobbled in their ability to monetise the investments they make than their counterparts elsewhere.

6.3 OPPORTUNITIES TO STRENGTHEN AND TO SCALE UP MUST NOT BE SQUANDERED

As indicated in section 1.4, capex on telecoms in Europe fell in 2023. At an aggregate level it is likely that there will be further falls in operator capex on telecoms networks for the rest of the decade, which renders the achievement of the Digital decade targets even more difficult considering the EC estimated a EUR200 billion investment gap (from the start of 2023) to reach them. This will not apply everywhere; it does not apply to countries where much of the FTTH rollout is still to occur, and in some cases will happen through the rest of the decade and possibly into the 2030s. Much of the roll-out of 5G has already been achieved, and FTTH, the largest element in capex bills, is largely a one-off investment that enables low cost incremental capacity capex once that foundation is in place. This potentially improves cashflows, even if there are still important investments to be made in networks' evolution including 5G SA and cybersecurity.

Though they may eventually become less burdened by infrastructure capex, operators still need to be in a position to capture new opportunities, to be less burdened by regulation and to work in a more harmonised market environment that enables scale, efficiency and ambition.

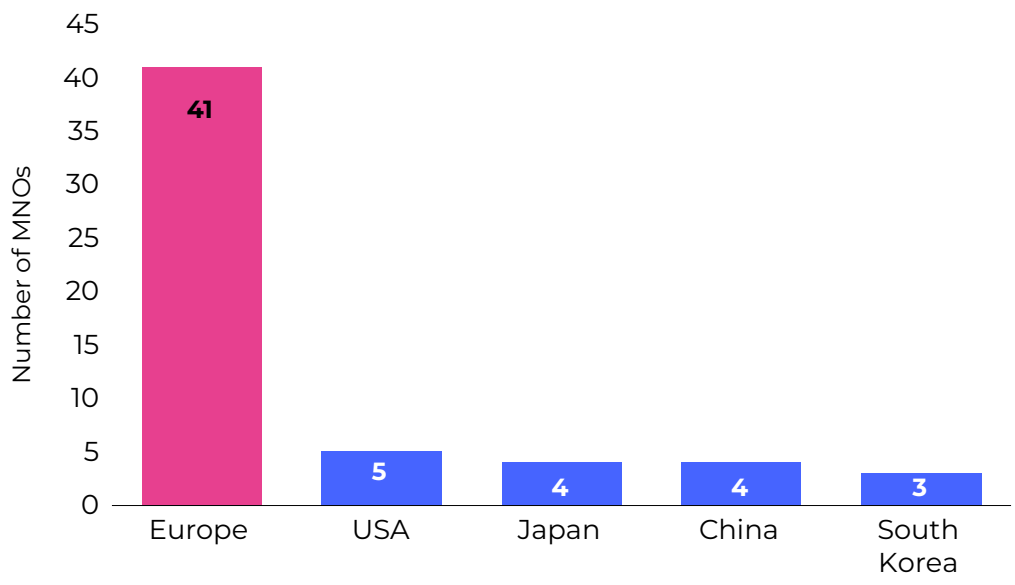
Nobody seriously doubts that a healthy dose of competition helps stimulate investment, but that investment is not always directed in a way that best benefits all Europeans. While progress towards the Digital Decade's challenging targets has been rapid, there remains a lot to do. An excessive emphasis on reducing already low prices by creating artificial competition, mainly through heavy-handed wholesale regulation or a strict merger control policy, but also via direct price regulation, makes the business case for reaching those people harder.

The current regulatory frameworks and competition policies developed at a time of copper monopoly are no longer fit for purpose because they seek to preserve an artificial *status quo*. This not only hinders meeting these challenging build-out targets, which fall into a category of core business and which may deliver only modest returns. It also hinders the development of new adjacent businesses, which, though riskier, could deliver real economic growth.

The Draghi report correctly identifies Europe's weakened position to drive investment at the scale to improve productivity, or to be genuinely competitive in a global marketplace when faced with the huge economies of scale enjoyed by US and Chinese players. For industries to become more productive, to invest in new areas and skills, to drive innovation at scale is critical for Europeans' economic, and indirectly social, well-being. The ability of telecoms operators to invest in new and genuinely innovative services and technology at scale, to take risks, and to harness new productive forces, depends on their ability to secure a fair return on investments already made or planned. Achieving scale and ensuring ability to grow in turn depends on the degree of regulation they face.

The European telecoms landscape remains as ever highly fragmented. This is highlighted in the Letta report: "Despite the implementation of the Telecom Single Market Regulation, the EU still includes, currently, 27 distinct national electronic communications markets. This enduring fragmentation hinders the scale and growth of pan-European operators, limiting their ability to invest, innovate, and compete with their global counterparts".[34] At 2Q 2024, Europe had 41 operating groups with a mobile subscriber base of over 500 000, compared with 5 in the USA and fewer in China, Japan and South Korea.[35] All MNOs in Europe are confined to a subset of markets, and there is no truly European-level MNO.

