etno

European Telecommunications
Network Operators' Association

STATE OF DIGITAL COMMUNICATIONS 2024

Published by:
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January 2024

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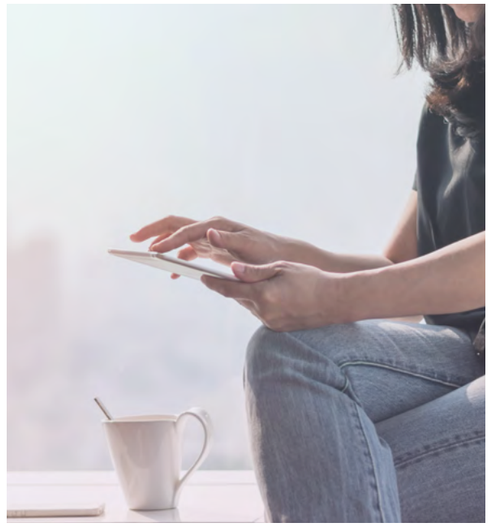
Executive Summary

This year's report paints a bittersweet picture. On the one hand, network innovation is starting to take-off and the investment by European telecoms operators is reaching historic levels. On the other hand, global competition in the connectivity value-chain has started biting Europe, and the financial health of the telecoms sector is far from improving. This raises critical questions about Europe's ability to deliver on the promise of Open Strategic Autonomy and to lead in future communications technologies.



Europe's connectivity value-chain: a "lead or lose" moment

- This year's report, for the first time, tracks progress on key network innovations, including 5G standalone (5G SA), Open RAN, cloud and edge cloud. These technologies will define leadership in connectivity and services in the next decade and will, as a result, be crucial to achieving Europe's Open Strategic Autonomy in tech.
- In use of 5G SA and new RAN technologies, Europe significantly trails Asia, but does currently better than North America in some respects. When it comes to edge cloud, Europe trails both Asia and North America.
- In August 2023, only 10 out of 114 operational 5G networks in Europe were **'5G SA'** (i.e. a network that uses a 5G core network, meaning it has no dependency on 4G LTE). This means Europe trailed Asia with its 17 5G SA networks, but performed better than North America, which had 4.
- In terms of Radio Access Network (RAN) technologies, telecoms operators continued to demonstrate a firm belief in **Open RAN:** with 11 trials and developments in 2023, Europe was ahead of North America (8), but behind Asia and Japan (19).
- Worldwide, the importance of tech companies in the operations of telecoms businesses is demonstrated by the cloud and IT spending of telecoms operators: in 2023, for the first time, we expect telecoms operators to spend more on external cloud and IT providers than on their own in-house services: external opex is expected to hit USD35 billion as opposed to USD33 billion in-house, thus reversing a historical trend.
- In 2023 Europe counted 4 commercialised **edge cloud** offers, all from ETNO members. Despite this, Europe trailed both the Asia-Pacific region, which counted 17 offers, and North America (9). Similarly, in the same period, we counted 59 operative edge nodes in Europe, as opposed to 159 in North America.

European telecoms: lower profitability, lower investment

- Historical trends in telecom markets remain fundamentally unchanged this year. The European telecoms sector continues to underperform global peers both in terms of revenue and in terms of investment.
- The report finds that European operators have in effect absorbed inflation on behalf of their customers, meaning that revenue decreased in real terms. EU telecoms retail revenues rose in 2021 and 2022 by only 0.7% and 2.1% respectively, growth figures that are more than offset by inflation, which stood at 2.9% in 2021 and 9.2% in 2022.
- **Average Revenue Per User** (ARPU) in Europe continues to trail all global peers. In 2022, mobile ARPU was EUR15.0 in Europe, as opposed to EUR42.5 in the USA, EUR26.5 in South Korea, and EUR25.9 in Japan.
- In 2022, fixed broadband ARPU was EUR22.8 in Europe, as opposed to EUR58.6 in the USA, EUR24.4 in Japan, and EUR13.1 in South Korea.
- Underperformance in revenue is reflected also on the investment side of the equation. In 2022, telecoms capex per capita in Europe stood at EUR109.1, lower than in Japan (EUR270.8), in the USA (EUR240.3) and in South Korea (EUR113.5).
- In absolute terms, however, European **telecoms investment** reached EUR59.1 billion in 2022, up from EUR56.3 billion the previous year. Around 48% of the investment was dedicated to fixed access, over 20% to mobile access, and the rest covered aggregation and core transport networks, IT and various non-network assets such as offices.
- ETNO members – in line with the past – remain responsible for the largest part of Europe's telecoms investment, with ETNO representing 67% of the total sector capex.
- For comparison, tech giants' direct investment in digital infrastructure other than in data centres stood at under 5% of ETNO investment in these assets.

5G: Europe lags all global peers

- In 2023, 5G in Europe reached 80% of the population, up from 73% the previous year. However, Europe still trailed all its global peers: South Korea (98%), the US (98%), Japan (94%), and China (89%).
- The European median mobile downlink speed of 64.1Mbit/s was lower than that in the USA (97.1Mbit/s), in South Korea (121.1Mbit/s) and in China (171.6Mbit/s).
- Europe also has lower mobile usage: in 2022, Europeans used an average of 14.2GB/month, compared to 17.5GB/month in South Korea, 16.2GB/month in Japan and 15.6GB/month in the USA.
- By October 2023, European operators had spent a total of EUR26 billion at spectrum auctions for the principal 5G bands.

Gigabit connectivity: still far from the EU Digital Decade Targets

- In 2023, 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 79.5% in 2023, as opposed to 98.5% in China, 97.0% in South Korea, 89.6% in the USA and 81.4% in Japan.
- In comparison, Europe's **FTTH** coverage of the population (excluding FTTB) reached 63.4%, better than South Korea's 59.9% and the USA's 49.3%.
- Our estimates confirm that by the end of the decade almost 10% of the European population will still be without access to a fixed gigabit connection in 2030, thus falling short of the 'full gigabit connectivity' target.

> **Europe's connectivity ecosystem is at cross-roads: it's "lead or lose" time for 5G SA, edge cloud, open RAN**

Fundamentals of the sector: fragmented markets, weaker financial health, lower employment

- European retail **markets** taken as a whole remain uniquely fragmented. In 2023, Europe counted 45 large mobile operating groups with more than 500.000 customers, compared with 8 in the USA, 4 in both China and Japan, and 3 in South Korea.
- **ROCE**, return on capital employed, is a common metric to determine the return of investment. The ROCE for ETNO members has almost halved in the recent past: in 2017 ROCE was 9.1%, while in 2022 it was 5.8%, signalling that it is increasingly difficult for European telcos to generate adequate returns.
- In parallel, the sector's **investment capacity** continues to be stretched. In 2022, capital intensity for European telcos (i.e. capex as a proportion of revenue) remained very high at around 20%, a level higher than global peers. Coupled with weak revenue this results in an increasingly indebted sector. In 2022, the net debt/EBITDA ratio of ETNO members touched 2.60, the highest it has been in recent years.
- While revenues decreased in real terms, the cost of suitably skilled labour, of equipment and of raw materials kept on rising for telcos. Some of this was absorbed by efficiencies related to network operations. However, sadly, this also had a cost in terms of **employment:** ETNO companies employed 493 000 people in 2022 in their domestic markets, down from 550 000 pre-pandemic, in 2019.

Introduction

In 2022 and into 2023, European telecoms operators have extended further the long period of steady intensification in capital investment, enhancing the quality and coverage of connectivity to the benefit of consumers and businesses. At the same time, the telecoms sector has faced, like most of the rest of the economy, a period of rapidly rising costs.

FTTH is the largest contributor to capex, most of the funding for which is purely commercial. FTTH coverage looks set to rise to above 63% in Europe[1] by the end of 2023 (64% for the EU27) and builds on the rapid expansion in coverage over the past three years. Our forecast for FTTH coverage in 2030 increased by two percentage points to 91% (both for the EU27 and more broadly for Europe). Europe has a substantial and growing lead over the USA in this respect. FTTH became in 2022 the most popular form of broadband access, and on current projections around 45% of homes passed will take the service by the end of 2023.

The second largest contributor to investment is mobile, in particular 5G. Europe's position in terms of 5G is weaker than its peers. European 5G coverage is set to reach about 80% of the population by the end of 2023 (82% for the EU27). This is lower than in peer-group countries, as is take-up of 5G services. Moreover, a smaller proportion of European mobile operators has commercialised 5G standalone (SA) networks than elsewhere.

The impact of inflation

An inflationary macro-economic environment makes life harder for all sectors. Last year's State of Digital Communications report asked how the telecoms sector would traverse a period of high inflation. In particular, it posed the following four questions, which we now have enough accumulated evidence to answer.

1) Will operators be able to match opex (cost) increases with improved revenue, and capex (investment) increases with improved returns on investments?

Revenue did pick up a little (around 2% both for ETNO members and for the total European telecoms operator sector), but the improvement was far lower than the rate of inflation (9.2% in the eurozone in 2022). In real terms, revenue fell 6.5%. As inflation in the eurozone eases in 2023, even that revenue increase is falling away. Consumers of telecoms service benefited e.g. through increased FTTH coverage, but falling real-terms revenue makes the necessary investments harder to achieve.

Unit operating costs inevitably did increase: energy costs rose dramatically in 2022. Energy costs pressures have subsequently eased but have not reverted to pre-2022 levels. Employment costs represent a much higher proportion of operating costs (about 27% for the sector), and rising costs across the board have led to some job losses in the sector (3% of workforce for ETNO members in 2022).

ETNO members' capex rose 4% in 2022 over 2021, a continuation of an upward trend since the first half of the last decade (disrupted only by the COVID pandemic in 2020). Capex was also impacted by inflationary pressures: input costs for materials rose, as did capitalised labour costs. Aggregate ROCE for ETNO members picked up slightly in 2022, but remains low at 5.8%.

2) Will operators see price rises by competitors as opportunities to follow suit or will they compete for churners?

Operators often competed for churners, but the pattern was not the same in every country in Europe. In some countries a cohort of new challenger players in fixed (FTTH) access has been emerging, and their commercial imperative has been building customer bases and thereby converting homes passed to homes connected. This has limited increases in fixed connectivity ARPU, even as networks are upgraded and service quality improved.

3) Can operators break out of the pattern of flat ARPU, which has hampered the financial strength of the telecoms sector for a long time, in inflationary times?

ARPUs remained much flatter than the rate of inflation. Between 2021 and 2022 mobile ARPU rose only 1%, whereas fixed broadband ARPU rose 3%.

4) How will inflation, opex, price and competitive dynamics affect the telecoms sector's ability to invest rapidly?

Capex intensity for ETNO members is now around 20%, the highest it has been since the expansion years of mobile. Operators continue to seek innovative models to overcome investment hurdles, but these inevitably cede some value to third parties. Selling their passive infrastructure to third-party investors is an example of this.

Telecoms is a sector facing most of the same inflationary headwinds as other large infrastructure heavy networked industries, but, uniquely, it appears locked into a competitive dynamic that does not allow it fully to adjust prices to rising costs. There are two principal causes, one a factor that applies to competitive telecoms globally, and one that is Europe-specific.

Pricing models

Trends in telecoms consumer pricing are much harder to discern than in other infrastructure-heavy networked businesses. While it is possible to pull together benchmark prices in other networked businesses based on typical and fairly stable demand, this makes little sense in telecoms because what counts as typical demand changes substantially year on year. What counts any year as a standard basket of services (usually a mix of gigabytes of mobile data and Mbit/s of fixed broadband access) is to a large extent determined by how many more gigabytes and Mbit/s retail service providers are prepared to sell for the same price.

At this moment in time, telecom operators are stretched between continued growth of data consumption and the limited ability of existing pricing models to ensure adequate monetisation. While growth rates have been slowing in recent times, AD Little[2] expects Europe's overall mobile data consumption per user to continue growing in the coming years, increasing from the 2022 level of approximately 15 GB/month to 75 GB/month by 2030, creating an annual growth rate of 25%. Also, fixed data consumption per household is expected to grow from the 2022 level of 225 GB/month to 900 GB/month by 2030, for an annual growth rate of 20%.

Studies have shown that, currently, data consumption is mostly monetised by other actors in the digital value chain and not by telecom operators (AT Kearney, 2022)[3]. As we look at major commercial launches of VR headsets in 2024 and at the impact of AI-generated content, the question of how telcos can better monetise data traffic will remain central to their future success.

[1] For the purposes of this report Europe refers to all EU countries plus Albania, Bosnia, Iceland, Kosovo, Montenegro, North Macedonia, Norway, Serbia, Switzerland and UK.

[2] https://www.adlittle.com/sites/default/files/reports/ADL_Data_growth_Europe_2023.pdf

[3] https://www.kearney.com/industry/telecommunications/article/-/insights/the-internet-value-chain-2022-a-perspective-on-the-internet-value-chain-and-the-dynamics-driving-it

Competition and fragmentation

Pricing models are a problem for global telecoms, not just for Europe. However, the necessity to offer 'more for the same' or 'more for less' derives in part from the peculiarly high level of largely price-driven (rather than service-driven) competition in European telecoms. Decades of pro-competition policy and regulation have shaped a market where, uniquely, competitive telecoms players have a choice of different market entry points:

- in mobile, through pro-competition spectrum policies that preserve, or in some cases create, four-operator market structures, and through pro-MVNO regulation
- in fixed, through heavily tariff-regulated bitstream, virtual and physical unbundling, and physical infrastructure access.

While regulation that was fundamentally designed for a period of post-liberalisation continues to apply, competition has strongly developed since then, and technology actually makes market-entry easier. New developments in the virtualisation of networks reduce the friction of entry into the telecoms market for new players; not only mass-market competitors, but new players offering specialised B2B and B2B2C services.

The European retail telecoms market remains highly fragmented. Market consolidation is one of the key levers that would accelerate the creation of a European Telecom Single Market. Despite this, so far, there have been few signs that competition authorities are ready to promote substantive in-market consolidation in Europe. This, so far, seems to somewhat contradict both the high-level political goal of creating European scale and the advice of most analysts and investors. If anything, regulation has promoted yet more fragmentation in some markets, although some key test-cases are expected as we write.
The growing trend of separation of network-facing and customer-facing businesses, plus the technological advances in network virtualisation, are opening up new opportunities for European service-layer consolidation. But those same trends deliver a potent threat: it could be that external non-European players will be most financially fit to exploit them.

All of these factors throw into question the long-term profitability of the sector and the sustainability of investments. The telecoms industry remains highly leveraged: for ETNO members net debt/EBITDA stands at 2.6x. For ETNO members, aggregate return on capital employed (ROCE), which measures profitability in relation to all of a company's capital, rose a little in 2022 to 5.8% from 5.1% the previous year, but this is a level that is barely higher than (and in some cases lower than) the weighted average cost of capital (WACC) of operators.

In this context, policy must continue to address the gap between areas of investment where a return can be made and broader economic and social goals.
This report has been commissioned by ETNO to provide market context and a quantitative and qualitive assessment of digital communications providers within Europe and beyond. The report investigates five key areas.

> "Operators have in effect absorbed most of the inflation on behalf of their customers

- The first section of this report examines the direct and indirect impact of the telecoms sector on Europeans' lives.
- The second examines the demand for telecoms and digital services from both consumers and businesses.
- The third section looks to the future and considers how operators can meet the challenges of deploying fit-for-future networks, of efficiency and sustainability.
- The fourth section details telecoms innovations and Europe's contribution to their development and deployment.
- The fifth and final section reviews the financial performance of the telecoms industry, and highlights Europe-specific problems in relation to the global trends in the telecoms market.

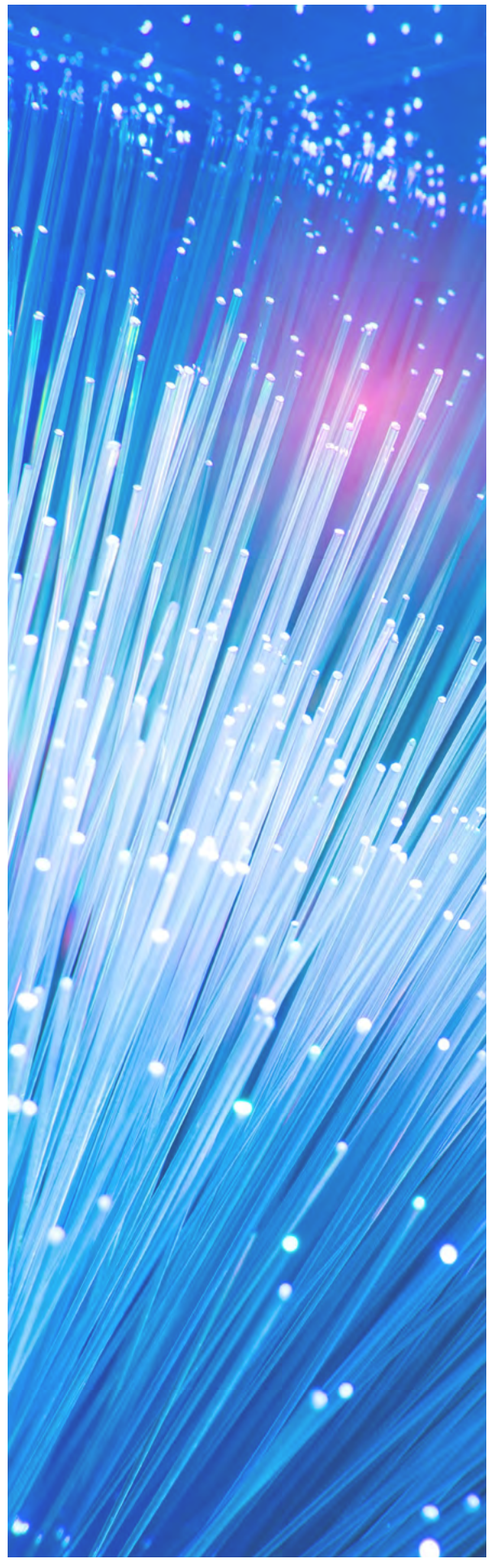
01 **Sustained investment for the European Digital Decade in face of increasing challenges**

02 **Changing demand for digital services**

03 **How network providers can help to deliver a new digital future**

04 **ETNO members play a key role in determining the pace of European technology innovation**

05 **The low returns of the industry are incompatible with the vision of open strategic autonomy**



Sustained investment for the European Digital Decade in face of increasing challenges

In this section, we review the impact of telecoms and digital services on society. We cover both the direct and indirect impact on the economy, provide insights into employment and compare trends in Europe to those in other markets around the world.

01

1-1 DIRECT IMPACT FOR EUROPEANS

The European Commission (EC) 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 fast, nationwide 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 – the ones that very high-speed broadband networks were designed to enable. Progress is reviewed biannually to advise member states on their trajectory. According to the latest report progress has been made on many fronts, but the EU is still far from reaching its targets. The latest European Commission estimates indicate that an "additional investment of up to at least EUR200 billion is needed to ensure full gigabit coverage across the EU"[4].

- **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 2023) the EU stated that 81% of the EU's population had 5G coverage and 56% had FTTH coverage. A higher proportion of people (73%) were covered by a fixed very high capacity network. The 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. At the start of 2023 there were 249 unicorns in the EU, and 77% of the SME digital process target had been achieved, along with 45% of the cloud computing target and 11% of the AI target.

- **Skills.** By 2030 there should be 20 million ICT specialists in Europe. As of September 2023, 47% of this goal had been reached (9.4 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 – 68% of this target had been achieved (54.4% of the population).

- **Public services.** The EU is on track to achieve its target of 100% of core services being accessible online by 2030; 88% of central government services, 76% of regional services and 62% of local services were online by September 2023. In addition to this, all medical records will be accessible online by 2030 and 80% of European citizens should have their ID online.

Europe's infrastructure targets from the Digital Decade programme and the Connectivity for a European Gigabit Society strategy prioritise gigabit connectivity and 5G coverage.

[4] State of the Digital Decade (europa.eu).

FIG 1.1 : *Infrastructure targets of the Connectivity for European Gigabit Society strategy and the EC's Digital Decade agenda*

Connectivity for a European Gigabit Society (2025)	Digital Decade (2030)
• Access to download speeds of at least 100Mbit/s (using gigabit-upgradeable technology) for all European households • Uninterrupted 5G wireless broadband coverage for all urban areas and major roads and railways • Access to 1Gbit/s speeds for all schools, transport hubs, major providers of public services and digitally intensive enterprises	• By 2030: All populated areas covered by 5G • By 2030: Gigabit for everyone. All European households covered by a Gigabit network • By 2030: 10 000 climate-neutral, highly secure edge computing nodes to be deployed in the EU, distributed in a way that will guarantee access to data services with low latency (a few milliseconds) wherever businesses and located • By 2030: EU to double its share in global production of cutting edge microprocessors • By 2025: Europe will have its first computer with quantum acceleration

Source: European Commission

As part of its efforts to meet its Digital Decade targets, the EC supports multi-country critical infrastructure projects that bring together a combination of both private and public investment. EU funding encourages private investors to invest in complex, long-term projects that no single country could achieve by itself. Multi-country projects support the telecoms market with investments for pan-European deployments of 5G corridors, blockchain, processing and computing, cyber security and quantum computing infrastructure.

Europe has been continuing to put people at the centre of its digital transformation since the Digital Decade targets were first announced. The EU declaration on Digital Rights and Principles[5] was released in January 2022 and subsequently approved by both the European Parliament and Member States. The Declaration is made up of six chapters including guidance on how to support solidarity and inclusion and how to ensure freedom of choice online. The declaration emphasises universal European access to high-speed connectivity and promotes the sustainability of next-generation networks and digital technologies that do not excessively contribute to climate change. In addition, the declaration stresses that all market actors should make a "fair and proportionate contribution" to the maintenance and expansion of the infrastructure required to bring the fruits of the digital transformation to as many people as possible.

Fixed broadband and FTTH coverage

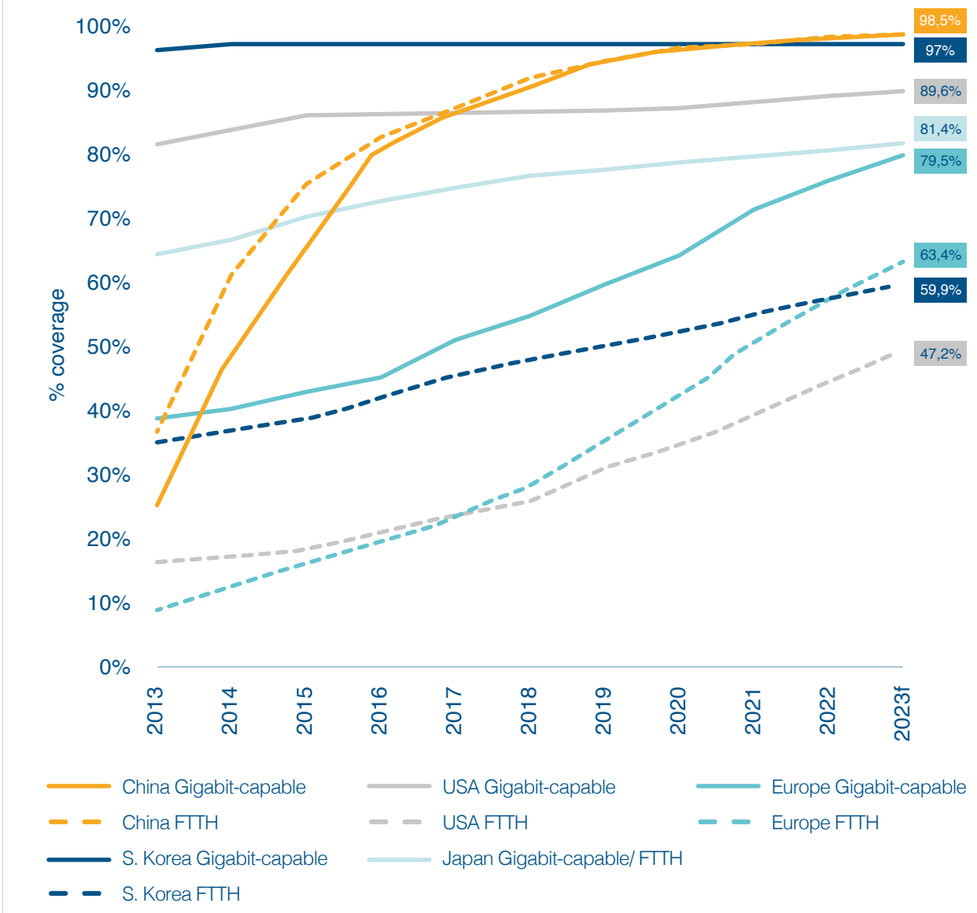
Fixed networks are the workhorse of the digital ecosystem, carrying over 85% of all data traffic. This means that improving fixed broadband connectivity is key to achieving the European Commission's targets for achieving gigabit-capable networks. Multiple connectivity options are available, and they will all be part of a technology-neutral response to the "full gigabit connectivity for all" challenge: fibre-to-the-home (FTTH), fibre-to-the-building (FTTB) with LAN cabling, and cable HFC with DOCSIS3.1. While certain variants of 5G fixed-wireless access (FWA) hold the potential for gigabit connectivity, few existing FWA services offer such high downlink speeds.

[5] European Declaration on Digital Rights and Principles | Shaping Europe's digital future (europa.eu).

While initial capex to deploy FTTH is high, FTTH networks have inherent strengths that make them the right choice for future proof high speed broadband networks: FTTH offers an evolution path to speeds of up to 100 Gbit/s, fibre assets have long life spans, are more cost efficient and energy efficient. And it should come as no surprise that European governments have been prioritising FTTH deployment, and countries have been making solid progress in rolling out new fibre infrastructure.

By the end of 2023, FTTH network coverage in Europe will have risen to 63.3% of the population, up from 57.0% in 2022 (**FIG 1.2**). Gigabit-capable access networks, which in addition to FTTH include networks based on HFC-based DOCSIS3.1 and FTTB/LAN technologies, are now available to 79.4% of Europeans. In terms of FTTH availability, Europe maintains its lead over the USA – where high-speed internet is still delivered mainly via cable, while China has been mandating the deployment of FTTH for a decade and so is very close to achieving 100% penetration. However, overall Europe remains behind on gigabit-capable networks, which also shows up in the lower median fixed downlink speeds compared with the USA, China and Japan.

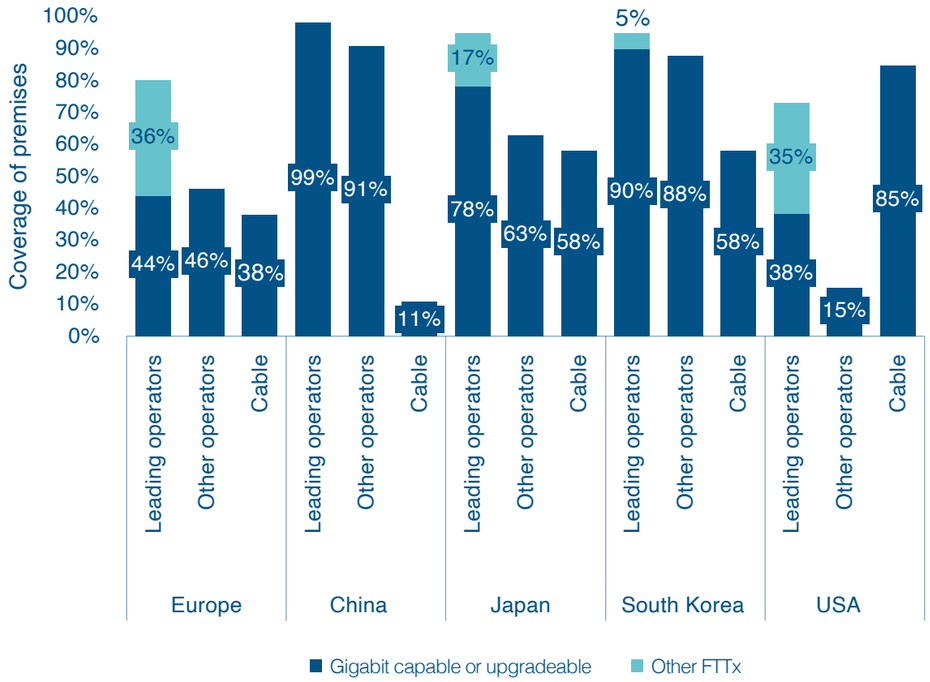
FIG 1.2 : *Gigabit-capable and FTTH population coverage, China, Europe, Japan, South Korea and the USA, 2013-2023f*



Source: Analysys Mason, 2023

Under the pressure of low revenues and by building on regulatory incentives, several fibre investment models developed over the recent past: leading operators are launching 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.

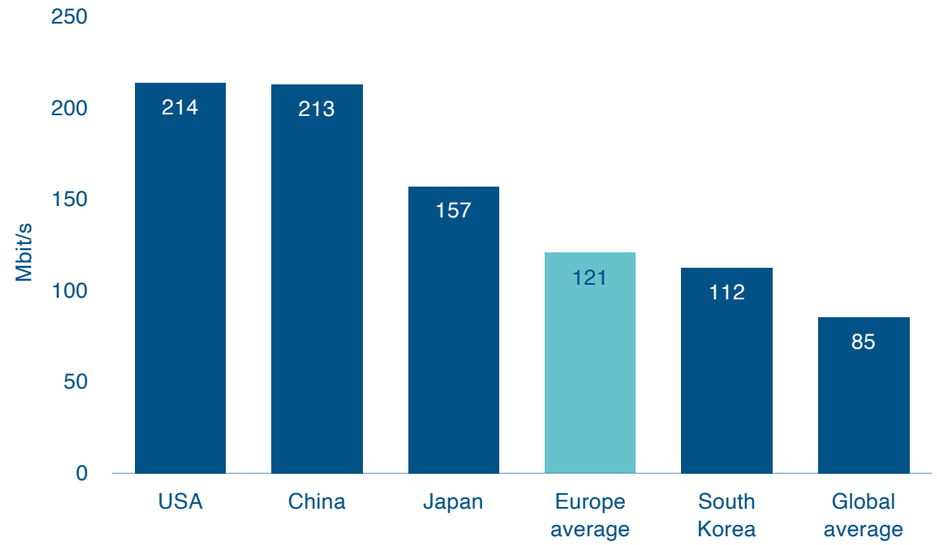
FIG 1.3 : ***Coverage of gigabit-capable or gigabit-upgradeable networks and other FTTx networks by leading, alternative and cable operators, China, Europe, Japan, South Korea and the USA, 2023f***



Source: Analysys Mason, 2023

Europe's median fixed broadband downlink speed is 121Mbit/s, which places Europe well above the global average of 86Mbit/s, but well behind the USA and Japan, due to lower legacy cable/HFC coverage. Europe has a much stronger copper-based infrastructure legacy, which is unsuited to gigabit broadband and is slow and costly to replace. HFC (cable) can be upgraded to provide gigabit speeds, whereas copper-based networks require replacement.

FIG 1.4 : ***3.4: Median[6] fixed downlink speeds, China, Europe, Japan, South Korea and the USA, 2023***



Source: Ookla, 2023

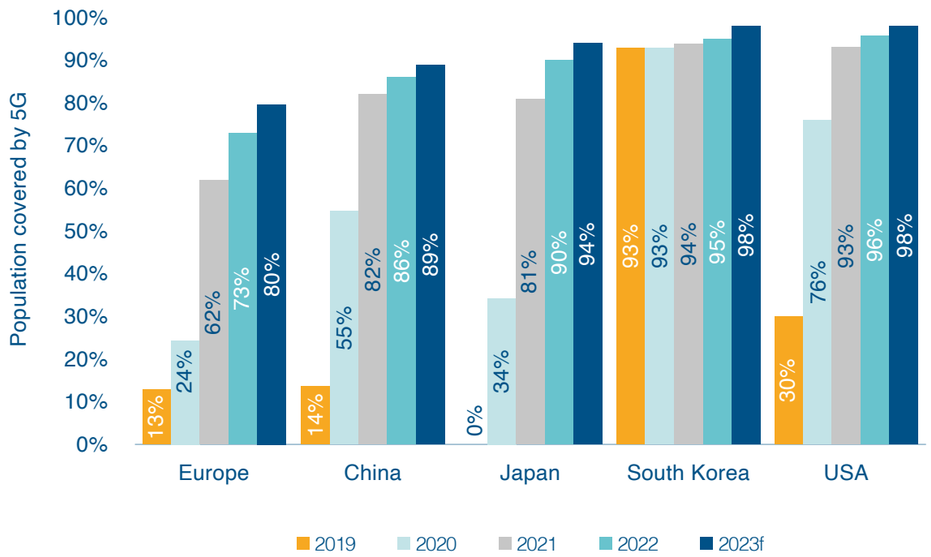
> **On gigabit-capable coverage, Europe is still behind all global peers, but on speeds it's better than global average**

[6] Downlink speed data cannot be compared to the previous year's figures as the basis of reporting has changed from mean to median speeds.

Mobile and 5G availability

4G mobile networks in Europe cover more than 99.8% of the population.[7] The first 5G networks in Europe were launched in 2019, and there were 114 public, operational 5G networks in Europe as of August 2023 (compared to 111 as of August 2022). Only a small number of new deployments have been announced over the past year.

FIG 1.5 : ***Percentage of the population covered by at least one 5G mobile operator, China, Europe, Japan, South Korea and the USA, 2019–2023***



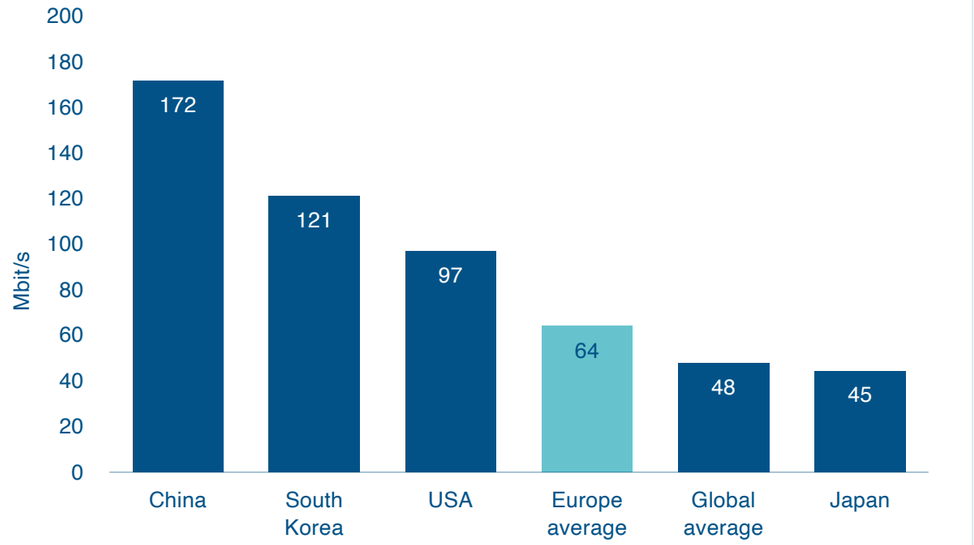
Sources: Analysys Mason, 2023

80% of the European population is currently covered by 5G networks, up from 73% at the end of 2022 (**FIG 1.5**). The equivalent figure for the EU27 is higher at 82% at the end of 2023. Europe's coverage remains lower than that of China, Japan, South Korea and the USA. 5G coverage figures should also be viewed in the context of both the spectrum used and the speeds delivered.

- **Spectrum used.** Low-band spectrum (at 600MHz in North America but 700MHz elsewhere) enables rapid rollout of networks and the provision of 5G coverage. However, capacity is limited and a 5G network based on low-band spectrum on its own offers less impressive improvements 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 only provides for a 4G experience. 5G networks using midband spectrum at 3.5GHz offer substantially improved capacity. Many operators in Europe have been focused on deploying 5G in midband spectrum, and where deployment of 5G in mid-band spectrum follows 5G in low-band spectrum, the coverage figure does not change much (if at all). The 5G customer experience changes significantly though.

- **Speeds experienced by customers.** Median European mobile downlink speeds are higher than the global average, but they are significantly lower than those in South Korea, China and the USA (**FIG 1.6**). Indeed, the median European speed is now 64Mbit/s, which is less than 40% as fast as the fastest speed in the world (171Mbit/s in China). The median figures reported for 2023 are not comparable with the average figures reported in 2022. Nonetheless it is interesting to note that the 2023 median figures are often substantially lower than the 2022 average figures – around 30% lower in the case of Europe, more than 50% lower in the case of South Korea, but virtually unchanged for China.

FIG 1.6 : ***Median[8] mobile downlink speeds, China, Europe, Japan, South Korea and the USA, September 2023***



Source: Ookla, September 2023

[7] A member of the population is typically deemed to be covered if they have useable signal *outdoors* at their home location, or if they are within range of a useable signal. We take these definitions to be effectively the same, but it is important to note that there is nothing in either that guarantees indoor coverage. This depends on building materials as well as factors that are more in operators' control such as spectrum, power and equipment capability.

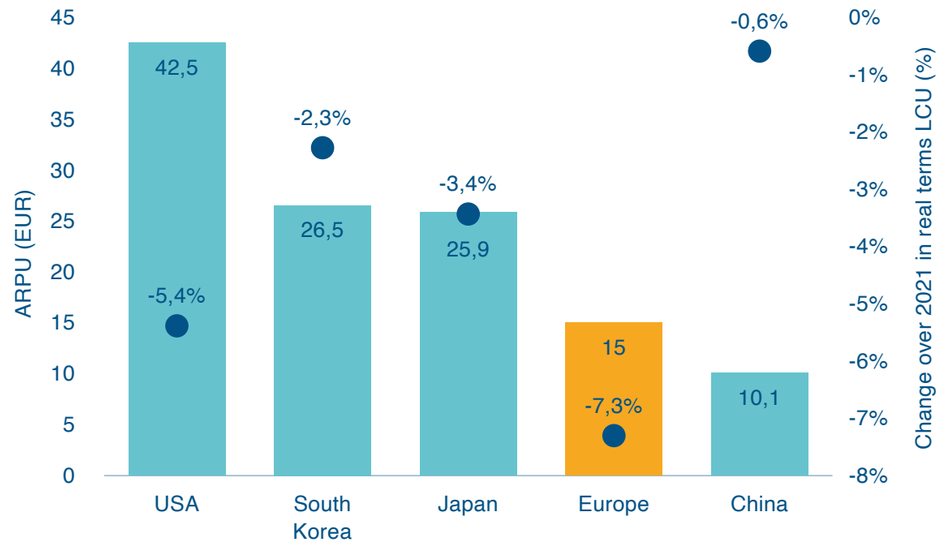
[8] Downlink speed data cannot be compared to the previous year's figures as the basis of reporting has changed from mean to median speeds.

The prices that European consumers pay remain very low by global standards

Monthly average revenue per user (ARPU) for both fixed and mobile services is low in Europe compared with other regions of the world. Factors that have suppressed European ARPU values include strong retail competition, boosted by strict competition enforcement; very high usage of fixed mobile convergence (FMC) bundling to attract customers and reduce churn, which has had the effect of reducing prices and in turn the overall revenue generated per customer; and a general inability to price 5G mobile services at a premium, as the benefits and returns of the value-chain flow principally to players in the online services segment.[9]

Mobile ARPU was EUR15 in Europe in 2022, compared with nearly EUR26 and EUR27 in Japan and South Korea respectively and more than EUR40 in the USA. Operators in China and South Korea, where the market is less fragmented, have sold 5G at a premium.

FIG 1.7 : ***Mobile ARPU (excluding IoT SIMs) and change in real terms (LCU), Europe, USA, Japan, South Korea and China, 2022***



Source: Analysys Mason, 2023

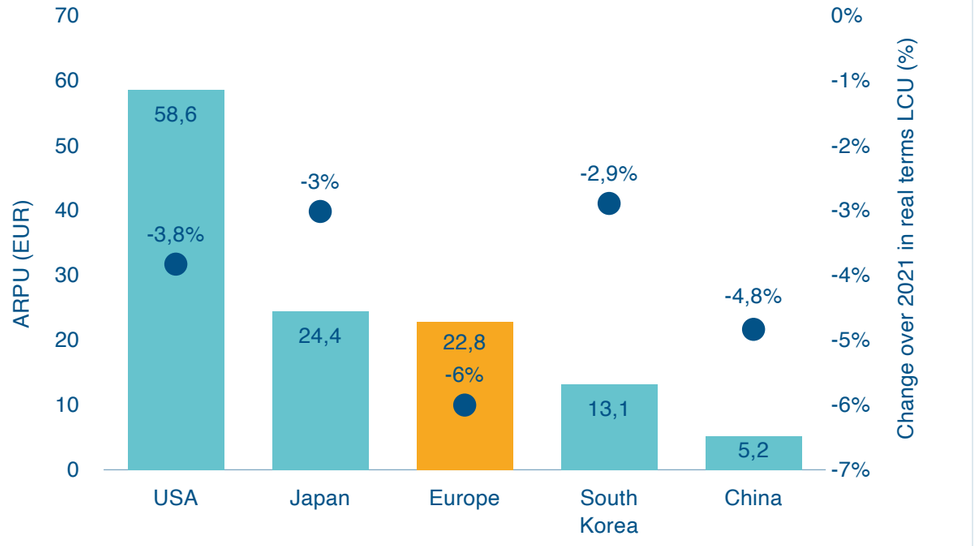
[9] GSMA | The internet Value Chain: latest numbers, current dynamics, and future trends - GSMA Europe.

Historical ARPU trends for countries and regions must be evaluated in local currency to avoid the impact of currency exchange rate fluctuations (which were quite significant in 2022). After steady declines in Europe between 2018 and 2021, mobile ARPU rose in nominal terms by around 1% between 2021 and 2022. However, taking into account 9.2% inflation in 2022 European mobile ARPU declined in real terms by 7.3%, more than in any of the comparator countries.[10]

While low prices are generally considered good for consumers, especially during a period of high inflation, they are not fit for encouraging long-term infrastructure investment, delivering higher quality or incentivising telecom innovation; especially when operators are facing rapidly rising costs themselves, and the need to sustain large scale FTTH or 5G network upgrades.

The trends in fixed broadband ARPU are broadly similar: modest nominal gains from a low base more than offset by high inflation.

FIG 1.8 : ***Fixed broadband ARPU and change in real terms (LCU), Europe, USA, Japan, South Korea and China, 2022***



Source: Analysys Mason, 2023

[10] Inflation source: Eurostat.

The USA has easily the largest monthly fixed broadband ARPU at EUR58.6, after consistent rises year-on-year for the last decade, culminating in a 3.9% rise in 2022. The USA has lower levels of competition in fixed broadband than Europe, Japan or South Korea. The trend in nominal terms in Japan is very slight decline, whereas in South Korea it is broadly flat. The trend in China is strongly negative; China's low fixed broadband ARPU has been brought about by service bundling where broadband services are typically subsidised by mobile services. In Europe, nominal ARPU rose by modest amounts in 2021 and 2022. Once again though, decline in ARPU in real terms was the steepest among the comparators.

China continues to have by far the lowest ARPU in both the fixed and mobile markets, but there are a number of important market differences to take into account. Firstly, Chinese operators are 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 occasion the government can request price decreases. Secondly, regional operating divisions of the mobile companies have the liberty to adjust local prices according to local economic conditions. Third, the economics of supply are very different in China, and the ability of consumers to spend is very different. China has lower labour costs and lower national income levels relative to the other countries covered by this study.

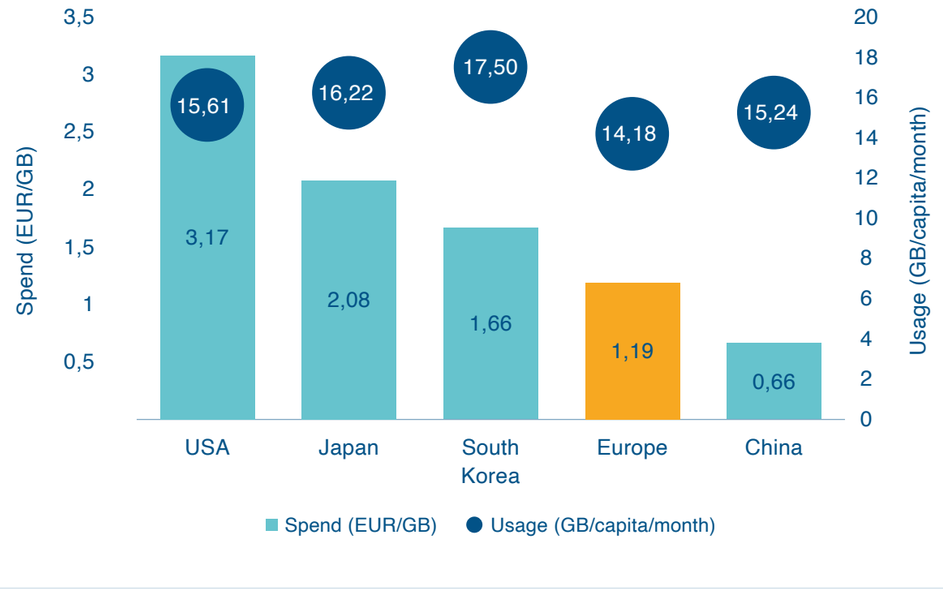
FMC subscriptions provide a single contract for both fixed and mobile services and may include pay-TV services. Typically, the service bundle is priced at a discount compared to cumulative cost of the individually purchased constituent services. In the context of Europe's hyper-competitive markets, operators introduce such contracts in order to attract new customers, reduce churn and upsell them from one service to multiple services. While this is commercially one of the main strategic options, where bundling becomes prevalent in a highly competitive market the consequence can be an overall decline in the total ARPU of individual customers.

The penetration of FMC subscriptions reached more than 80% of households in China in 2022. China has greater mobile penetration than broadband penetration and data-heavy mobile contracts are most commonly marketed with discounted FTTH subscriptions.

The opposite has often been true in Europe where FTTH services have often been bundled with discounted mobile services. In some countries (such as Portugal and Spain) this has exerted downward pressure on the price of mobile-only services too and led to rapid devaluation of mobile connectivity. Europe is not homogeneous though. There is substantive variation in FMC adoption; FMC accounted for over 76.1% of Spain's fixed broadband connections in 2Q 2023, but just 20.7% of fixed broadband connections in Germany.

Average monthly mobile usage is more similar between countries than ARPU. South Korea has the highest mobile usage, at 17.50GB per capita per month, while Europe reports the lowest at 14.18GB per capita per month. The disparity between usage levels in the different regions narrowed to just over 3.3GB per capita in 2022 compared to a range of nearly 5GB per capita in 2021. **FIG 1.9** also demonstrates that only China has lower spend per GB than Europe.

FIG 1.9 : ***Average spend per gigabyte of mobile data used and average mobile data usage per capita, China, Europe, Japan, South Korea and the USA, 2022***

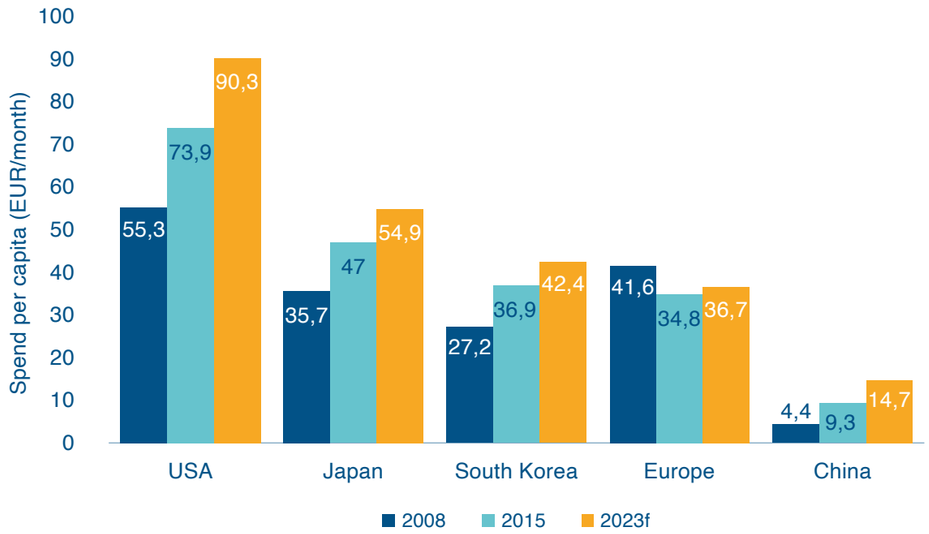


Source: Analysys Mason, 2023

Revenues in European markets are lower than in all other geographies, with the exception of China, which is a managed economy

Europe continues to register lower per capita spending on telecoms in comparison to Japan, South Korea and the USA (**FIG 1.10**).

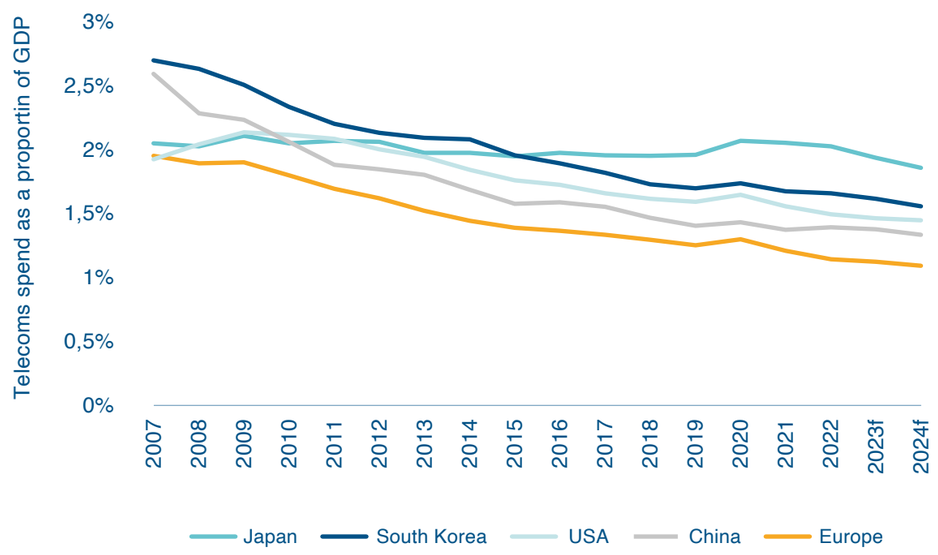
FIG 1.10 : ***Average spend per capita on mainstream telecoms, China, Europe, Japan, South Korea and the USA, 2009, 2016 and 2023f***



Source: Analysys Mason, 2023

Telecoms spend as a proportion of GDP has remained consistently lower in Europe than in the comparator countries for the last 15 years. It accounts for less than 2% of GDP in all countries and has been in general decline. Given the substantial growth of fixed broadband and mobile network availability, and service adoption, this suggests regulatory initiatives to constrain the cost of services (largely through the introduction and regulation of competition) have had an impact. At the same time GDP growth has continued across the regions. A notable outlier is Japan where GDP has been flat, and telecoms spend as a proportion of GDP has remained at around 2%. The temporary upward blip in 2019 caused by GDP decline during the COVID pandemic has now reversed.