FIG 6.9 : Number of MNOs with over 500 000 connections, Europe, China, Japan, South Korea and USA, 2Q 2024



Source: Analysys Mason, 2024

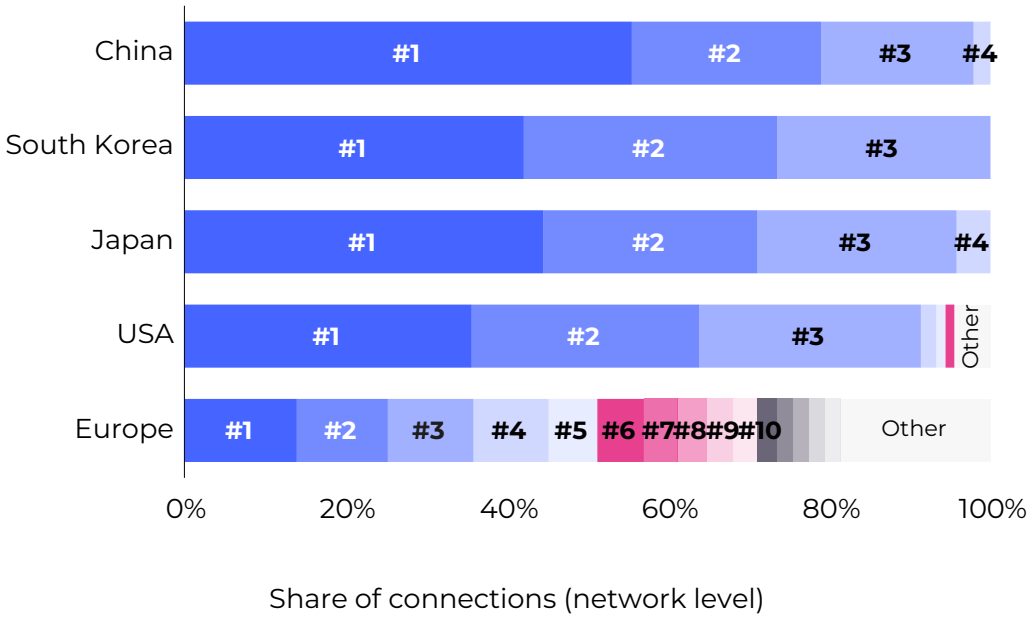
In fact, the largest operating group in Europe has now only 13.9% of the entire market, and the four largest together fail to reach 50%.

[34] More than just a market, p52.

[35] The basis of these numbers is share of connections (including the MVNO subscribers they host). Some entities are in the process of transforming from MVNOs to MNOs by gaining spectrum licences (including CBRS). We have counted these as MNOs. An analysis based on pure retail subscribers would show an even more fragmented landscape, particularly in Europe.

In December 2024, the UK Competition and Markets Authority (CMA) approved the proposed merger of Vodafone UK and Three UK, the third and fourth largest mobile operators in the UK, subject to two main sets of conditions: price and contract control for MVNO access for three years and certain retail tariffs to be price-capped for three years; the merged operator to implement in full its network investment plan. The companies had already agreed to sell a portion of their combined spectrum to VMO2. Although the CMA has degree of freedom it would not have had pre-Brexit, this is an important decision in the context of European telecoms. The remedies focus on network investment and quality, and although they reinforce MVNO-level competition in the short term, they do not release spectrum to a potential new MNO entrant.

FIG 6.10 : Split of mobile connections, network operator level, Europe, China, Japan, South Korea and USA, 2Q 2024[36]



Source: Analysys Mason, 2024

[36] The largest 50:50 JVs in Europe are counted on an equity basis.

A different kind of response to the need to be more innovative and productive has been to delayer operations, separating off towers and other passive assets, but in fuller delayerings, into a netco that runs networks, and one or more servcos or techcos that serve consumers and businesses. The process promises to create efficiencies, sharpen commercial focus and even foster creativity by allowing delayered businesses to develop more independently. More often than not, though, delayering has been a response to a need for additional injection of funds to invest, or simply to improve balance sheets. The evidence so far is that delayered businesses are struggling to achieve the full operational advantages they envisaged, sometimes get bogged down in the separation of systems and resources, and that both parties are tied into a master contract between each other that restricts their freedom to act independently. Hence delayering may 'unlock hidden value' in a sale-leaseback of assets to institutional infrastructure funds, but the process can struggle to unlock additional revenue lines, or cost efficiencies.

More worryingly, at a strategic level, the separation of parts of a business creates, initially at least, two or more even smaller companies, each with less purchase and visibility of the value-chain, in an already incredibly fragmented sector. In addition, where stakes are sold to third parties this could also raise issues in terms of EU strategic autonomy, as the latest trends demonstrate the interests of non-EU stakeholders in taking stock in EU strategic assets.

The Budapest declaration in November 2024 was a call to action to realign European industrial policy to make Europe more competitive especially in the tech sector that will drive most new growth. There is now real political impetus, and an opportunity for change that should not be squandered. The communications sector has suffered from many of the problems faced by other sectors, but it is also a key industry to scale up tech growth and green transition. For the communications sector the successful implementation of a pro-growth industrial policy that would meet the challenges Europe faces requires a rethink of the long-standing competition policy in the sector.

Connect Europe Members

Albania

Austria

Belgium

Bosnia and Herzegovina

Bulgaria

Croatia

Cyprus

Denmark

Finland

France

Germany

Greece

Hungary

Hungary

Iceland

Italy

Italy

Lithuania

Luxembourg

Malta

Malta

Netherlands

Netherlands

North Macedonia

Norway

Poland

Portugal

Romania

Serbia

Slovakia

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