FIG 1.11 : ***Telecoms spend as a proportion of GDP, China, Europe, Japan, South Korea and the USA, 2007–2024f***

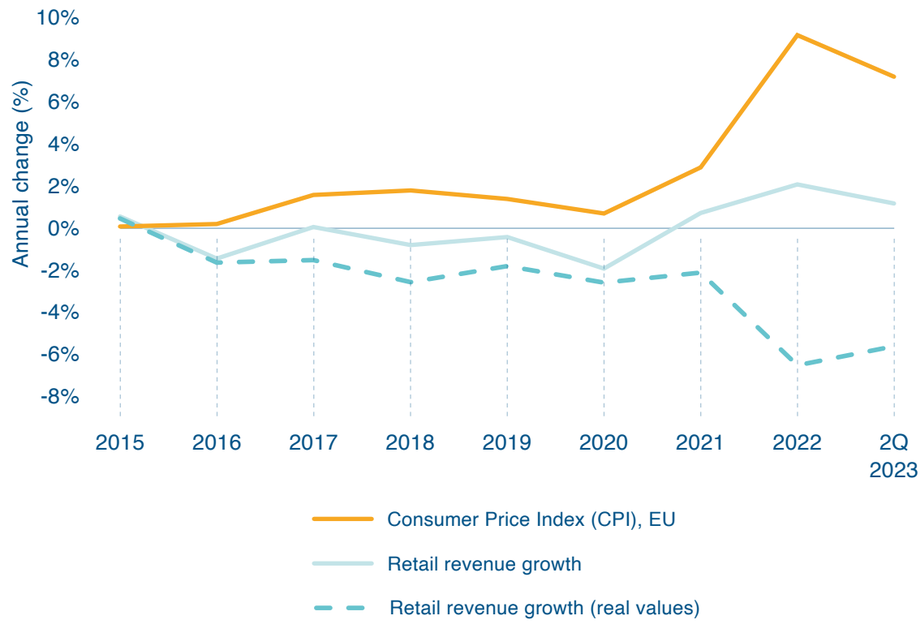


Source: Analysys Mason, 2023

European telecom operators have absorbed inflation on behalf of their customers

EU telecoms retail revenue rose in 2021 and 2022 at 0.7% and 2.1% respectively. Growth for the first half of 2023 was 1.2%. However this growth has to be set against a backdrop of surging inflation. After years over very low-price rises, inflation in the EU rose to 2.9% in 2021, 9.2% in 2022 and 7.2% in the first half of 2023. That means that operators have absorbed a large increase to input costs and that in real terms their revenue has been falling sharply. In fact, in real terms, telecom revenue in the EU has been falling steadily since 2016 and declined sharply in 2022.

FIG 1.12 : ***Retail revenue growth compared to inflation, EU***

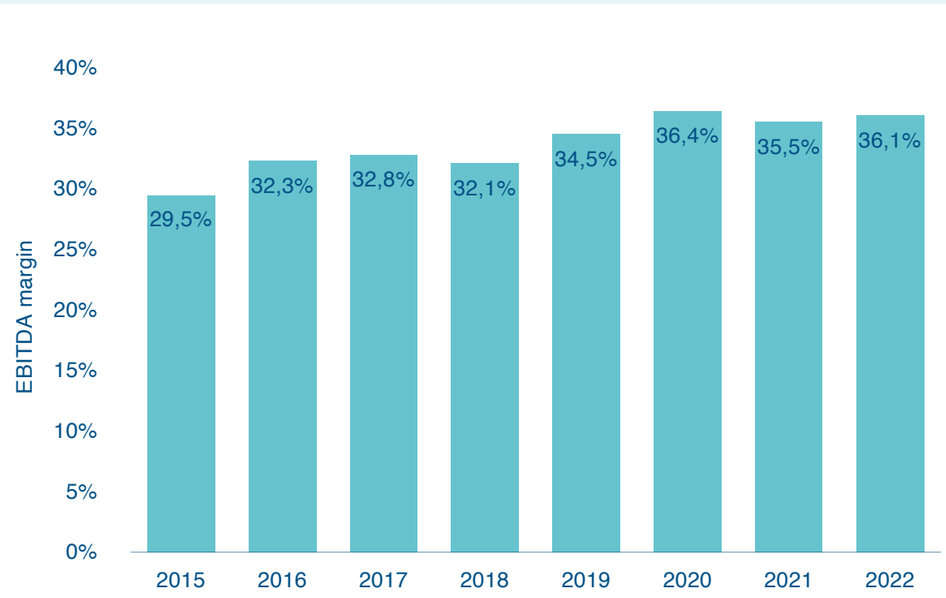


Source: Analysys Mason, 2023

So far operators are managing to offset the inflationary increases in their costs by finding new ways to increase their efficiency. This, unfortunately, has also had a social cost. Some operators absorbed inflation in part by reducing their workforce: in recent years, ETNO operators have lost roughly 10% of their workforce in their home markets, going from 550 000 employees in 2019 to 493 000 in 2022. On the positive side, operators are also finding ways to streamline their operational processes. Updating networks to modern technologies plays a significant role too. 5G is more energy efficient than prior mobile network generations in terms of watt-hours per gigabyte, but it does consume additional energy when added to existing networks. A similar scenario applies to fixed telecoms; energy savings and cost reductions will only materialise when legacy networks are retired. To this end, operators are working towards a copper switch-off and a number of them have turned off 3G networks. Many more legacy network retirements are planned in the coming years in order to refarm spectrum for 5G.

The strong upward pressure felt by operators on labour, equipment and raw material costs was reflected in a small decline in EBITDA margins for ETNO operators in 2021, with a fall from 36.4% to 35.5%. EBITDA ticked back upwards in 2022, and (apart from 2020) is higher in comparison with recent history. (**FIG 1.13**).

FIG 1.13 : ***Aggregate EBITDA margin, ETNO members at the group level, 2015–2022***



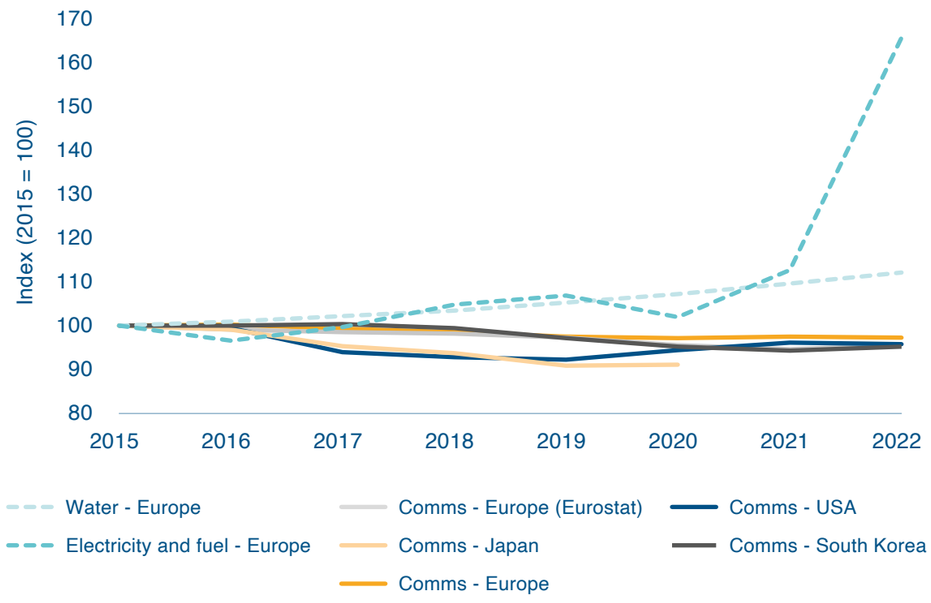
Source: Operators, Analysys Mason

Telecom ARPU typically remains stable during periods of low inflation, and increased usage leads to lower unit prices. If ARPU remains stable in periods of high inflation this can become really problematic; and during 2022 inflation peaked at around 12-15% in several Western European countries. In an industry which has either reached or is nearing saturation, raising prices becomes the primary avenue for growth, and that may not sit well with consumers. It can lead to the migration of customers onto more budget-friendly plans and stagnating customer spending.

Some telecoms service contracts allow operators to raise prices, but the extent to which they can do so is often limited by national laws. Index-based price increases are written into some contracts, enabling operators to raise prices by CPI+ in the middle of a contract. When an established operator increases prices in line with inflation, other operators often follow rather than compete. However, some challenger operators also have the opportunity to gain market share through promising to lock prices for a certain period of time. For example, Free has kept the same prices for mobile in France since 2012, and announced in January 2024 that it would keep these prices frozen until 2027 (the data allowance of the higher-priced plan has increased from 3GB to 250GB since 2012). This reinforces the problem for the industry that consumers have come to expect more for the same price over time.

The impact of inflation on telecoms service prices can be seen when compared with other capital intensive networked businesses. This problem is not unique to Europe; prices as measured by the OECD have fallen in most countries over the period since 2015.

FIG 1.14 : ***Consumer price indices for infrastructure-based services***[11]



Source: OECD[12], Eurostat, Analysys Mason, 2023

FIG 1.14 also includes a price index compiled by Eurostat. While the figures diverge slightly (pointing to an inherent difficulty in devising appropriate baskets of services in an industry where demand changes rapidly) the downward trend is the same.

[11] Europe figures based on OECD data are derived from a weighted average of changes in individual European countries.
[12] OECD (2023), OECD.Stat at https://stats.oecd.org/ (Accessed December 2023).

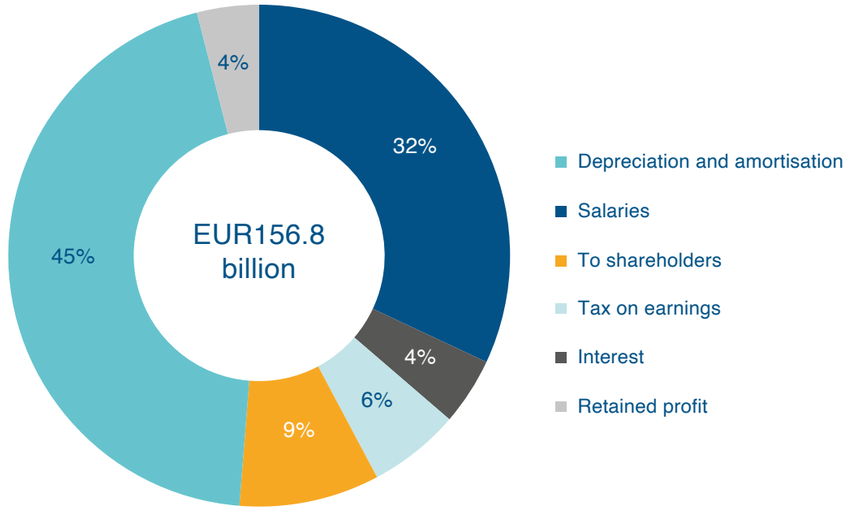
1-2 INDIRECT IMPACT FOR EUROPEANS

ETNO members contribute indirectly to European society well-being in several ways: through taxation, through investing in skills and rewarding employment, and through sustained capital investment.

Distribution of value added

ETNO members are not simply providers of communications services; they are deeply embedded in European economic and social life. ETNO members generated EUR295.8 billion in revenue in 2022 (up 2.6% on 2021), EUR190.1 billion of which was generated by their European operations (up 1.7%)[13]. Value-added (essentially revenue minus the direct cost of goods and services) stood at EUR156.8 billion in 2022. The distribution of this value has substantial indirect benefits for the broader European economy, for employees, for suppliers and for shareholders.

FIG 1.15 : ***Distribution of value added, ETNO members at the group level, 2022***



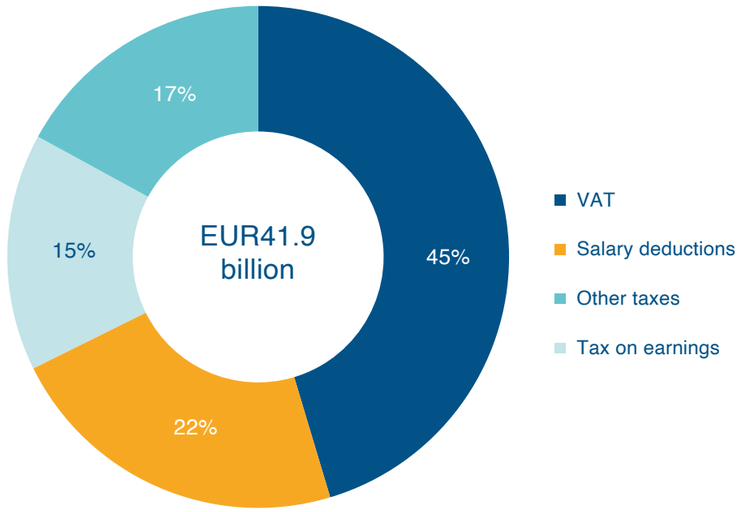
Source: Operators, Analysys Mason

[13] European businesses are defined as those incorporated in Europe.

A high proportion of ETNO member shares are in the hands of institutional investors such as pension funds. Hence the sustained profitability of the industry has a direct impact on Europeans' well-being. Aggregate net profit for ETNO members stood at EUR20.4 billion in 2022, up from EUR12.7 billion in 2021. In 2022, ETNO members distributed EUR14.2 billion in dividend payments. Excluding one-offs but including impairment the payout ratio was around 69%, somewhat ahead of what is typical for utilities, and substantially ahead of technology businesses.

ETNO members paid around EUR41.9 billion in direct taxes (tax on earnings and other direct taxes) and indirect taxes (VAT and salary deductions) for their European operations in 2022; this is equivalent to about 22% of their revenue base.

FIG 1.16 : ***Total direct and indirect tax, ETNO members (Europe only), 2022***



Source: Operators, Analysys Mason

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 prices paid at auction for spectrum licences are not strictly a tax, but they have a similar function. European operators (ETNO and non-ETNO) paid EUR30.2 billion at auctions between 2018 and 2022.

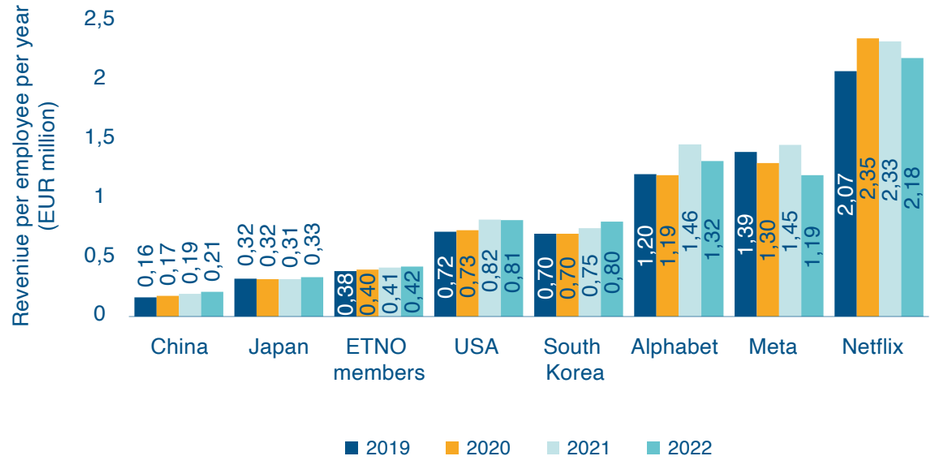
Changes in corporation taxation with regards to the expensing of capex can have a beneficial effect on the ability to invest. BT had argued that full expensing of capital investment in plant and machinery, allowing companies to claim a deduction from taxable profits that is equal to 100% of their qualifying expenditure in the year that expenditure is incurred, would facilitate higher investment in essential infrastructure such as FTTH and 5G.[14] In November 2023 the UK government made full expensing a permanent measure; in the EU the only two countries have full expensing are Estonia and Latvia.

[14] Investing in the UK's future - the case for fundamental reforms to capital allowances (bt.com).

Productivity improvement has stalled among operators and CAPs alike

FIG 1.17 compares the revenue per employee for ETNO members and their counterparts in China, Japan, South Korea and the USA. ETNO members have recorded incremental productivity gains in recent years, but the process is slow and not above inflation. The disparity between ETNO members and US operators can be attributed to economies of scale and substantial differences in ARPU.

FIG 1.17 : ***Revenue per employee for ETNO members, operators in China, Japan, South Korea and the USA and selected CAPS, 2018–2022***



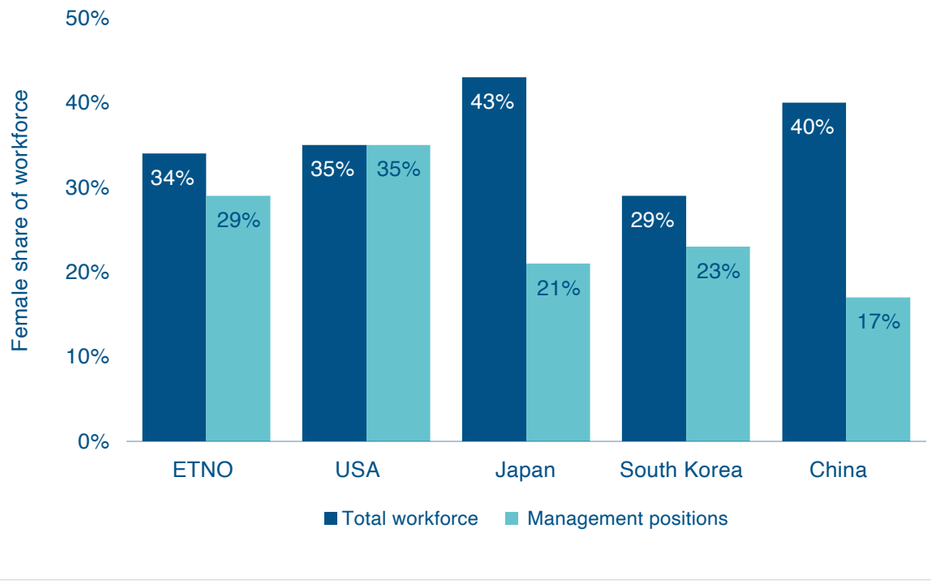
Source: Companies, Analysys Mason, 2023

> European telecom operators are a backbone of our economies: they generate €41.bn/year in value added

The gender gap is slowly narrowing

Females remain a minority in operator workforces, but their representation varies between regions.

FIG 1.18 : *Share of women in the workforce among ETNO members and operators in China, Japan, South Korea and the USA, 2022*



Source: Operators, Analysys Mason, 2023

Higher rates of female employment do not necessarily lead to a higher proportion of females in management roles. China and Japan have the most gender-balanced workforces (40% and 43% females, respectively), yet the lowest representation in senior positions (12% and 21% female, respectively). However, this gender gap is narrowing in Europe and the US. The only change to the average proportion of women in the workforce between 2021 and 2022, was a 1% increase in female managers among ETNO members. There are some caveats to this data; management roles do vary in definition between operators, but usually include middle management and above, with some just including senior management, and these figures do not reflect women's representation at the highest levels of European operators. It is noteworthy that of the six largest operator groups in Europe, three now have female CEOs.

Most ETNO members are committed to increasing female representation in leadership roles and have set specific goals. Here are some examples:

- **Orange (2025 goal):** aims to have 35% of leadership roles filled by women.
- **TIM (2025 goal):** aims to have at least 29% of women in leadership position.
- **Telia Company (2025 goal):** plans to achieve a 50/50 gender balance between its extended leadership team (management plus direct reports) by 2025, with 47% of management positions already held by women in 2022.
- **Altice Portugal (2030 goal):** working towards the Portuguese national target of 40% of women in senior management positions.

ETNO members are actively involved in initiatives to increase the presence of women in technical and digital positions:

- **Elisa** collaborates with Women4CyberFinland, an organisation mentoring women aspiring to enter the cybersecurity industry in Finland.
- **Swisscom** encourages young women to pursue engineering roles through its Digital Days for Girls program, showcasing technical positions within the telecoms sector.
- **TIM** is carrying out development and empowerment projects aimed at guaranteeing the equality of women in terms of opportunities and professional growth (Female LeadHERship). Its Partnership with Young Women Network is aimed at more than 220 female colleagues under 35 years old to support their personal growth journey with coaching and mentoring programmes.
- **Altice Portugal** has worked on making job descriptions more gender neutral to improve gender balance within recruitment.
- **Orange** has launched dedicated programmes such as the "Hello Women program", which has been implemented in association with several partners in more than 20 countries to increase female representation in technical and digital jobs.

Addressing the ICT skills shortage

Europe suffers with a shortage of IT skills, as do other regions. This is exacerbated by high employment rates in some countries which constrict the pool of potential applicants, resulting in recruitment challenges.

The EU's Digital Decade highlights a shortage of ICT specialists and STEM qualified workers. It states that the lack of available staff with such skills is damaging investments for 85% of EU firms. Without intervention, the number of ICT specialists would be around 12 million by 2030, and the EU has targeted 20 million. This is despite the share of ICT employment increasing from 3.2% to 4.6% between 2012 and 2022, and absolute numbers increasing by 57.8% (a rate almost 7 times the increase for total employment (8.8%)).

One barrier is that, despite the EU's ageing population, 63.3% of ICT specialists were under 35 years old in 2022[15]. This demonstrates the lack of digital expertise among the existing workforce, and the need to promote ICT skills from an early age to ensure an increasing pool of recent graduates. In addition to this, during 2022 81.1% of employed ICT specialists were male, with Romania and Bulgaria being the only EU member states where the share of men was lower than 75%.The gender balance is becoming slightly more even though, with the number of employed female ICT specialists growing faster (5.8% per year) than that for males (4.4% per year). This stresses the importance of promoting digital careers among females as well as young people. Some operators are seeking to develop specialist skills internally. For example, during 2022, TIM invested a total of over 2.1 million hours of training, of which a third was for updating technical skills.

Improving employee well-being

ETNO members are involved in a couple of key projects focused on the importance of staff well-being.

- **ETNO/UNI Europa Statement on Remote Work**

The European telecom social partners have jointly developed comprehensive guidelines on remote work, emphasizing the importance of maintaining social dialogue, collective bargaining, and trade union rights in this context. The guidelines cover a range of critical issues related to remote work, including working conditions, data protection, equipment and resources, training, and equal opportunities. Additionally, they underscore the need to ensure equivalent employment rights and conditions for remote workers as for those on the employer's premises.

The document outlines best practices for occupational health and safety, work-life balance, and working hours for remote workers. It also stresses the importance of gender neutrality and inclusivity in remote work arrangements. The social partners recommend thorough assessments and surveys to measure the impact of remote work on employees' work-life balance. Furthermore, they advocate for the development of minimum requirements and conditions for remote workers.

- **EU Cross-sectoral Guidelines on Violence and Harassment at Work**

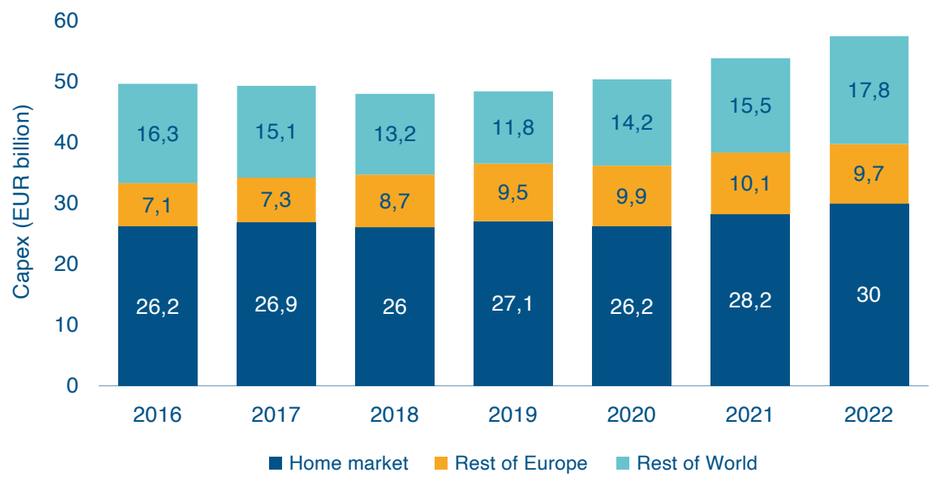
This initiative, supported by social partners, emphasizes the significance of fostering respectful, tolerant, and inclusive workplaces. It acknowledges that gender-based violence and harassment, particularly against women workers, are rooted in power dynamics and gender inequalities. Organizational culture plays a pivotal role in addressing sexual harassment, and the guidelines advocate for transformative approaches to combat such behaviour.

[15] See ICT specialists in employment - Statistics Explained (europa.eu).

1-3 FTTH ROLL-OUT DRIVES CAPEX HIGHS, WITH EUROPE STRETCHING ITS INVESTMENT INTENSITY

European operator capital expenditure, and ETNO member capital expenditure, once again increased in 2022. Europe's leading operators – ETNO members – also remain the main investors in the continent's digital backbone. With the one exception of the pandemic-affected 2020, there have been increases every year since 2014. The European telecoms sector remains more capex intensive than most peer regions and countries. Operator capital expenditure delivers not only direct benefits, in the form of improved communications services, but also a number of indirect benefits. The latter include social cohesion, good-quality jobs, and investment in a European supply chain (two of the three largest telecoms equipment vendors in the world are based in Europe).

FIG 1.19 : *ETNO member capex (excluding spectrum costs), home markets, rest of Europe and rest of the world, 2016–2022*

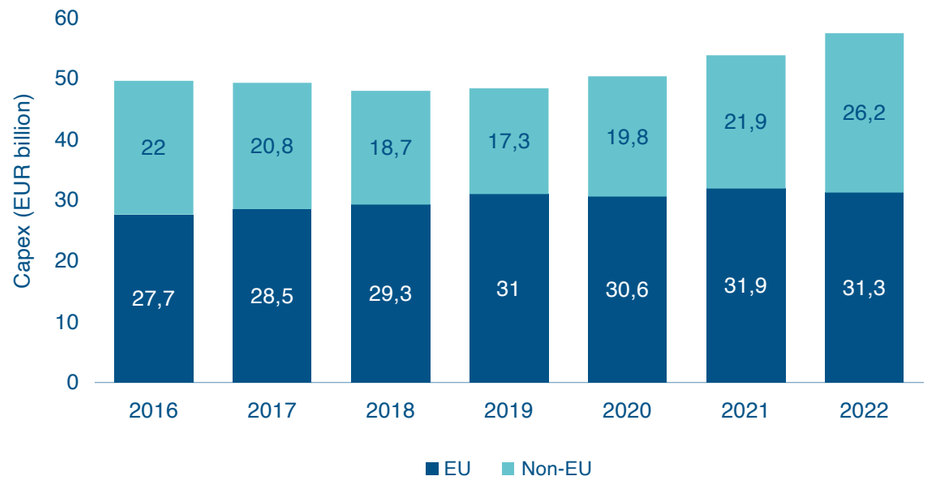


Source: Analysys Mason, 2023

ETNO member capex rose 6.9% overall in 2022, while in Europe ETNO capex rose 3.7%. This rise occurred in the context of total European operator capex rising 5.0%.

FIG 1.20 shows the same total capex for ETNO members split this time into EU and non-EU investment (investment in non-EU European countries counts as 'rest of the world').

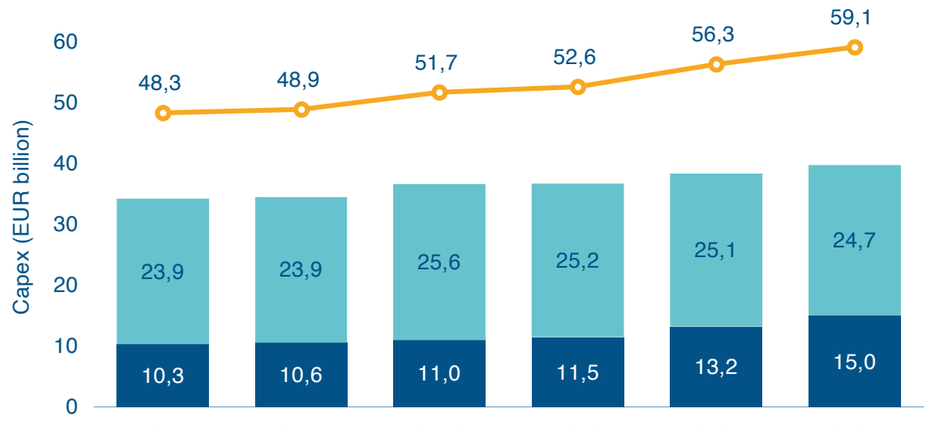
FIG 1.20 : ***ETNO member capex (excluding spectrum costs), EU and non-EU***



Source: Analysys Mason, 2023

With the European Commission indicating an unfulfilled investment need of at least EUR200 billion for the EU, it is important to understand how the numbers in our report compare. First, our report refers to the total annual capital expenditure of the sector in Europe (EU + several other European countries, see footnote 1 for details). Second, the total annual investment of the telecom sector is more than just pure network investment, but it also comprises other elements such as investment in buildings, cybersecurity, physical infrastructure and civil works.

FIG 1.21 : ***ETNO member capex in Europe only (excluding spectrum costs), plus total capex in Europe, 2016–2022***



Source: Analysys Mason, 2023

In 2022, Europe's total telecom investment reached €59.1bn: 48% went to fixed networks, 20% to mobile networks and the rest to IT and non-network assets

Some of the rise in capex in the past two years can be attributed to inflation of costs in projects already committed to, but the larger factor in Europe was the continuing rise in spend on the fiberisation of fixed access networks (principally FTTH), combined with sustained investment in the mobile RAN (principally 5G).

- Fixed access accounted for just under half (48%) of all telecoms operator capex in Europe in 2022. Of this sum about 90% was on FTTH. This figure represents capex spent on passing premises with FTTH networks. FTTH capex has a one-off character: the expected asset lives of the main components, civil works, ducts and fibre cables, are 40 years and 25 years respectively, while active equipment (network and consumer premises equipment (CPE)) contributes to only about 10% of capex.

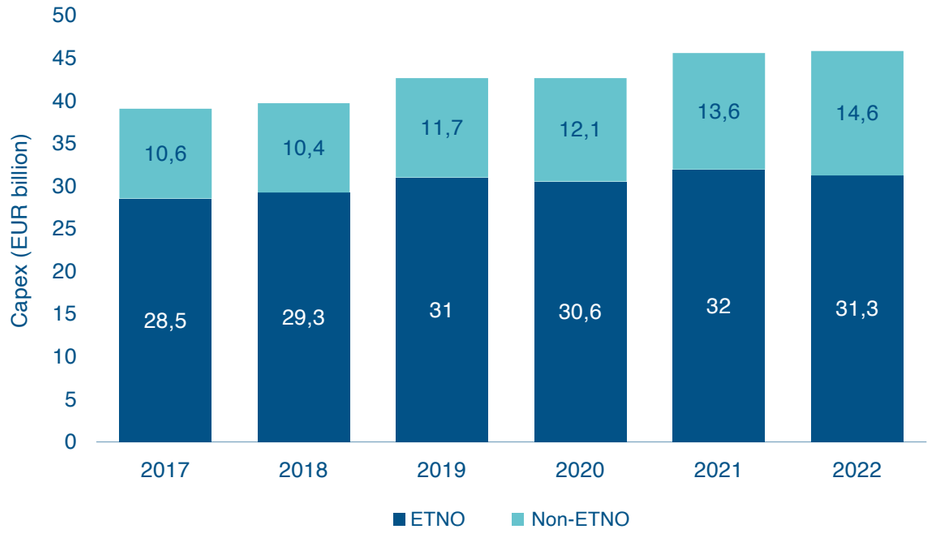
- Additional spend on fixed infrastructure comes in the form of aggregation and transport networks used by both fixed access and mobile. This typically amounts to between 10% and 16% of investment.

- Mobile capex tends to be more evenly spread than FTTH, although it does move to the rhythm of spectrum awards and successive generations of networks. Mobile networks accounts for about 20-30% of capex, most of it spent on radio access networks. The capex numbers in **FIG 1.19** would be higher if spectrum costs were included (See **Section 3.2**).

- The rest of operator capex comprises mainly CPE, IT, and various non-network elements such as offices and vehicles.

ETNO member capex in the EU27 alone amounted to EUR30.9 billion in 2022, 68% of the total.

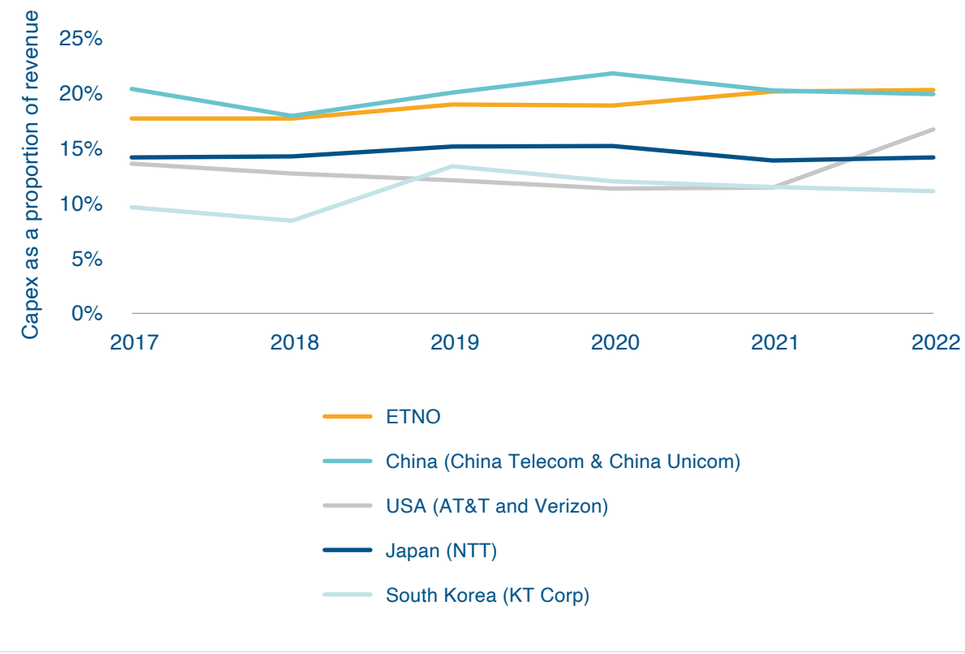
FIG 1.22 : ***Total capex, EU27, ETNO and non-ETNO, 2017-2022***



Source: Analysys Mason, 2023

ETNO members as a whole have higher capex intensity than their peers elsewhere. In 2022 capex intensity in home markets[16] stood (excluding spectrum acquisitions) at 20.3%, up marginally from 2021, but still higher than for similar operators in Japan, South Korea and the USA, and for the first time higher than peers in China, where operators have tended historically to invest more as a proportion of revenue. This, in face of sluggish or declining revenues and return on capital, should ring the alarm bell for policymakers.

FIG 1.23 : ***Capital intensity in home markets, ETNO members and comparable leading operators in China, Japan, South Korea and the USA, 2017–2022***

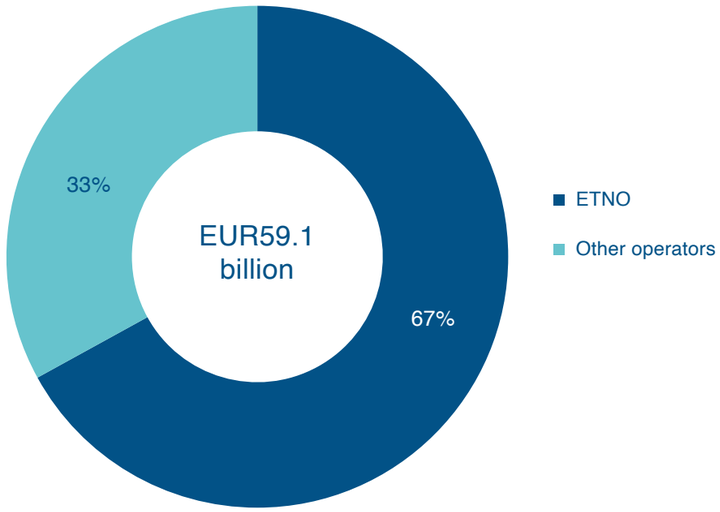


Source: Analysys Mason, 2023

[16] Home markets are the countries in which the operator is the historical incumbent. The definition includes lines of business that serve multinational enterprises, but excludes mainstream operating businesses based in other countries. Comparator operators outside Europe have few mainstream operating businesses outside their home markets, and hence a comparison on the basis of 'home markets' is appropriate.

ETNO members' share of total operator capex in Europe stood at around 67% in 2022, down one percentage point compared to 2021.

FIG 1.24 : *Split of capex between ETNO members and other operators, Europe, 2022*

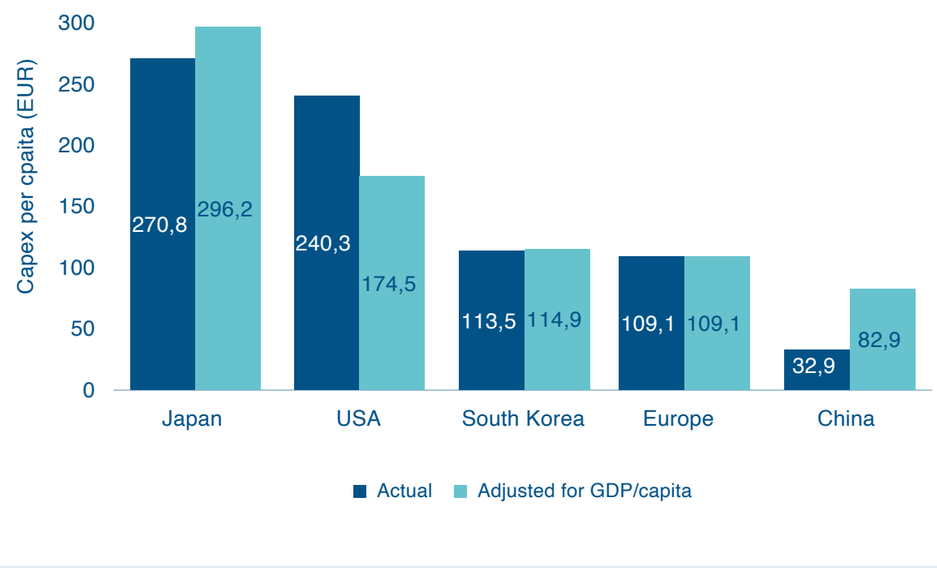


Source: Analysys Mason, 2023

Despite high capex intensity, Europe is characterised by low investment per capita

High and rising capex intensity must be placed in the context of low ARPU compared with peers. The actual investment per capita is substantially lower than that in the USA and Japan, even when adjusted for GDP per capita.

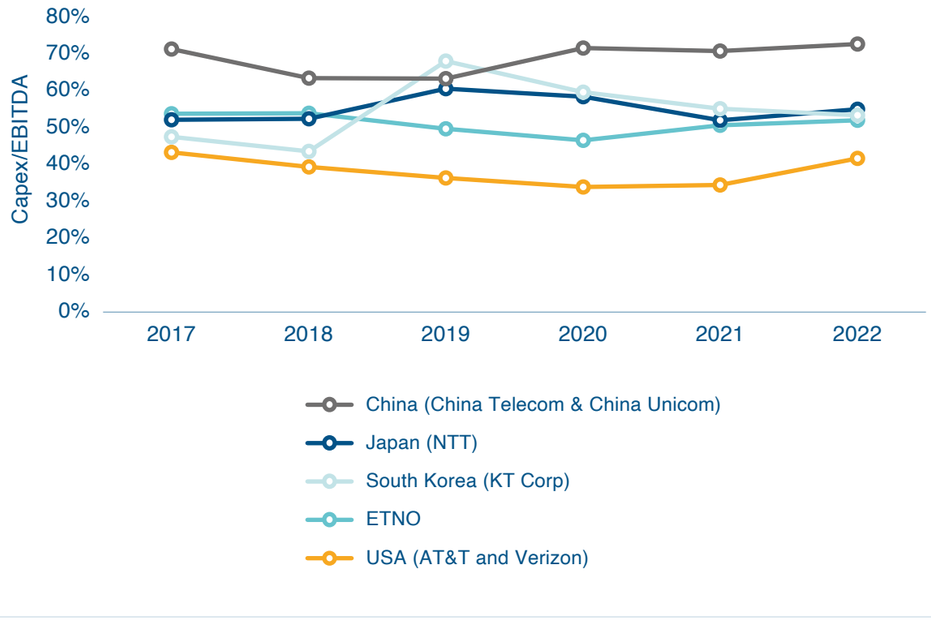
FIG 1.25 : *Capex per capita, China, Europe, Japan, South Korea and the USA, 2022*



Source: Analysys Mason, 2023

Capex as a proportion of EBITDA for ETNO members has settled down a little after several years where it was higher than peers in Japan, South Korea and the USA.

FIG 1.26 : *Capex/EBITDA ratio, ETNO members and peers in China, Japan, South Korea and the USA, 2017–2022*



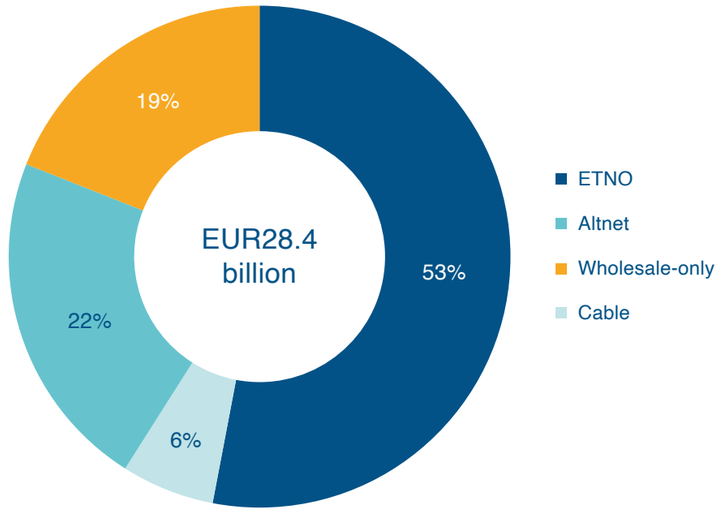
Source: Analysys Mason, 2023

This trend has to be placed in the context of rising EBITDA among ETNO members. In fact ETNO members' aggregate EBITDA margin (36.1% in 2022) has generally exceeded that of their peers over the past six years, a result of continuing efficiency initiatives, such as job cuts and operational efficiencies. The Chinese state's ownership and direction of Chinese operators makes their reinvestment level higher.

Fixed/FTTH capex

Fixed access renewal (essentially FTTH) accounts for most of the current growth in telecoms capex. ETNO members continue to be the largest investors in Europe's fixed networks, accounting for 53% of fixed access capex in 2022. 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' investment can be divided into two camps: those that are self-overbuilding their hybrid fibre coax (HFC) plant with FTTH, and those that are content to upgrade their HFC-based technologies (DOCSIS3.1 and possibly in the future DOCSIS4.0). The former is more capex intensive than the latter, although as with telcos, cable operators will be looking to FTTH to deliver not only improved network performance but also substantially lower operating costs. There were fewer major announcements about FTTH upgrades in 2022 than previously, but the trend is still away from DOCSIS and towards FTTH.

FIG 1.27 : *Split of fixed capex between ETNO members and other operator types, Europe, 2022*



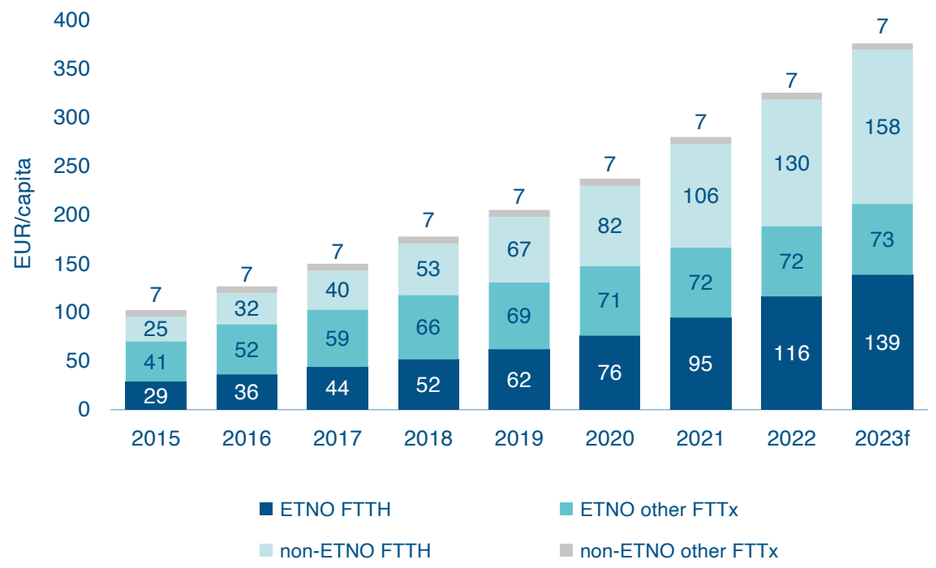
Source: Analysys Mason, 2023

Ownership structures are complex: infrastructure investors, usually with investments in various asset classes across network businesses and utilities, have substantial equity stakes, sometimes as the result of carve-outs of netcos from integrated operators. The larger infrastructure investors have stakes across multiple European countries. The smaller players are beginning a process of consolidation, and a handful of smaller players have withdrawn or faced bankruptcy.

The cumulative amount spent per capita on FTTH in Europe stood at EUR296 by the end of 2023.

> **In 2022, 67% of the total sector investment, comprising both fixed and mobile deployment, came from ETNO members**

FIG 1.28 : *Cumulative FTTH capex per capita, ETNO and others, 2015–2023f*



Source: Analysys Mason, 2023

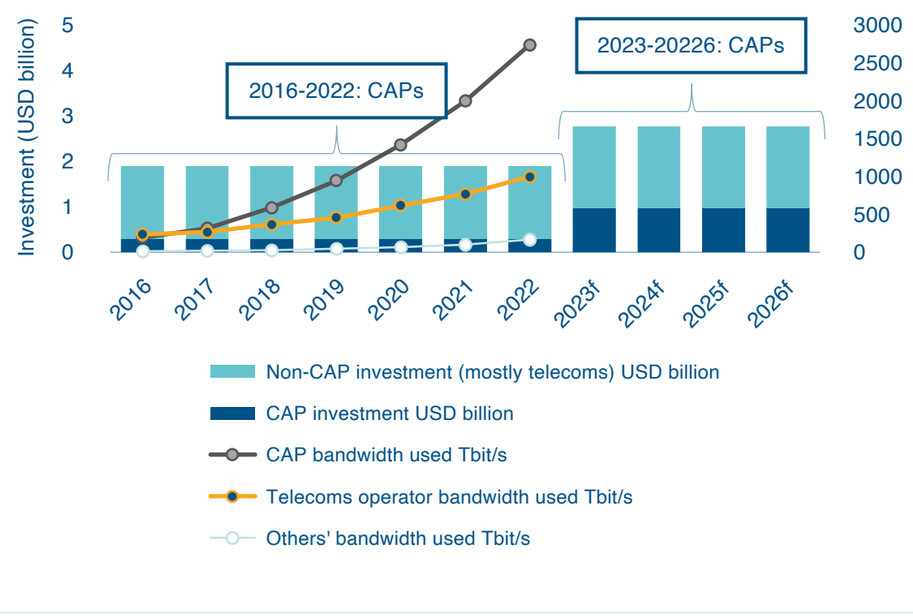
The EU has encouraged infrastructure-based competition in FTTH networks, which has, in most countries without an overarching broadband plan, had the effect of delivering overbuilt networks in some areas and a lack of investment in others. The level of FTTH-on-FTTH overbuild was 1.4 aggregate premises passed to 1 unique premises passed at the end of 2022. This ratio will grow as cable operators start to upgrade to FTTH, although the level of overbuild in Europe varies greatly between countries. The total investment in FTTH by the end of 2023 was the equivalent of EUR579 for every premises in Europe (including those not yet covered), which is equivalent to EUR296 per member of the population. If earlier waves of telco investment FTTx (including fibre to the cabinet and fibre to the building) are included the figures rise to EUR734 per premises and EUR376 per capita.

Investment in digital infrastructure: telecoms players versus CAPs

The end-to-end digital infrastructure value-chain (excluding the content and applications that end-users consume or use) includes, critically, datacentres. Telecoms operator investment in datacentre capacity has been spasmodic and patchy across the world, and in Europe it has been no different; investment has been dominated by the hyperscale content and applications providers (CAPs). Conversely CAPs have invested little compared with telecoms players in the asset-classes that are at the heart of telecoms businesses. Their investment in these asset classes has been focused on some major inter-datacentre and international routes, plus some caching infrastructure. Hence there is only limited overlap with what telecoms operators invest in.

CAPs have increased their investment in submarine cable systems, but their contribution to total investment is still substantially smaller than that of other players (nearly all telecoms operators act as internet backbone providers). Between 2016 and 2022 CAPs accounted for approximately 15% of investment in new submarine cables, and this is expected to rise to 34% between 2023 and 2025.[17]

FIG 1.29 : *Global submarine cable investment by business type, 2020-2025f*



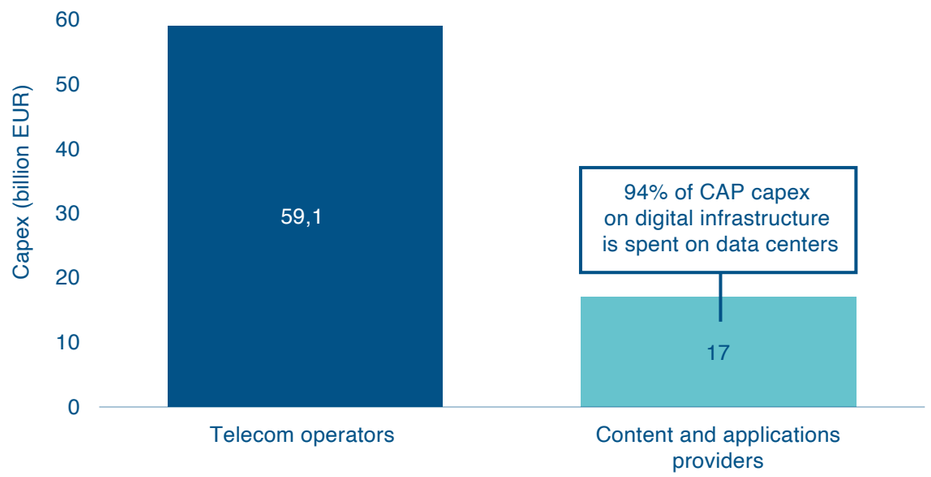
Source: TeleGeography, 2023

[17] See Content Providers Are Still Hungry for Bandwidth, TeleGeography blog, June 2023.

At the same time, CAPs accounted for about 70% of used bandwidth by 2022, a proportion that has risen every year since 2012.[18]

The average annual direct investment by CAPs between 2018 and 2021 in European digital infrastructure is estimated at EUR17 billion (29% of what telecoms operators invested in 2022). About 94% of CAPs' direct investment in infrastructure worldwide was directed towards datacentres, and this proportion is unlikely to be significantly different in Europe. As such, we can estimate that CAPs invested annually approximately EUR16 billion in data centres and approximately EUR1 billion in a mix of transport networks and internet peering/direct transit and caching. CAPs have so far invested almost nothing in European physical networks that are closer to end-users than caches, and certainly nothing at all in European FTTH or the physical RAN, which are by far the two largest capex buckets for operators.

FIG 1.30 : ***Direct capex on digital infrastructure, total European telecoms sector and CAPs, 2022***



Source: Analysys Mason, 2023]

[18] See A Complete List of Content Providers' Submarine Cable Holdings, TeleGeography blog, undated, and How the US is pushing China out of the internet's plumbing, Financial Times, June 2023, sourced to TeleGeography.

Changing demand for digital services

In this section, we consider the demand side of the telecoms and digital services market, including revenue for consumer and enterprise services and the relative amounts spent with operators and content and applications providers (CAPs).

02

2-1 DEMAND FOR BASIC COMMUNICATIONS SERVICES

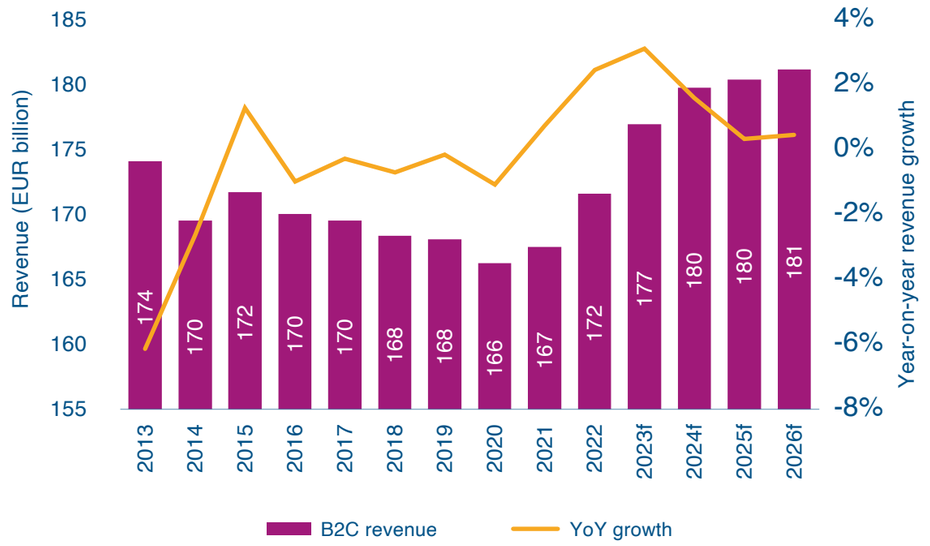
European appetite for basic communications services continues to grow. Although European countries have reached saturation point in terms of mobile and are close to reaching it for fixed broadband, consumption of internet-based applications and online content is driving demand for faster, higher quality fixed and mobile connections. There are limits to what customers can afford, and how much time they can spend on networked applications, but desire for connectivity remains robust.

In general, digital services can be broken down into those that are sold directly to consumers (B2C) and those that are used by businesses (B2B). There is overlap in terms of the sorts of services sold, but the markets operate very differently.

Revenue patterns

Consumer revenue increased by 0.8% in 2022, after a 1.3% increase in 2021. This can be contextualised as continued recovery following the pandemic, as 2021 saw the first positive growth rate since 2015. As such, significant growth in B2C spending in the coming years is unlikely; prior to the pandemic the telecoms sector was characterised by a sustained gradual decline in revenue (Compound Annual Growth Rate (CAGR) of -1% between 2013 and 2018). Prices have been constrained by regulation and intense competition, and this looks set to continue. Faced with current inflationary pressures some challenger operators are seeking to expand their market share, which is limiting the overall market's ability to increase consumer prices.

FIG 2.1 : ***Consumer telecoms service revenue and year-on-year growth, Europe, 2013–2026f***

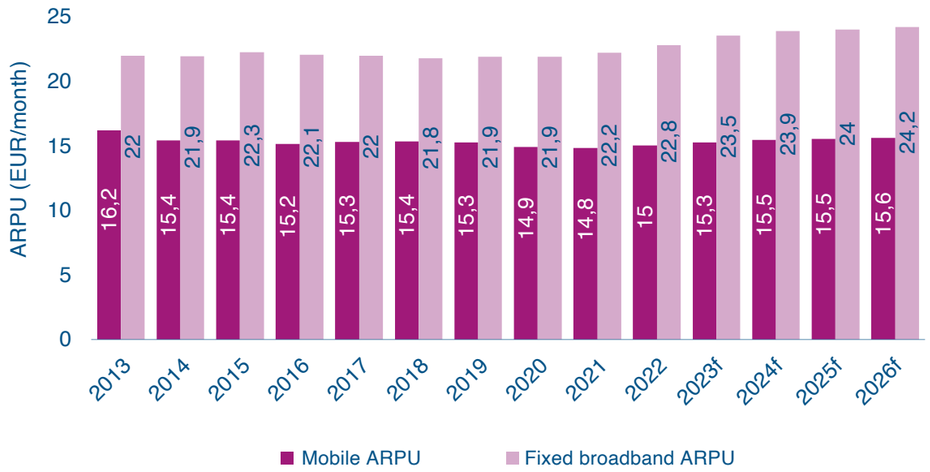


Source: Analysys Mason, 2023

Mobile ARPU is projected to see incremental year-on-year growth (**FIG 2.2**) in nominal terms. Operators are making cautious and very limited adjustments to pricing in response to inflationary pressures.

Fixed broadband ARPU remains stable in nominal terms; for the last decade it has remained at around EUR21-EUR22. Similarly to the mobile market, this is projected to increase, largely to absorb some inflationary costs as opposed to true increases in price.

FIG 2.2 : ***ARPU for mobile and fixed broadband services, Europe, 2013–2025f***



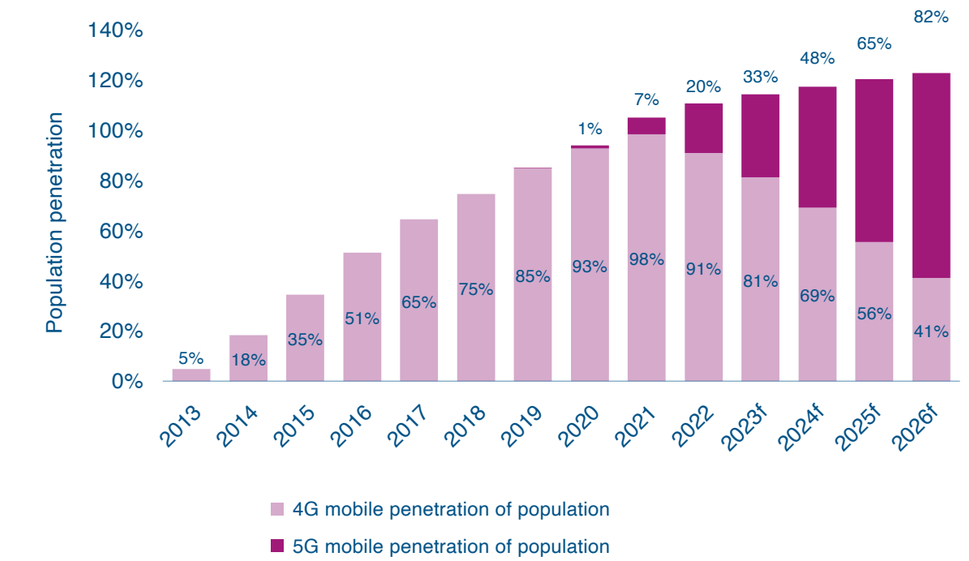
Source: Analysys Mason, 2023

Mobile connections

5G services are now widely available in Europe as a result of significant recent efforts to increase coverage in many EU countries. Population coverage in the region reached 81.2% by the end of 2022[19]. Despite this investment, 5G coverage in the EU stills lags a number of other key markets. For instance China and Japan – markets that were much quicker to invest – have now achieved more than 90% population coverage with their 5G networks.

As a consequence of the investment in 5G networks, 5G adoption in Europe is starting to grow rapidly. 5G population penetration stood at just 6.8% in 2021. That figure increased to 19.7% by the end of 2022 (**FIG 2.3**).

FIG 2.3 : ***Population penetration of 4G and 5G, Europe, 2013–2026f***



Source: Analysys Mason, 2023

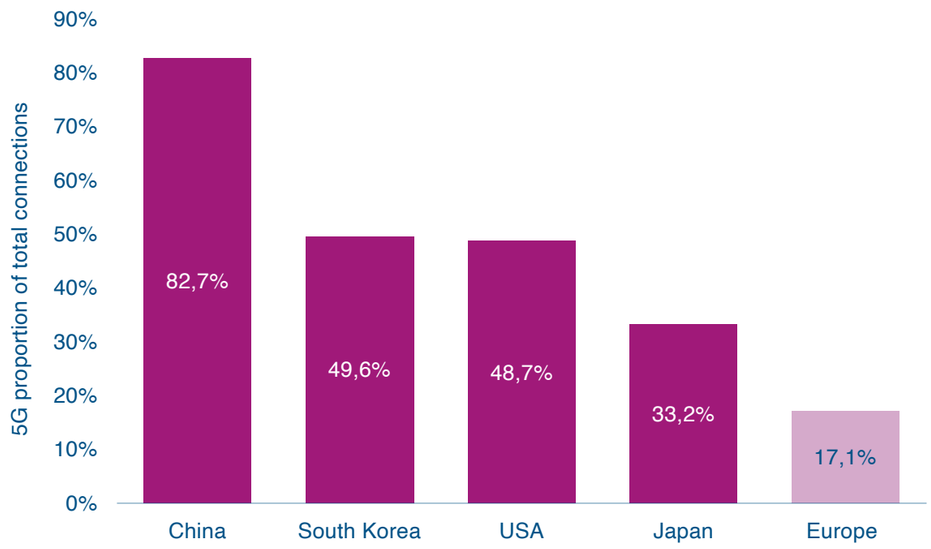
[19] Source: EU: Broadband Coverage in Europe 2022. https://www.astrid-online.it/static/upload/bce_/bce_2022_final_report_.pdf

5G share of mobile connections has also exhibited notable recent growth in Europe. 5G connections accounted for 17.1% of all mobile connections by the end of June 2023. (This figure is lower than 5G penetration because overall mobile penetration (connections per 100 people) exceeds 100%).

Partly as a consequence of the later investment and lower coverage, and also possibly due to factors such as spectrum availability (which impacts on service quality), and device replacement habits (longer refresh cycles), 5G share of total mobile connections is lower in Europe than other regions. In China the 5G share of connections has now reached 82%. It has reached nearly 50% in South Korea, and nearly 49% in the USA. Japan is also ahead of the EU at 33% 5G share of mobile connections.

Other regions are continuing to pull away too. The share of mobile connections accounted for by 5G in Europe grew by 8.4 percentage points in the twelve months to the end of June 2023. In the same period, the share of 5G connections grew by 8.9 percentage points in South Korea, 11.4 percentage points in Japan and 15.7 percentage points in the USA, and 19.3 percentage points in China.

FIG 2.4 : *5G share of all mobile connections, China, Europe, Japan, South Korea and the USA, end of June 2023*



Source: Analysys Mason, 2023

5G services are expected to continue to gain in popularity in Europe, with the absolute number of 5G connections projected to increase from 104 million in 2022 to 430 million by 2026. By that date, 5G services (which also include 4G service as a fallback option) are projected to reach 81.7% penetration, which is a substantial increase in only four years. (**FIG 2.3**). The share accounted for by LTE services (which also include 4G and 3G as fall back options, but no 5G connectivity) will decline as a consequence. LTE services accounted for the large majority of mobile services in Europe at the end of 2020, but we expect LTE penetration to fall from 91.1% in 2022 to 41.2% by 2026.

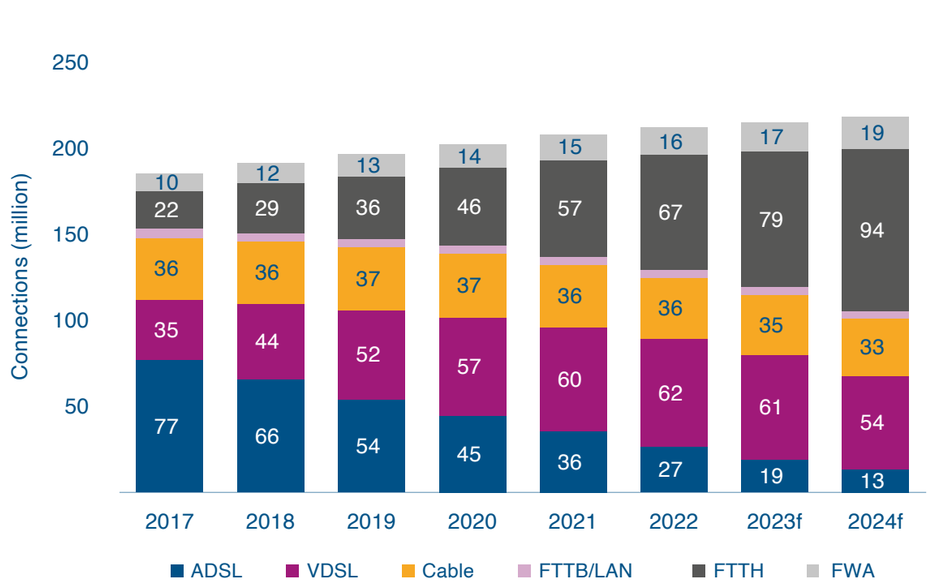
Fixed broadband connections

The fixed broadband market has evolved significantly over the last five years with marked policy and competitive shifts towards deployment of FTTH rather than alternative technologies. Fibre offers a future-proofed, scalable option for broadband network deployment, as well as – depending on which technology alternative it is compared to – better quality, higher capacity or lower opex (through reduced maintenance and energy costs). Lower ongoing energy costs are particularly attractive in the context of the 2022 rises in European energy prices, and operator initiatives to achieve net zero. As a result, regulators are setting targets for new fibre infrastructure. France, for example, aims for all fixed infrastructure to be fibre-based by 2030, as does Germany's Gigabitstrategie.

The widespread rollout and adoption of FTTH has inevitably led to the decline of ADSL based services, and VDSL based services are predicted to go into decline from 2023 (**FIG 2.5**). Use of cable is likely to wane too, with some cable operators expected to overbuild their DOCSIS networks with FTTH.

The picture for FWA varies from country-to-country. FWA still only comprises a small proportion of Europe's connections. Availability of services (and hence adoption) has steadily grown, particularly in areas where it is challenging or cost-ineffective to deploy FTTH. FWA connections are consequently expected to increase from 16 million in 2021 to 18 million in 2024. In some countries FWA will remain insignificant as an alternative to FTTH. In other countries – such as Austria and Finland – take-up has grown, with FWA respectively used to connect remote and rural areas, and suburban single dwellings which lack fibre access.

FIG 2.5 : *Fixed broadband connections by technology, Europe, 2017–2024f*



Source: Analysys Mason, 2023

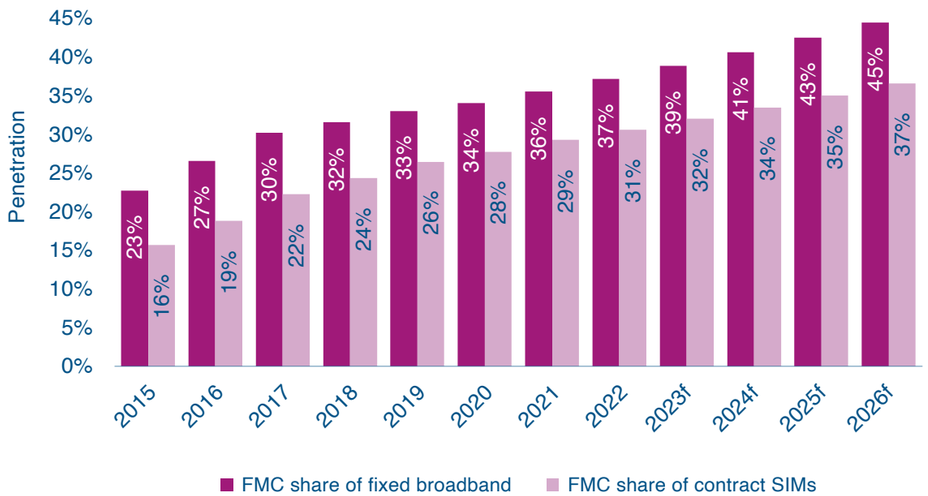
The cost of deploying fibre networks is substantial, and it varies greatly according to local sets of circumstances. One country facing unusually strong capex headwinds is Germany, where the Federal Ministry for Economic Affairs and Energy stated in 2016 that the cost of deploying a nationwide FTTH network in Germany could reach EUR100 billion[20]. This means the FTTH transformation will take time to happen. While FTTH connections are expected to grow quickly, they will still constitute only 45% of all connections by the end of 2024. This underscores the necessity of maintaining alternative access solutions, as more than half of Europeans will continue to rely on them in 2025.

Fixed–mobile convergence (FMC)

FMC bundling – combining fixed and mobile services within the same customer subscription – has been an effective strategy for customer retention and has played a key role in the rapid adoption of FTTH in some European markets. It has been growing in significance in Europe, driven by merger and acquisition activity and by competition. In addition, new wholesale business models have emerged that enable operators to enter the market without owning both fixed and mobile network infrastructure. FMC bundling is not without risk as it can lead to erosion of ARPU.

FMC bundling still represents a minority of fixed broadband subscriptions and contract mobile services sold in Europe (**FIG 2.6**), but its importance is growing. FMC is expected to increase in many European countries between 2023 and 2026, although slight declines are expected in France and Spain where the leading FMC operators have significantly reduced the price discounts granted to FMC customers after years of intense price competition. FMC bundling of fixed broadband subscriptions in Europe is projected to reach 44.5% of subscriptions by 2026. Bundling of contract SIMs is forecast to rise to around 36.6% by 2026.

FIG 2.6 : ***FMC share of fixed broadband subscriptions and contract mobile SIMs, Europe, 2015–2026f***



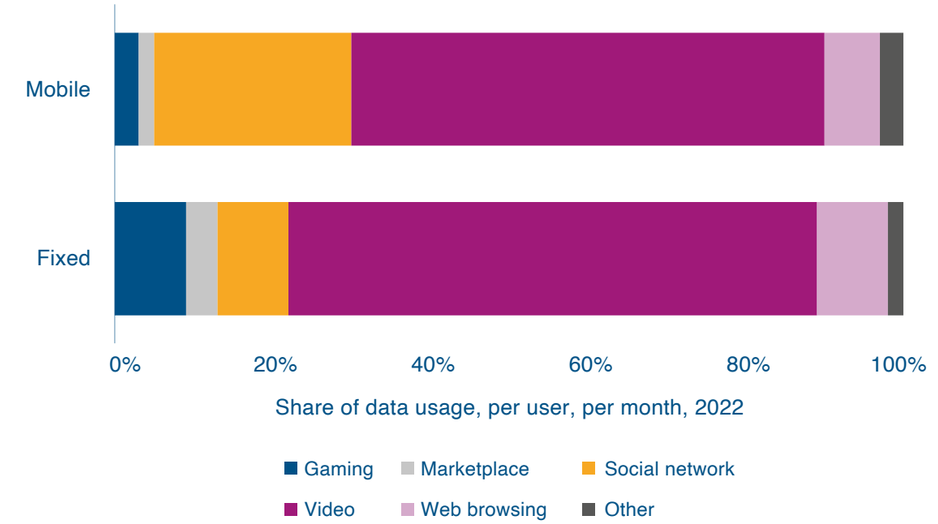
Source: Analysys Mason, 2023

[20] https://www.de.digital/DIGITAL/Redaktion/EN/Publikation/digital-strategy-2025.pdf

Fixed and mobile data usage trends

Growth in the volume of cellular and fixed data consumed in Europe is continuous. The temporary boom in consumption caused by the global COVID pandemic in 2020 and 2021 meant that overall growth was lower in 2022 (around 14% in Europe in 2022). However, behaviour changes caused by the pandemic have persisted: many more people still work from home, leading to a generally greater reliance on connectivity and cloud applications for work. Demand for TV and video content (which accounts for the majority of all traffic on networks – see **FIG 2.7**) continues to grow too. There are signs of an uptick, with growth perhaps returning to its pre-pandemic trajectory. One recent study expects a CAGR of approximately 25% a year on mobile and 20% per year on fixed until 2030.[21]

FIG 2.7 : ***Share of data usage by application type***

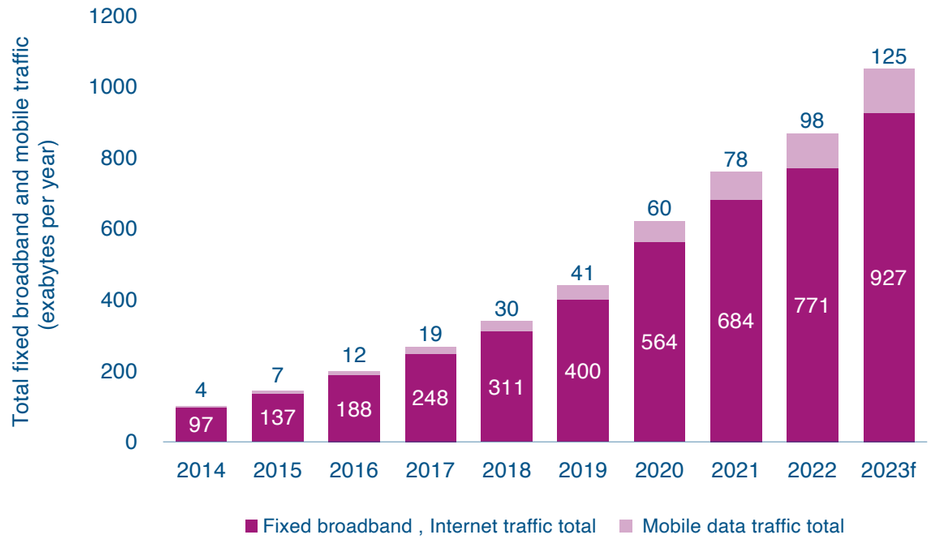


Arthur D Little commissioned by ETNO, 2023

[21] See Arthur D Little: The Evolution of Data Growth in Europe, May 2023.

The volume of traffic carried on Europe's fixed broadband networks is still much larger than the volume carried on mobile networks. Cellular data traffic accounted for an estimated 11.2% of all data traffic in 2022. Fixed broadband networks are used for watching huge volumes of video and TV services (including in some cases linear IPTV), and can support multiple users at the same time. Although video content is increasingly consumed on mobile devices, viewing sessions on mobiles are typically shorter, the format of the content is lower in definition, and typically only one stream of content is delivered at a time. Around 70% of data traffic generated by mobile handsets is on fixed/Wi-Fi networks, a proportion that appears to be quite stable, despite the increased prevalence of unlimited data plans.

FIG 2.8 : *Fixed and mobile data usage, Europe, 2015–2023f*



Source: Analysys Mason, 2023

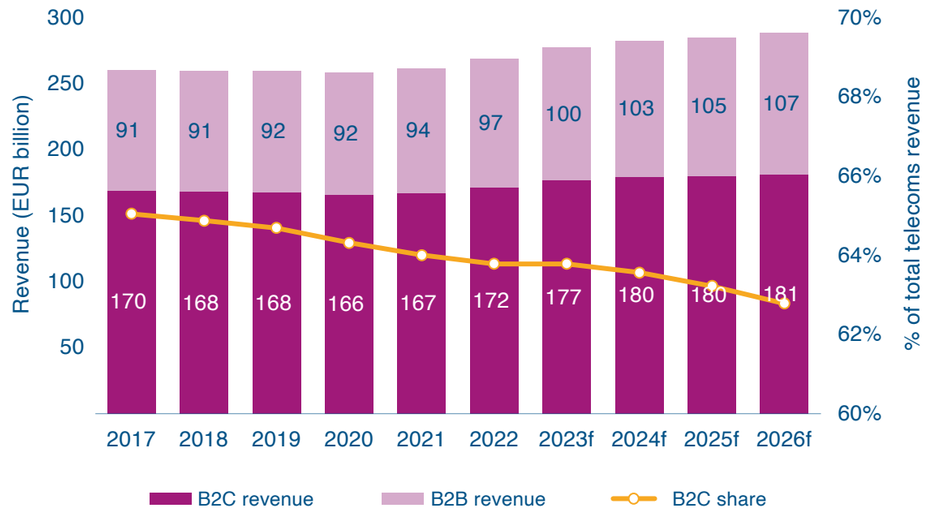
The development of AR/VR/metaverse type services has the potential to generate enormous volumes of data traffic for each user (most likely on fixed networks at first). Exactly what these services will look like, how they will be used and how fast they will grow is open to speculation. Aside from the question of how popular services will be, location of processing and rendering resources will have a significant impact on how much traffic flows, and where it goes. Although exact quantification is not really possible until the question of where processing will take place is resolved, we expect that AR/VR/metaverse services will begin to drive an uptick in fixed and cellular data traffic growth rates as we approach 2030, and have the potential for greater impact on data traffic from 2030 and beyond.

B2B and B2C revenue comparison

The split of telecoms revenue generated by B2B and B2C services has remained similar for more than a decade, with B2C services accounting for 63% to 65% of the total since 2012. Since 2021, both B2B and B2C revenue have increased in nominal terms with a range of factors likely having an impact including wider adoption of FTTH, and increased availability and adoption of 5G, both of which can attract a small premium compared to previous technology generations. (The long-term sustainability of that premium is questionable). Notably the increase has also accompanied a world-wide and European-wide rise in inflation which began in 2021, and which became much more pronounced in 2022. (For more analysis on inflation vs revenues see **Section 5**).

The use of 5G to deliver innovative enterprise applications has the potential to lead to growth of mobile-related B2B revenue, although 5G SA network deployment increasingly looks like a necessary precursor to this, and the business case for deployment of 5G SA remains uncertain for some operators. (For further analysis of this see **Section 4**).

FIG 2.9 : *Operators' B2B and B2C revenue and the B2C share of the total telecoms revenue, Europe, 2017–2023f*

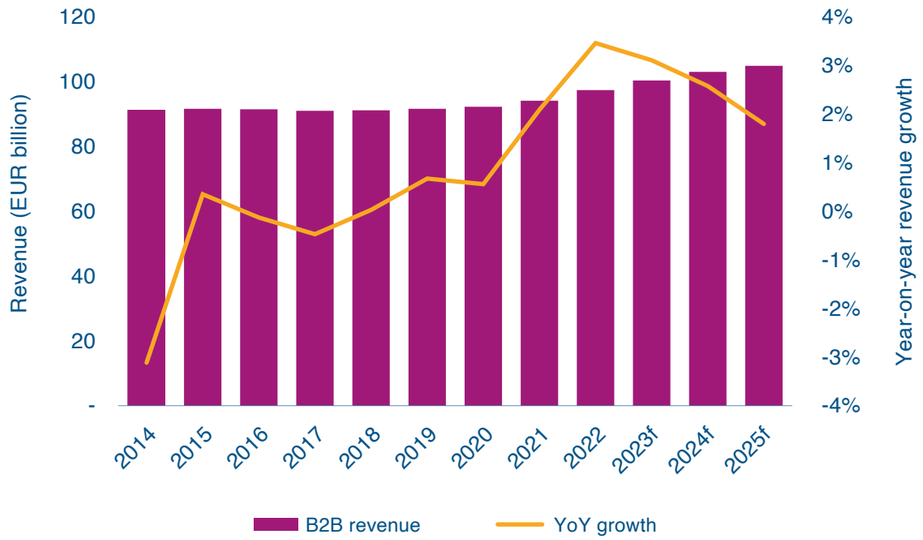


Source: Analysys Mason, 2023

2-2 B2B CONNECTIVITY AND SERVICE REVENUE GROWTH

B2B connectivity revenue remained at around EUR92 million between 2015 and 2021 with less than 1% year-on-year growth (**FIG 2.10**). In contrast, B2B connectivity revenue is forecast to rise over the next three years. Growth will be caused by several factors, including shifts in working practices brought about by the pandemic (hybrid work requirements have led to increased spend on connections), the demand for higher quality connectivity, and of course inflation. While growth rates will peak in 2022 at 3.5%, revenue will continue to grow, reaching EUR105 million by 2025.

FIG 2.10 : ***Operators' B2B connectivity services revenue and year-on-year growth, Europe, 2014–2025f***



Source: Analysys Mason, 2023

2-3 TRENDS IN DIGITAL SERVICE DEMAND

Digital services encompass the wide range of applications and services that run over IP networks. B2C digital services present an opportunity for operators to diversify their portfolios, increase revenue, improve customer loyalty and boost engagement. Digital services include traditionally core services for operators (especially voice and messaging) that can now be delivered over IP networks and that are open to wide competition. They also include services such as IP TV that operators have introduced to their portfolios, moving themselves into competition with new sets of companies; as well as new digital services in areas such as finance, physical and digital security and health.

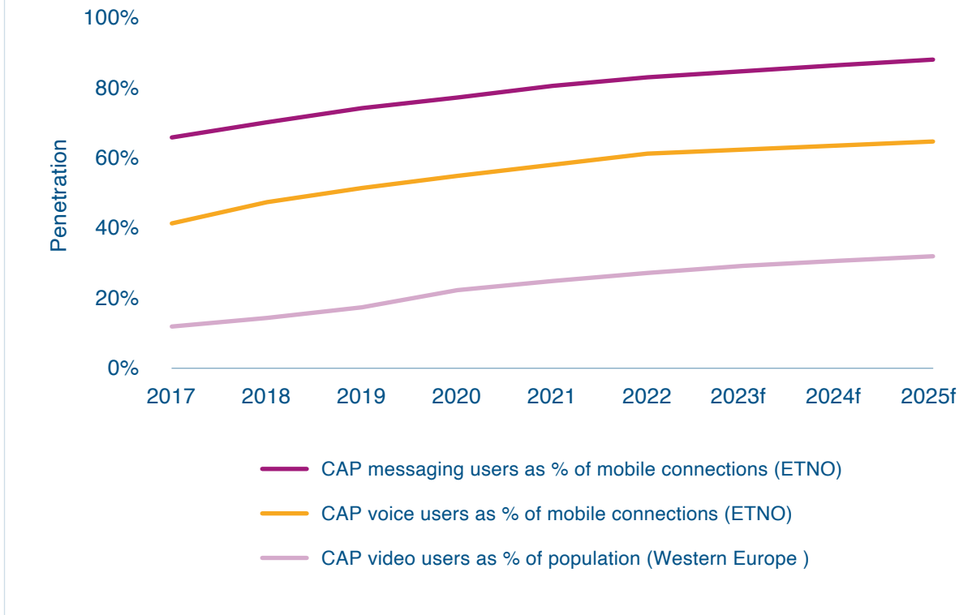
Operators are moving beyond connectivity-focused revenue. By developing their own digital services, they move into competition with very large international CAPs for some of those new services. Competing with these CAPS requires a shift in attitude to product and service creation from a risk-averse approach to a fast-fail approach.

Proficiency in software skills has become critical, not only because of competition from CAPs, but also because modern efficient networks demand them. Operators also need to rethink their cost models and adjust operating models to be more adaptable. This entails a shift from dependence on proprietary hardware to virtualised, open hardware within a cloud-native network. It also requires a rethink in relation to partnerships, with operators looking to multi-vendor partnerships to help them identify and respond to new customer needs.

B2C digital services: operators and CAPs

CAPs have already made the reverse move from the provision of internet content and applications into telecoms operators' core markets. They have successfully introduced voice and messaging products, with WhatsApp and Telegram being widely recognised examples. Most resell direct connectivity to business customers for their core cloud offerings. CAPs have enjoyed consistent usage growth in recent years, and service adoption is still on an upward trajectory (**FIG 2.11**).

FIG 2.11 : ***Penetration of CAPs' services, ETNO members and Western Europe, 2017–2026f***

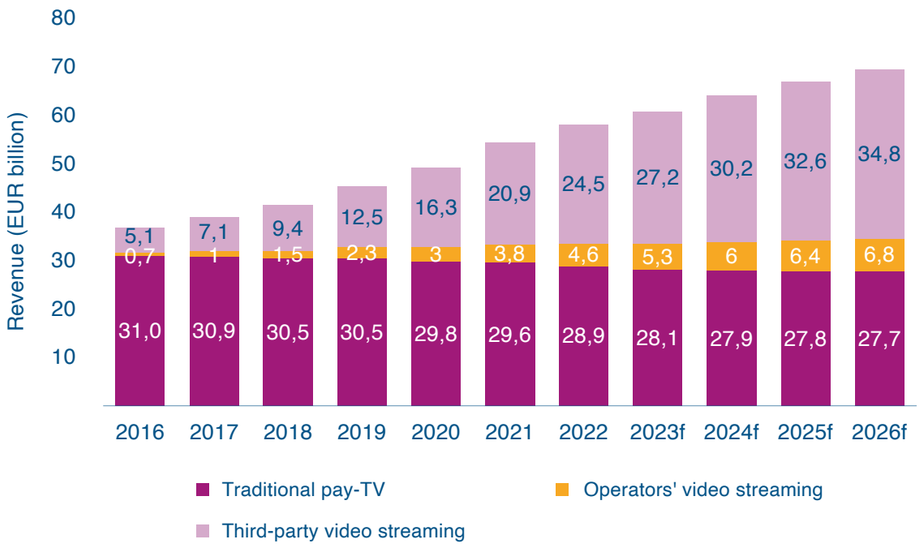


Source: Analysys Mason, 2023

Messaging apps continue to be the most common form of CAP consumer services; these apps were used in around 83% of mobile connections during 2022 with sustained penetration growth. Voice and video app adoption is rising but the growth rate is slowing.

In the B2C video market, traditional pay-TV is forecast to account for around half of the market share by the end of 2022 (**FIG 2.12**), but its share has been decreasing steadily for some time, having declined 29 percentage points over the previous five years. This decline will persist, with third-party streaming services expected to account for the largest part of the market by the end of 2024. Operators' video streaming services only hold a small market share, but revenues are projected to increase by 48% between 2022 and 2026.

FIG 2.12 : ***Revenue from traditional pay TV, operator video streaming and third-party video streaming services, Europe, 2016–2026f***



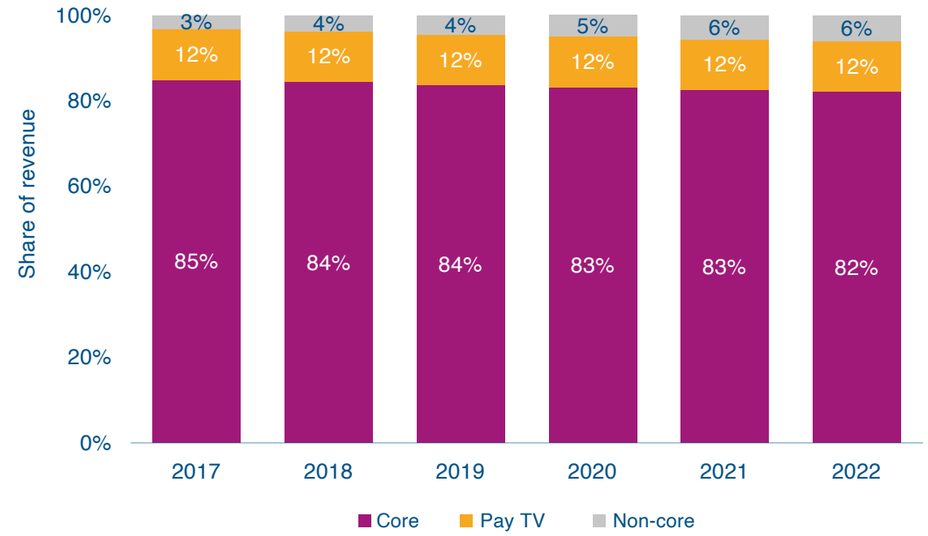
Source: Analysys Mason, 2023

Sporting content has traditionally been and remains a big driver of pay-TV subscriptions. The market looks like a good fit for operators, as sporting content broadcast rights and to a certain extent interest groups, follow national lines. Sports content needs to be delivered with a high level of quality to many users at the same time – a factor which also plays to operators' strengths. Operators have widely added sports services to their portfolios in recent years.

However, telecoms operators now face increasing competition from CAP giants for major sporting events, marking a significant shift in the TV market's competitive landscape. With the rising costs of sports rights, operators may be forced to rethink the strategies when bidding for rights and could be overtaken by well-funded CAPs. For instance, BT shares the rights to the UEFA Champions league (2024-2025) with Amazon, and Amazon holds the rights to stream a number of matches from the English Premier League in the UK. Meanwhile, BT underwent a carve-out process in 2022, with Warner Bros Discovery acquiring a 50% stake. BT Sport was subsequently rebranded as TNT Sports.

Pay-TV is a reliable and steady source of revenue for ETNO members; it has consistently comprised 12% of total revenue (**FIG 2.13**), despite the proliferation of third party streaming services. The majority of operators' revenue continues to come from core services (connectivity), although the share accounted for by core services declined from 85% to 82% between 2017 and 2022. Revenue from the non-core segment doubled in the same period.

FIG 2.13 : ***Breakdown of total revenue, ETNO members, Europe only, 2017–2022***



Source: Analysys Mason, 2023

Big data analytics

Data monetisation is the central component of hyperscale CAPs business models, but big data analytics is also an important component of what operators do. Operators have made substantial investments in big data platforms in the first instance to meet internal operational requirements. These platforms perform big data analysis to optimise customer engagement, subscriber experiences and network operations. Despite the well-established use of big data for internal purposes, attempts to achieve external data monetisation encounter challenges due to the stringent regulatory framework outlined in the ePrivacy Directive. This restricts the telecoms sector's ability to monetise data compared to the rules applicable to CAPs. As European operators have experience in selling aggregate and anonymised data while upholding data protection regulations, setting up a level playing field for telcos based on GDPR would allow enhanced innovation and the potential for additional revenue streams. Some examples of ETNO members' external data monetisation solutions, and the verticals they address, are shown in **FIG 2.14**.

FIG 2.14 : ***Examples of ETNO members' external data monetisation services in a range of verticals***

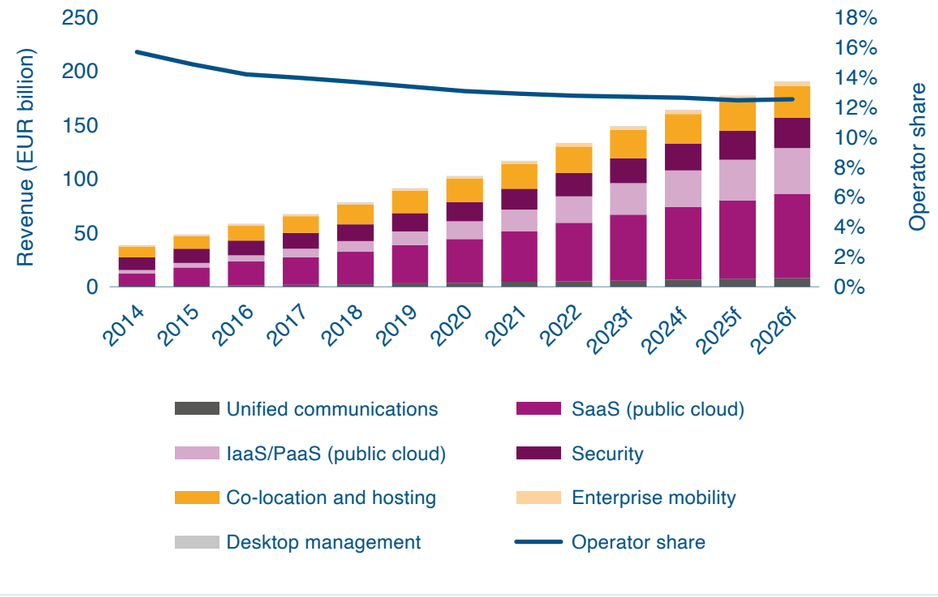
Sector	Applications	Operators (solution name)
Retail	Shopper behaviour, competitive intelligence, supply chain assurance and customer profiles	BT, Orange (Flux Vision), Telia Company (Crowd Insights), Swisscom (Mobility Insights) and Telefónica (Telefónica Tech)
Government	Smart cities, traffic monitoring, digital behaviour, mobility and disease surveillance	BT, Telenor (BDSG), Telia Company (Crowd Insights), Orange (Flux Vision) and TIM (TIM Urban Genius)
Transport	Traffic analysis, environmental monitoring, emissions surveillance and population flows	Orange (Flux Vision), Telia Company (Crowd Insights, Travel emission insights), BT and Swisscom (Mobility Insights)
Manufacturing	Smart factories, automation, remote robotics, supply chain monitoring, environmental surveillance and health and safety	Telia Company (IoT Platform), A1 Telekom (A1 Digital), Elisa (IndustrIQ), Deutsche Telekom (IoT Cloud), Telefónica Tech (digital twinning), TIM (Industrial IoTIM powered by Comau)

Source: Analysys Mason

B2B digital services

The market for B2B digital services is growing, and revenue from non-connectivity B2B services revenue is expected to increase from EUR134 billion in 2022 to EUR178 billion in 2025. SaaS represents the largest share of this (41% in 2026) and will grow in proportion to the overall market. Revenue from IaaS is the next largest segment, and its share will rise from 19% to 22% between 2022 and 2026). Security revenue is also rising, albeit with higher initial investments, but its relative proportion of non-connectivity-related spending decreased from 20% in 2018 to 16% in 2022. Cybersecurity is now a fundamental component of enterprise operations and has become integrated into various products and services (though not necessarily just those on offer from network operators). While this limits the necessity for separate security purchases, it does give the added benefit of increasing networks' resilience to cyber-attacks.

FIG 2.15 : ***Non-connectivity-related B2B services revenue and operators' market share, plus a data table for non-connectivity-related B2B services revenue, Europe, 2014–2026f***



Operator	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023f	2024f	2025f	2026f
Unified communications	0.9	1.3	1.7	2.2	2.7	3.3	4.0	4.7	5.4	6.0	6.8	7.5	8.1
SaaS (public cloud)	11.5	16.5	21.9	25.5	29.9	35.3	40.5	46.7	54.3	61.1	67.4	72.8	78.5
IaaS/PaaS (public cloud)	3.5	4.6	5.9	7.7	9.9	12.9	16.4	20.3	24.7	29.2	33.9	38.1	42.1
Security	11.8	13.0	13.7	14.6	15.7	17.1	18.2	19.5	21.3	23.2	25.1	26.7	28.4
Co-location and hosting	9.7	11.7	13.7	15.8	18.3	10.6	21.8	23.1	24.8	26.3	27.3	28.3	29.2
Enterprise mobility	0.8	1.0	1.1	1.3	1.5	1.7	1.9	2.2	2.6	3.1	3.5	3.8	4.0
Desktop management	0.1	0.2	0.2	0.2	0.3	0.3	0.4	0.4	0.4	0.4	0.5	0.5	0.5
Total (rounded)	**37.9**	**48.0**	**57.7**	**66.7**	**77.4**	**90.0**	**101.4**	**114.2**	**128.4**	**141.6**	**154.5**	**167.0**	**167.0**

Source: Analysys Mason, 2022

Operators are increasingly bundling core connectivity services with non-connectivity and ICT services with the aim of increasing 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).

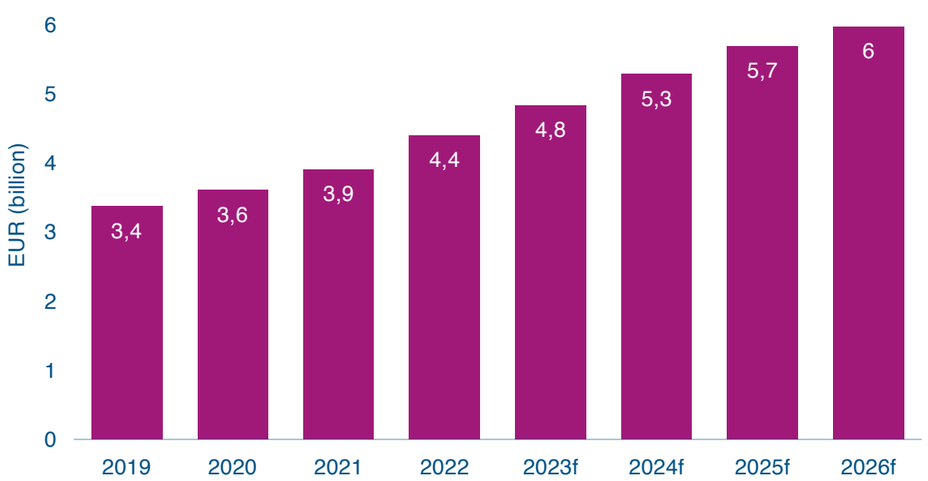
Despite this, operators' share of the enterprise ICT market is gradually declining, from 16% in 2014 to an estimated 13% by 2022. Although operators will sustain revenue growth in absolute terms due to the market's overall expansion, IT specialists, particularly those active in the SaaS market, will increase more rapidly. This increase in IT specialist revenue growth will reduce the operators' total market share.

Digital security services

Enterprises, citizens and government organisations are faced with a range of security threats, including those that are designed to disrupt operations; those that are designed to cause damage; steal industrial secrets or money; and those that seek to compromise their customers' security. They are also facing the need to provide increased protection for consumer data within the EU. As a result, there is increased demand for cyber security services.

Perceiving an opportunity, some operators have moved into the market, placing themselves into competition with cybersecurity specialists. They have also made a number of acquisitions of cyber security firms in recent years to improve their expertise in this area. Examples include Telefónica's purchase of cyber-resilience firm Govertis in 2020, Orange's acquisition of full-service cyber security company SCRT and Telsys SA in 2022 and BT's acquisition of a large stake in cyber-risk quantification firm Safe Security in 2021. One of operators' main competitive strengths in the market is their control of the networks that are used to propagate threats. Another is their relationship with very large numbers of potential customers. Operators have introduced a number of retail services that take advantage of these attributes including cryptography to secure communications, firewalls, and threat detection and mitigation for both enterprise customers and consumers. Forecasts suggest that total operator revenue from security services in Europe will reach EUR6 billion by 2026 up from EUR4.4 billion in 2022.

FIG 2.16 : *Operators' cybersecurity retail revenue, Europe, 2019–2026f*



Source: Analysys Mason, 2023

The Internet of Things

The Internet of Things (IoT) has long been viewed as a potential area of growth for operators. Companies in the automotive sector are leading the deployment of IoT connections in Europe. They are deploying sensors within vehicles to support remote maintenance and problem prediction / prevention, and within manufacturing plants to increase production efficiency. Organisations are also proactive in the property (smart buildings), utility (smart infrastructure), asset tracking and smart city markets. In the smart building market IoT devices can used to improve building management (for instance through improved security or energy, heating and cooling management). In the utility market connections can be added to meters to enable remote collection of data and management of services; and connected sensors can be added to energy generation and transmission infrastructures to enable more efficient management and maintenance of remote assets, and the energy grid as a whole. Asset tracking is used across sectors where expensive equipment or shipments of goods can be lost or stolen, or managed more effectively when their location is known. Smart cities include smart buildings, of course, but smart city concepts also involve the deployment of IoT systems to manage transport systems, security systems, and a range of public services, from lighting management to refuse collection.

FIG 2.17 : *Number of active IoT connections by vertical industry, Europe, 2022–2030f*

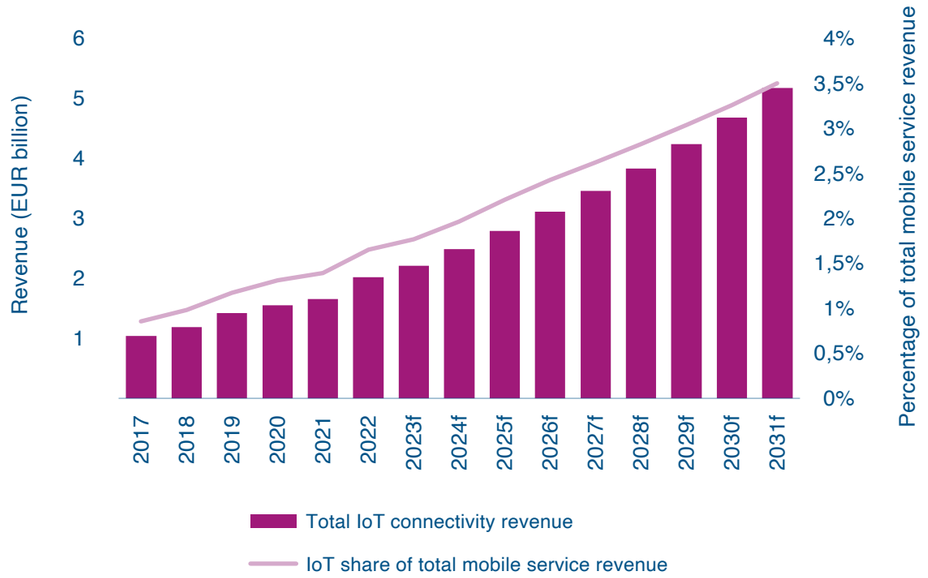
Vertical industry	2022	2025f	2028f	2031f
Agriculture	7.3	22.8	41.1	58.9
Automotive	90.6	138.0	197.3	254.6
Finance	0.1	0.1	0.1	0.1
Health	7.9	10.8	14.3	18.2
Industry	8.3	13.3	17.9	22.2
Retail	6.6	8.3	9.5	10.9
Smart buildings	19.9	45.7	87.4	144.0
Smart cities	17.9	38.6	57.9	72.5
Tracking	12.1	46.9	68.7	88.7
Utilities	43.7	79.3	106.7	125.5
Miscellaneous	28.6	35.3	41.6	46.7
Total	**252.0**	**439.1**	**642.7**	**843.5**

Source: Analysys Mason, 2022

The number of IoT connections in Europe is expected to increase at a CAGR of 46% between 2022 and 2031. The automotive industry will continue to account for the highest number of connections in the region, and in absolute terms the largest number of new connections. Other parts of the market with substantial growth rates in absolute terms will be the smart buildings and utilities sectors. Increases in the number of connections rebounded to pre-pandemic levels in 2022, with 23% year-on-year growth matching the growth rate seen in 2019. The three-year rebound period reflects the long-term nature of IoT connectivity contracts; typically there is a 12-18 month delay between signing a contract to the activation of devices and contracts last 5-10 years. Supply chain disruptions that acted as a barrier to growth during and after the pandemic are now easing.

Operators' IoT connectivity revenue is growing, and is projected to reach EUR5.1 billion by 2030 (**FIG 2.18**). IoT connectivity will account for 3.5% of operators' total mobile service revenue in 2031, marking an increase from 1.6% in 2022. However, connectivity tends to account for the minority of IoT revenue, with application and hardware generating additional value for operators who invest in the required expertise. Revenue is also growing more quickly in China than in Europe due to the increased availability of 5G, use of device management platforms, and a concerted national plan to digitalise public infrastructure and build vast smart cities; all three of the main Chinese operators reported IoT revenue growth of over 30% in 2022.

FIG 2.18 : *Operators' IoT connectivity revenue and the IoT share of mobile service revenue, Europe, 2017–2030f*



Source: Analysys Mason, 2023

How network providers can help to deliver a new digital future

In this section, we consider the future of European telecoms networks and how they can deliver long-term social and economic benefits in an environmentally sustainable manner.

03

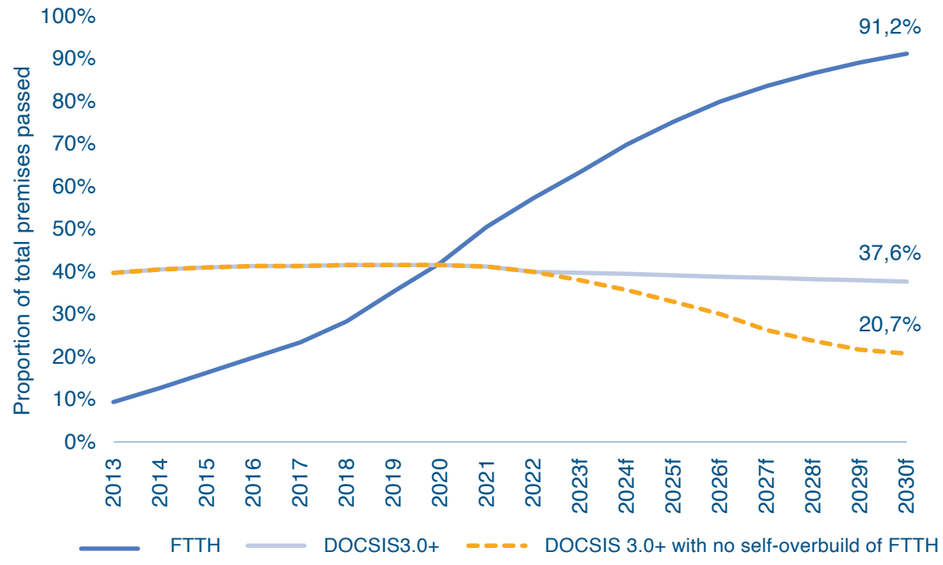
3-1 ENSURING EFFICIENT, FIT-FOR-PURPOSE NETWORKS FOR ALL

The EU Digital Decade infrastructure targets – universal gigabit and 5G coverage – are ambitious and exceed the ambitions of many other liberal economies. For example, the USA's universal broadband speed target is 100Mbit/s/20Mbits/s. Few other non-European advanced economy licensing authorities are demanding universal 5G coverage. But 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 91.2% of premises in Europe by the end of 2030 (**FIG 3.1**). This translates to approximately 256 million unique premises out of a projected 280 million in total. Taking the EU alone, the coverage figure is also 91.2%. The projection is now higher than we projected last year, but continues showing that there remains some way to go to achieve the "full gigabit" ambition in the EU Digital Decade targets. Some countries face strong capex headwinds in non-remote areas because there is an absence of ducting, or because of restrictive planning laws. Moreover, the risks of investment in FTTH are higher in those strong headwind countries where end-users have historically placed a greater reliance on mobile networks for basic connectivity.

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. Whether they do choose to do so or not depends to a large extent on the intensity of infrastructure competition in the market. 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.

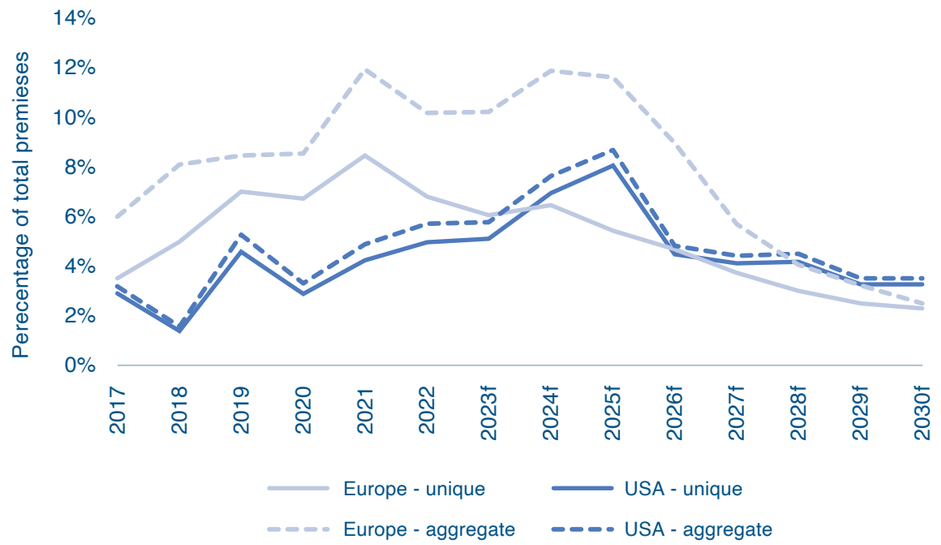
FIG 3.1 : ***Premises passed by FTTH and DOCSIS3.0+, Europe, 2013–2030f***



Source: Analysys Mason, 2023

European FTTH build is broadly similar to that of the USA in terms of additional unique premises passed per year, and projections suggest peak build in the USA is about 2 years later than in Europe. However, these figures disguise the higher level of overbuild in Europe encouraged by pro-infrastructure competition regulation as laid down in EU telecoms regulation: additional aggregate premises passed in Europe is substantially higher.

FIG 3.2 : *Additional unique premises passed and additional aggregate premises passed, Europe and the USA, 2017 – 2030f*

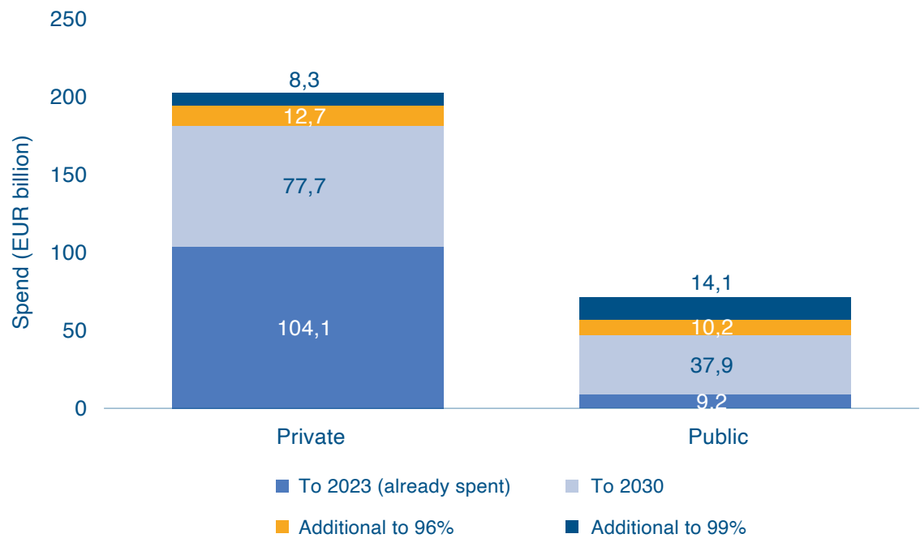


Source: Analysys Mason, 2023

The 256 million premises passed by FTTH 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, their viability, capex trends, competition levels and expected take-up levels. If true, it will leave approximately 24 million premises not served by an FTTH network.

FIG 3.3 shows a projection of the total costs to 2022, the costs out to the 91.2% projection, and the costs of coverage required to cover out to 96% and further out to 99% of premises with FTTH, with an estimate of what has already been and what would have to be covered by public money. The total capex excludes any overbuild so far and any projected overbuild.

FIG 3.3 : *Cost of deploying future FTTH networks by coverage bands, Europe*

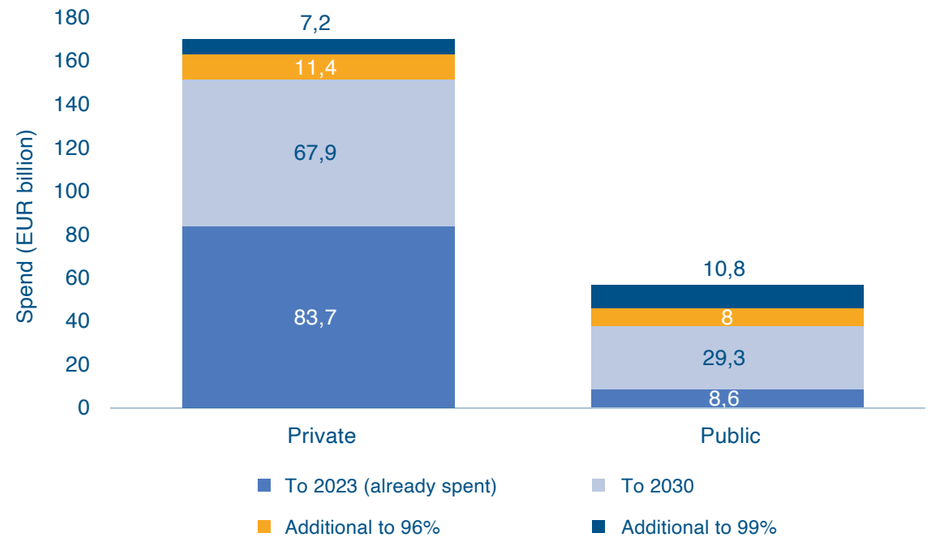


Source: Analysys Mason, 2023

For Europe as a whole, there is still EUR116 billion to be spent between the end of 2023 and the 91% FTTH coverage projection for 2030. The additional cost from that coverage to 99% will amount a further EUR45 billion, of which almost two thirds of which would have to come from the public purse.

For the EU27 alone, the additional cost to the very similar coverage projection (91%) by 2030 amounts to EUR97 billion and the additional cost to reach 99% is EUR37 billion.

FIG 3.4 : *Cost of deploying future FTTH networks by coverage bands, EU27*



Source: Analysys Mason, 2023

Other studies have reached similar conclusions about the funding needs of the Digital Decade fixed connectivity targets. For FTTH, the WIK-Consult's study, commissioned by the European Commission, puts the total at EUR114 billion, although this figure excludes some transport network costs associated with FTTH and the total could incur additional costs related to the mode of deployment.[22]

[22] WIK, Investment and funding needs for the Digital Decade connectivity targets, July 2023

3-2 5G NETWORKS AND SPECTRUM

The additional costs required to reach the Digital Decade targets for 5G, though lower than those for FTTH, are nonetheless very large. 5G coverage in the EU will be around 82% by the end of 2023. The WIK-Consult study estimates EUR33.5 billion is required for the provision of 'full 5G service' in the EU, with possible additional costs associated with transport networks to cell sites.

Radio spectrum is a key resource used by the telecoms industry and governments to deploy wireless networks, where users include mobile and fixed network operators, satellite operators, broadcasters, as well as a variety of specific enterprise and government sectors. With rapid evolution in wireless technologies and new models emerging for making use of spectrum on a shared basis, there are competing demands for spectrum. However, the less spectrum that is available to MNOs, the poorer (slower) the service. Mobile network usage continues to rise worldwide, but the intensity of usage is itself a consequence of underlying demand and supply-side factors including, importantly, the amount of spectrum that is available to MNOs and the timing and conditions under which it is assigned.

Regulators in most European countries have now assigned spectrum (via auctions in nearly all cases) in the 3.4–3.8GHz band (the most important band for 5G mobile), and many have assigned spectrum in the other two principal bands for 5G, 700MHz and mmWave. **FIG 3.5** shows the allocation of spectrum in the 5G bands as of October 2023.

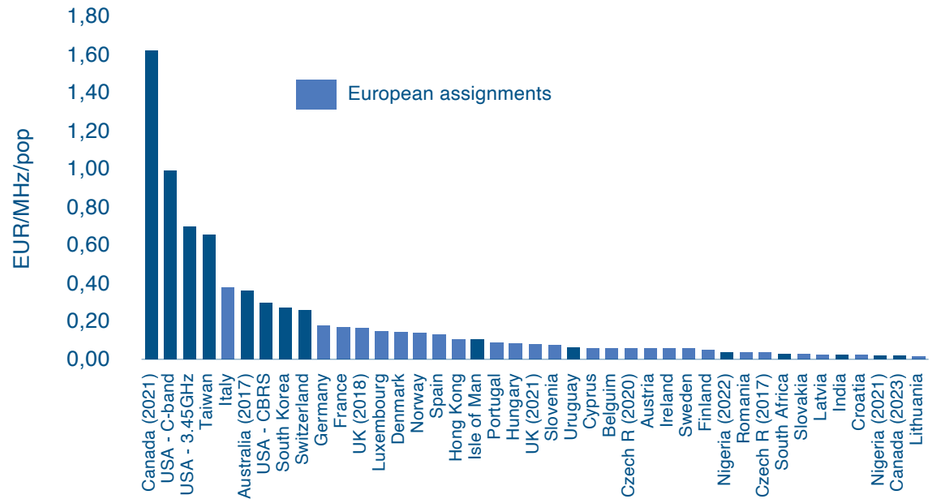
FIG 3.5 : ***Assignment of spectrum in the main 5G bands, Europe***

Country	Spectrum assigned in the 700MHz band (MHz)	Spectrum assigned in the 3.4–3.8GHz band (MHz)	Spectrum assigned in the mmWave band (MHz)
Albania	0	0	0
Austria	60	390	0
Belgium	60	370	0
Bosnia	0	0	0
Bulgaria	0	360	0
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+100 local	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	0	0
North Macedonia	0	0	0
Norway	60	400	0
Poland	0	400	0
Portugal	60 (10 unsold)	400	0
Romania	30	655 (85 unsold)	0
Serbia	0	0	0
Slovakia	60	390	0
Slovenia	75	380	1000
Spain	60 (15 unsold)	380	1800
Sweden	40	320+80 local	0
Switzerland	70	300	0
UK	80	400	0

The amount of spectrum assigned varies considerably between countries in Europe but there are only a handful of countries that are yet to assign spectrum in any of the bands. There are also major differences in the conditions of the licences in terms of coverage and roll-out speed. For example, for 3.4-3.8 GHz, these vary from effectively no coverage conditions in countries such as Finland, Sweden and the UK, to a very tightly defined set of conditions in Germany.

The prices paid for mid-band spectrum (3.4–3.8GHz) in Europe remains fairly low relative to the prices paid in Canada and the USA (though US licences are indefinitely renewable after an initial 15 years, thereby making direct comparison difficult). In general, the prices paid in Europe have varied greatly: the Italian auction in 2018, saw operators pay EUR0.378 per megahertz per member of the population (MHz/pop) the highest so far in Europe and over double the price paid per megahertz per member of the population in Germany (which was the second highest in Europe after Italy).

FIG 3.6 : ***Prices paid for spectrum in the 3.4–3.8GHz band, normalised to a 20-year duration, worldwide***

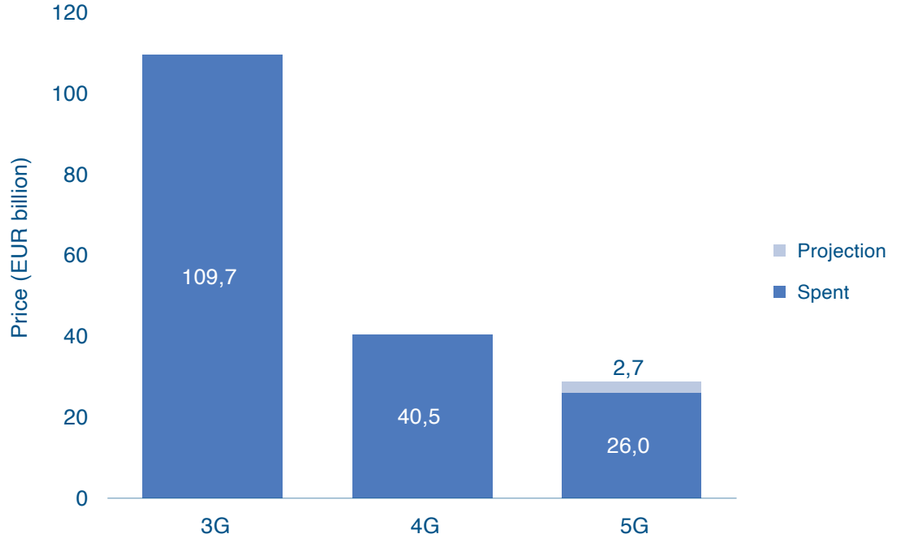


Source: Analysys Mason, 2023

The total sum raised in European 5G spectrum auctions so far is lower than for 4G and around a quarter of what was paid for 3G. Prices for 3G spectrum were exceptional and driven by factors that, in some cases, no longer apply. At the time, there were growing and profitable retail mobile markets that induced market entry.

> **Spectrum is expensive: European telcos have already spent €26bn in spectrum auctions and are expected to spend an extra €2.7bn**

FIG 3.7 : ***Total prices paid at auction for the main 3G, 4G and 5G licences, Europe, 2000–October 2023***



Source: Analysys Mason, 2023

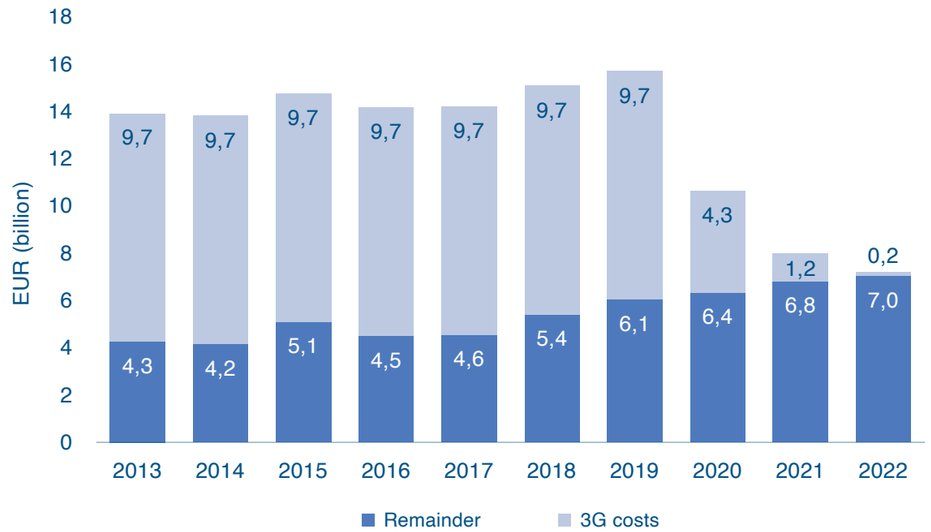
There is now only a handful of principal auctions for the 3.4GHz-3.8GHz band and for the 700MHz band left to conduct in Europe. While mmWave remains unassigned in many markets, the prices paid at auction worldwide for mmWave have fallen very sharply, and several mmWave lots have failed to find bidders. In South Korea, where in 2018 operators paid the second-highest price for mmWave per MHz/pop anywhere in the world, all three operators stopped investing in mmWave deployment on the grounds it had insufficient economic value, and they have consequently had to return their spectrum.

Spectrum costs consist principally of prices paid at sporadic auctions or paid at a fixed price to the state. On an annualised basis spectrum costs include:

- The annual cost of the spectrum amortised over the period of the licences
- Annual licence fees associated with those prices: often an administrative fee but occasionally a larger fee in lieu of prices paid
- Annual licence fees, based on a calculation of economic value, paid by licence holders to prolong the licence or to retain spectrum indefinitely after the original licence has expired. Such is the case in the UK with 900MHz, 1800MHz and 2100MHz spectrum, essentially the main 2G and 3G bands.

3G auctions held in the early 2000s commanded very high prices at auction, a result of some over-exuberance and of the need to secure spectrum in what was then a growing and competitive market. Many of these licences have expired over the past three years. Re-auctioning licences or imposing annual licence fees in lieu of auctions will not typically cost as much as the annualised cost of the original licences. **FIG 3.8** shows an estimate (with 6% discount rates applied) of the total spectrum burden for European mobile operators since 2013 with and without the impact (of very high priced) 2100 MHz awards (early 2000s).

FIG 3.8 : ***Annualised spectrum costs, European mobile operators, 2013-2022***



Source: Analysys Mason, 2023

While annualised costs have fallen, the EUR7.2 billion for 2022 still amounts to 6.6% of mobile revenue and is equivalent to 9.8% of opex. The overall trajectory of annualised licence costs is now trending upwards everywhere, and has been for several years in those markets where 2100MHz licences cost less, whereas mobile revenue remains flat or in decline. The assignment of spectrum via auctions is typically designed to maximise spectrum revenue for governments. In the context of declining real-terms revenue and of spectrum costs rising again, governments need to re-assess the wider societal costs and benefits of spectrum.

Future spectrum needs

The full 5G vision has long been about more than providing faster speeds and more capacity for generic mobile broadband. The promise is that 5G technology will also be used for industrial use cases and for private networks, and that it will thereby expand economies.

Regulators have evaluated the ways in which to ensure that spectrum regulation facilitates the use of 5G for these use-cases. Regulatory approaches range from spectrum being earmarked for B2B use or for private networks (as in Germany and Sweden, for example) to obligations being placed on MNO spectrum owners to support industrial requirements such as improved indoor or remote site coverage.

These two approaches tally with the two basic models for private networks:

- where the industrial network user deploys a private network using either dedicated local spectrum (where available) or unlicensed spectrum, and an operator or vendor potentially plays a role in building, integrating and managing the network
- where the industrial network user takes a configurable slice of an existing public network; this model can be deployed on 4G and 5G non-standalone networks via software upgrades, but it is an integral feature of future 5G standalone networks.

There is a role for operators in both private network models. Existing operators act as experienced network builders and integrators in the first model, without being traditional licensed operators. Virtualisation introduces new ways for new types of enterprise users to expand the geographical presence of their networks in the second model, without commissioning new physical network infrastructure; in other words, it offers considerable scope for capex avoidance.

These models can coexist under some circumstances, and the geographical coverage of the networks will define which approach works best to a great extent. Nevertheless, consideration must be given to whether the first model acts to the detriment of not only of the second, but also of more traditional mobile use. Setting aside spectrum for local use cases, in particular in bands harmonised for public mobile networks, where take-up by industries could be quite weak, reduces the resources for public mobile offers to the disadvantage of the customers. Furthermore it creates an induced scarcity which results in higher spectrum costs and finally has an impact on the quality of networks enjoyed by the majority of users.

3-3 AUTOMATION AND AI FOR LEANER AND MORE TARGETED OPERATIONS

Automation has been a strategic focus for operators for many years as they have sought to improve operational efficiency, reduce cost, and improve the quality and time to market for new services. In many cases, the first application of automation has been in customer service, with the increasing use of self-service mechanisms and chatbots. However, many operators see even greater benefits from extending automation to many areas of their operations, including the network and data centre, and the idea of the ‘ultra-lean’ or ‘zero-touch’ operator is gaining traction.

There are two overall goals in increasing automation of networks and operations. One is to improve efficiency, optimising the usage and allocation of key resources such as spectrum, network capacity and energy. The other is to improve quality of experience, notably predictability of performance, by automating the management and orchestration of networks and data centres from end to end. This predictability, in turn, enables new services that require unbroken connectivity and may be based on service level agreements. The introduction of 5G, and of cloud-based networks, will both accelerate automation strategies because of the large number of elements that need to be controlled and optimised, and the new types of services that operators hope to offer. For instance, network slicing relies on a highly automated platform that can orchestrate a diversity of network and cloud resources in response to a particular requirement, enabling the operator’s systems to configure connectivity in a highly targeted way for each user or application.

New enablers are emerging to support the drive for more extreme automation, and to expand automation to many areas of operations. An important one is AI/ML, which can be used to ensure that automation is intelligent, and that it is applied to predictive scenarios such as preventative maintenance, or dynamic switching of a user’s connection to the most robust link available.

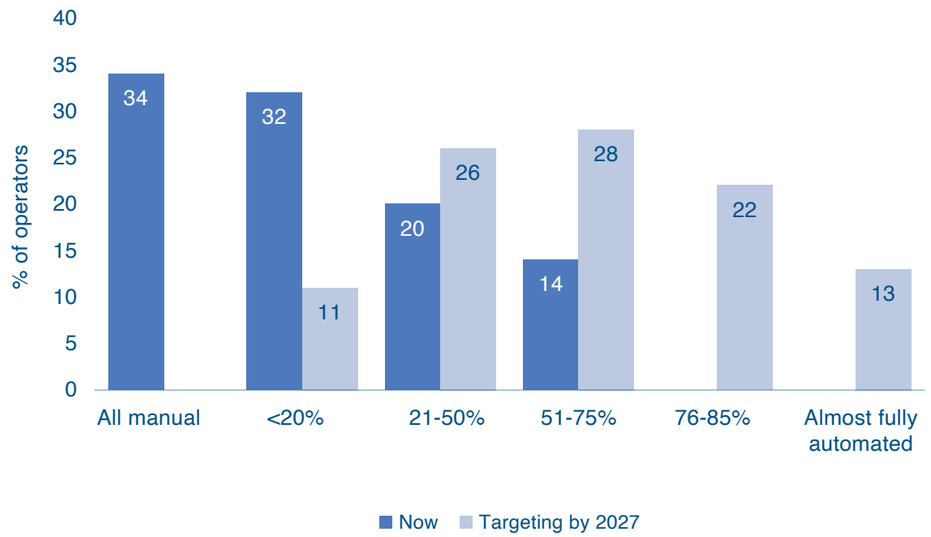
NFV and SDN are playing an important role in the ability of operators to increase automation, and the transition to cloud-native networks is also important in introducing some of the automation techniques that are familiar in the cloud world, to telecoms. These include CI/CD/CT pipelines for robust, automated integration, deployment and testing of new network functions. Such techniques will be essential for 5G and for emerging architectures such as Open RAN. For instance, extreme network automation is required when adopting open and disaggregated RAN to reduce the cost of integration across multi-vendor environments.

Examples of automation initiatives include:

- **Zero-touch CI/CD/CT frameworks** can result in significantly leaner operations that simplify deployment and change management in the network and so improve quality of experience. Telefónica Germany has implemented such a framework to support its cloud-native core and achieve agile response to changing network demands.
- **Automation of equipment installation and maintenance on towers using AI and drone inspections** can increase the reliability of services, reduce downtime and support predictive maintenance. Operators including BT and Orange have trialled such services, as have some towercos, claiming potential reduction in site visits and inspection costs of about 50%, with reduced outages.
- **Implementation of new functions and platforms in cloud-native environments.** For instance, Deutsche Telekom's next-generation IMS (NIMS) project in Germany was a radical implementation of an IMS for fixed-line voice services based on DevOps automation principles, which achieved a high level of operational automation.
- **Transition to 'dark network operations centres'** will be enabled by AI, according to exponents such as BT and Swisscom, which will use AI for network planning to reduce cost and increase accuracy.
- **Automation of traffic steering and allocation** to support differentiated quality of experience, and achieve optimal cost and energy efficiency through load balancing.
- **Automation of base station** waking and sleeping to reduce energy consumption.

Operators in Europe have ambitious goals for automation of their networks and operations. A survey conducted by Analysys Mason in 2022 found that 70% of operators had already started to automate their assurance and orchestration functions, and 20% had plans to start work within a year. In a different Analysys Mason survey, conducted in September 2023, plans for automation of the RAN, the costliest part of an operator's portfolio, were studied. **FIG 3.9** shows that while two-thirds of European respondents said that fewer than 20% of RAN functions were automated, by 2027, over 60% planned to have automated at least half their RAN. Most of the operators said that investing in AI/ML to enhance network automation would be an important enabler, as would the RAN Intelligent Controller in Open RANs.

FIG 3.9 : ***Degree of automation in the RAN in 2023, and targeted by 2027, by percentage of functions, European operators (28 respondents)***



Source: Analysys Mason, 2023]

3-4 MAKING NETWORKS GREENER AND MORE EFFICIENT

Globally, telecoms operators are facing economic and stakeholder pressure to reduce their carbon emissions. In response, many operators have already made commitments to significantly reduce their energy consumption and carbon emissions, as well as to support other industries in their efforts to tackling climate change. Initial strategies focused on decoupling energy consumption from greenhouse gas (GHG) emissions, but priorities are changing to focus on tackling the indirect emissions that are produced by upstream and downstream activities in the value chain (which typically make up to 80% of a telecoms operator's GHG emissions).

Energy consumption has historically not been a matter of great strategic concern for operators because energy costs amounted to about 2% of revenue and tended not to fluctuate greatly. However, a number of factors have led to a new focus on energy efficiency and the need to reduce energy consumption. These have included the need to reduce emissions to achieve sustainability targets, and geopolitical events that have put pressure on the global supply of natural gas, resulting in a significant increase in electricity prices.

The telecoms sector also offers digital services and technological solutions that contribute to the acceleration of the green transition of companies in all sectors, thereby helping them to reduce their environmental impact. Some of these solutions are considered in the enablement section below.

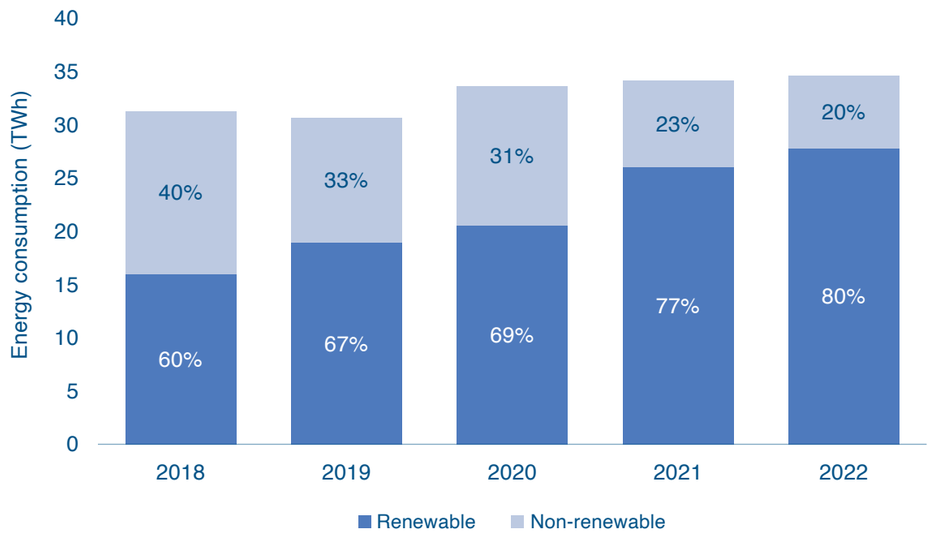
In this section, we analyse operators' ongoing efforts to minimise their own contribution to climate change, how they are optimising the networks to help their customers and suppliers to make a positive environmental impact, and how they are working towards lower energy consumption and lower energy costs in their own networks.

Decoupling greenhouse gas emissions from energy consumption

ETNO members continue to take significant steps to reduce their carbon emissions. The path to decarbonisation in the telecoms industry involves several steps but starts with the accurate measurement and reporting of emissions. Operators need to have a clear understanding of how much they are emitting and the sources of their emissions. They typically report emissions in alignment with The Greenhouse Gas Protocol standards which divide emissions into 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); and scope 3 (all other indirect emissions from an operator's value chain). While scope 3 emissions can make up to over 80% of an operator's total emissions, the reporting and measurement of scope 3 is significantly less consistent as obtaining reliable and granular data from suppliers and customers can be complex and costly. The major challenge for telecom operators in reporting scope 3 emissions is predominantly driven by a lack of supplier engagement downstream, but this is something most ETNO member are currently tackling as they strive to bring scope 3 emissions down to net zero.

At a group level, the total energy consumption of the ETNO members has stabilised over the last 2 years (after a small non-organic increase occurred in 2020 due to a major acquisition outside of Europe (**FIG 3.10**)). The proportion of energy coming from renewable sources continues to grow steadily, and now accounts for 80% of the total (an increase of 20% between 2018 and 2022).

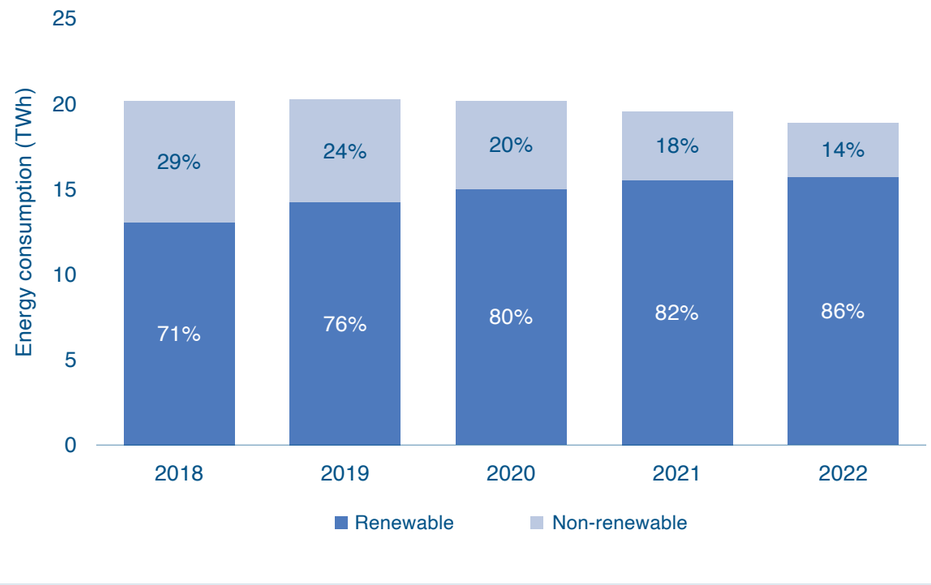
FIG 3.10 : ***Scope 1 and 2 energy consumption from renewable and non-renewable sources, ETNO members at the group level, 2018–2022***



Source: Operators, Analysys Mason, 2023

Energy usage of the ETNO members' European operations steadily fell between 2020 and 2022 and commitment to investing in renewable energy is growing. 86% of energy came from renewable sources in 2022 (calculated using the market definition of scope 2).[23]

FIG 3.11 : ***Scope 1 and 2 energy consumption from renewable and non-renewable sources, ETNO members, Europe only, 2018–2022***

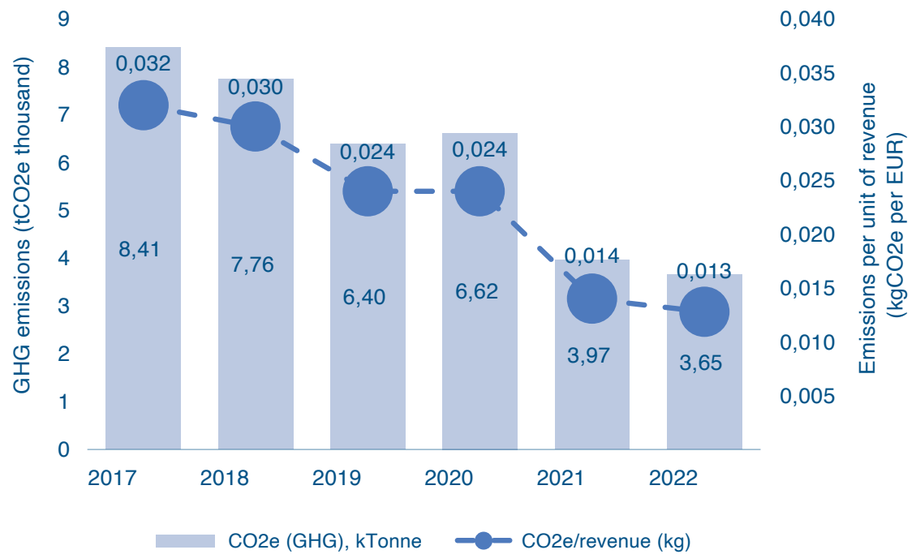


Source: Operators, Analysys Mason, 2023

[23] There are two different ways of defining scope 2 emissions: the location method and the market method. The location method involves only 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. Because of the greater level of granularity and the frequency with which operators have bespoke supply agreements, most operators use the market method for reporting their scope 2 emissions.

After a sharp decline in GHG emissions between 2020 and 2021 (a 40% decrease), the ETNO members' emissions dropped by a further 8% in 2022 (calculated using the market definition of scope 2). Emissions per unit of revenue fell to less than half of the 2017 value. This indicates that operators' strategies for increasing their use of renewables and pursuing energy efficiency is succeeding, despite increasing data usage.

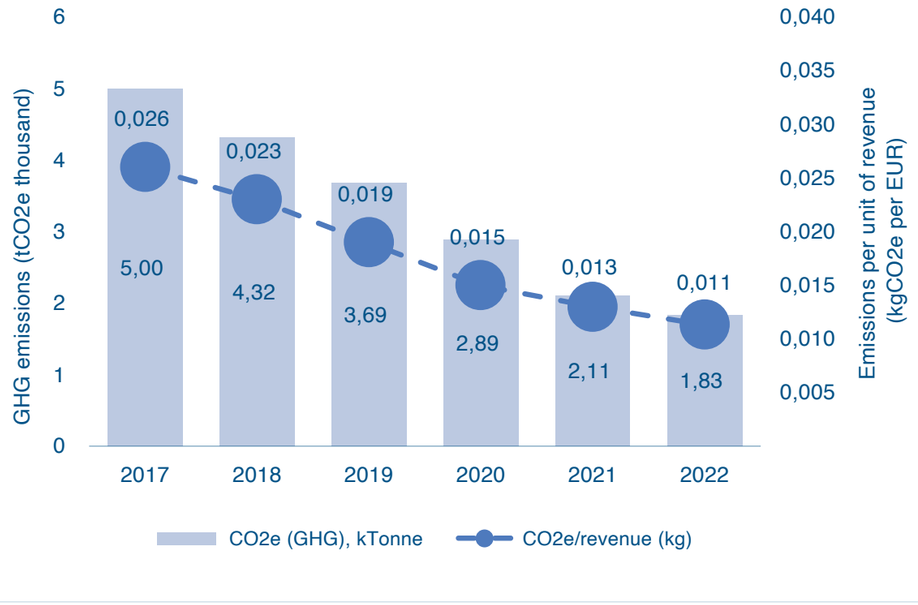
FIG 3.12 : ***Scope 1 and 2 GHG emissions and emissions per unit of revenue generated, ETNO members at the group level, 2017–2022***



Source: Operators, Analysys Mason, 2023

Operators' emissions within Europe have fallen consistently year-on-year. Additionally, the carbon intensity of revenue generated has followed a similar decline; in 2022 emissions per unit of revenue fell to less than half of the 2017 value.

FIG 3.13 : ***Scope 1 and 2 GHG emissions and emissions per unit of revenue generated, ETNO members, Europe only, 2017–2022***



Source: Operators, Analysys Mason, 2023

Fostering a sustainable economy in the telecoms industry

The vast majority of ETNO members have committed to reducing carbon emissions by setting net-zero targets, though the exact dates by which they aim to achieve net-zero varies. All ETNO members have announced net-zero scope 1 and 2 targets (this can include offsetting a portion of emissions), with some ambitious operators introducing targets as early as 2025 (**FIG 3.14**). In 2022 and 2023, some ETNO members also set net-zero target dates covering scope 3 emissions, typically aiming to achieve net-zero by around 2040. Achieving net zero for scope 3 will take much longer because the figures include emissions created upstream and downstream in the supply chain. Scope 3 is an all-encompassing definition of emissions, and reaching net zero under scope 3 requires working with multiple stakeholders across the value chain.

FIG 3.14 : ***Selected scope 1 and 2 and scope 3 emission reduction targets, ETNO members at the group level***

Operator	Target date for net-zero emissions (scope 1 and 2)	Target date for net-zero emissions (scope 3)
BT	2031	2041
Deutsche Telekom	2025	2040
KPN	2030	2040
Orange	2040	2040
TDC	2028	2030
Telefónica	2040	2040
Telenor	2030	2045
Telia Company	2030	2040
TIM Group	2030	2040

This table refers to net-zero targets as announced by companies and does not take into account if these targets 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

As mentioned previously, the ability to achieve net-zero scope 3 emissions will involve greater levels of engagement with equipment suppliers. For most operators, between 80-90% of scope 3 emissions are upstream in the supply chain. This means encouraging suppliers to address high-emitting activities; operators using their influence to promote more environmentally friendly and energy-efficient methods for manufacturing, transport and storage; as well as developing the use of circular economy principles in the supply chain.

Telia Company reinforces efforts to limit supply chain emissions

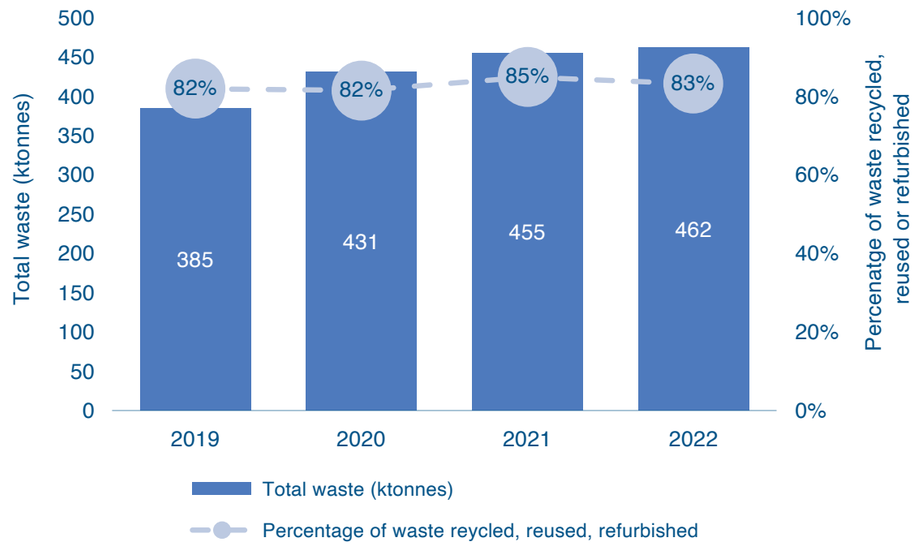
Telia Company has for several years been taking steps to increase efforts to limit its emissions by focusing on the global supply-chain that is responsible for more than 90% of its CO2 emissions. Telia Company encourages its suppliers to align their plans and activities with climate science. By June 2023, suppliers responsible for 45% of Telia Company's supply-chain emissions covering purchased goods and services and capital goods had, like Telia Company, set science-based targets. Its goal is for this figure to reach 72% by 2025.

Telia Company is engaging with suppliers in various ways, ranging from top-level management meetings to calls to action issued during the successive COP global climate summits. Telia Company is also collaborating with 26 other telecoms operators (including other ETNO members) through the Joint Alliance for Corporate Social Responsibility (JAC) initiative, an association tackling, along with other ESG issues, sustainability standards in the supply chain, including the journey towards net zero. The company is also active in the Exponential Roadmap Initiative – a cross-sector collaboration to scale initiatives to halve greenhouse gas emissions by 2030, including the work in global supply chains.

When selecting suppliers, Telia Company also undertakes a supplier sustainability risk assessment, including due diligence and audits. The objective of the due diligence process is to ensure that Telia Company only engages with suppliers that meet its sustainability standards.

Striving to ensure compatibility with a circular economy is a growing focal point of operators' environmental strategy. The circular economy refers to a model of economic activity in which there is no linear movement from raw materials to waste, but instead, the maximum effort is made at every level of the value chain to reuse and recycle, and thereby to reduce the volume of materials and resources required. Many operators now report on circular economy metrics such as total waste generation and total waste that is either recycled, reused or sent to landfill, at a group level.

FIG 3.15 : ***Total waste generated, and percentage of waste recycled, reused, or refurbished, ETNO members, group level, 2019–2022***



Source: Operators, Analysys Mason, 2023

Waste, particularly e-waste, has traditionally been a challenge for the telecoms industry. E-waste refers to electronic refuse (principally mobile phones, computers and tablets), which is difficult to recycle and reuse. The amount of e-waste produced globally is expected to rise by 27% between 2022 and 2030. Many operators have started to adopt a range of measures to help curb the growth of e-waste. This includes promoting sustainable products by working with credible equipment vendors to develop green smartphones; encouraging customers to hand in their old devices, which can either be refurbished, recycled, or resold; and helping consumers to factor sustainability into their mobile device purchases by labelling their devices according to environmental impact (using the Eco Rating labelling system[24]). Many ETNO members are already actively participating in these activities. For example, Proximus has established a refurbishment distribution centre and between 2014 and 2021, it refurbished around 2.85 million devices. Customers are also incentivised to hand in old devices where they gain a EUR10 voucher on top of their trade-in value.

[24] Eco Rating | evaluating environmental impact of smartphones (ecoratingdevices.com)

Many operators also refer to the resource hierarchy as a key guideline for reducing waste production. The hierarchy puts 'rethinking' at the top and ends in 'refuse'. Operators can implement new design principles to stop waste from occurring as part of the rethinking process and can then focus on ensuring that the waste that is generated is disposed of as responsibly as possible. Recycling and extending the life of advanced network equipment is an expensive and complex process, and governmental and EU support is essential to make it economically and environmentally efficient. This is the purpose of the programme OSCAR (Orange Sustainable and Circular Ambition for Recertification) launched by Orange to incentivise recycling of network equipment. Its goal is to put the circular economy at the heart of its infrastructure networks, and to encourage its partners, including vendors, to climb aboard.

Reducing energy consumption and investing in renewable energy supply

Improving energy management and achieving energy savings are clear priorities for operators. The surge in energy costs globally, and in particularly in Europe, has brought power consumption to the top of operators' agendas. Several ETNO members have reported that additional savings must be made (for instance by making job cuts) to help tackle soaring inflation and energy bills.

For a mobile operator, energy costs account for up to 7% of their operational expenditure (opex) and depending on the type of network they run, CSPs can spend from 3% to 20% of their total revenue on energy bills. The mobile radio access networks (RANs) account for a large part of their energy costs and for over half of their energy consumption (70% in a typical 5G macro network). In the current climate, pressure is further intensified by the increase in energy prices. Even if an operator can keep its energy consumption flat, costs will still be increasing.

The deployment of 5G networks is another factor that is encouraging operators to prioritise energy consumption and management. While 5G New Radio (NR) was designed to greatly improve energy efficiency compared to previous generations of mobile technologies, rising numbers of cell sites and antenna elements compared to 4G means that energy usage can increase significantly. Furthermore, because mass adoption of 5G is ongoing and the number of 5G subscriptions is still a small percentage of all mobile subscriptions, the connectivity and bandwidth of the network are not used to their full extent and the energy used to power 5G networks is partly wasted. Therefore, adding 5G without mitigation steps can add significantly to energy usage. Operators and vendors are highly aware of this issue and there have been several developments aimed at reducing the energy burden (such as 5G deep sleep mode).

There are plenty of ways to minimise the additional energy usage of 5G networks in mobile networks and this can include adopting new energy management solutions. Measures to reduce energy consumption can be taken in all elements of the network, but some will have a greater impact than others. The core accounts for only 8% of the total energy consumption in a 5G network (excluding transport), and most of the RAN's energy (83%) is used by the cell site equipment rather than the digital baseband. A large amount of power in the network is wasted in operating cooling systems (55%), running idling equipment and in powering amplifiers.

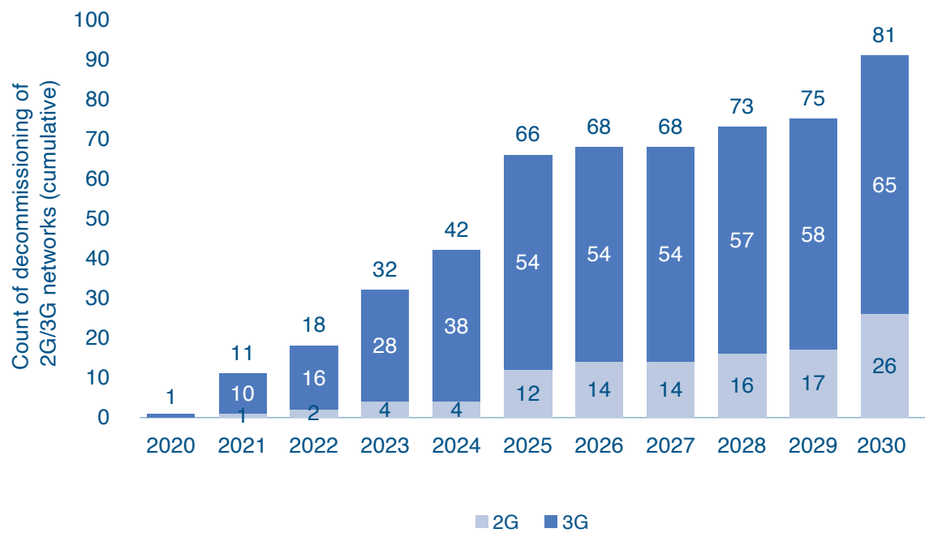
Many equipment manufacturers and operators are working on architectural and network transformations, including network modernisation and the introduction of intelligent power-savings features, some in more efficient usage of networks assets and some in alternative ways of sourcing of energy. In the short term, many operators are using intelligent power-saving features and novel software upgrades to improve network efficiency. The aim of these approaches is to align power consumption more closely with real-time usage; 'smart sleep' functions that power down equipment during periods of low traffic and intelligent changes in power supply to more efficient energy sources during peak traffic hours are good examples of this.

Decommissioning legacy networks

Although improving network energy efficiency is a vital step in an operators' sustainability roadmap, the decommissioning of legacy fixed (PSTN copper, local exchanges, FTTC and HFC) and legacy mobile (2G and 3G) networks is one of the biggest steps that most operators can take to reduce their energy usage. For example, decommissioning copper and the active equipment that uses copper can provide significant reductions in operators' energy usage. Indeed, an FTTH line uses at least 80% less energy than a copper line. Decommissioning 2G and 3G and moving to 4G/5G Single RAN deployment also provides significant reductions in energy usage. Many ETNO members have already been decommissioning or are actively planning to decommission network assets to support energy reductions. Operators yet to initiate network decommissioning processes should start to do so, as the process for decommissioning can be slow, particularly for fixed networks. There are considerations that may complicate the process including competition regulation, consumer protection regulation and the need to accommodate critical services.

Most operators plan to decommission their 3G networks before their 2G networks, particularly in Europe, where 2G shutdown plans extend out to 2033. Operators continue to leave 2G networks running because they are often critical for legacy voice messages and IoT and M2M technologies that require low data rates. 3G networks are often replaced by 4G and 5G (due to becoming increasingly obsolescent and expensive to run) and it is expected that 54 3G networks will be decommissioned in Europe by the end of 2025 (**FIG 3.16**).

FIG 3.16 : ***Cumulative number of decommissioned 2G and 3G networks, Europe, 2020–2030 and after***



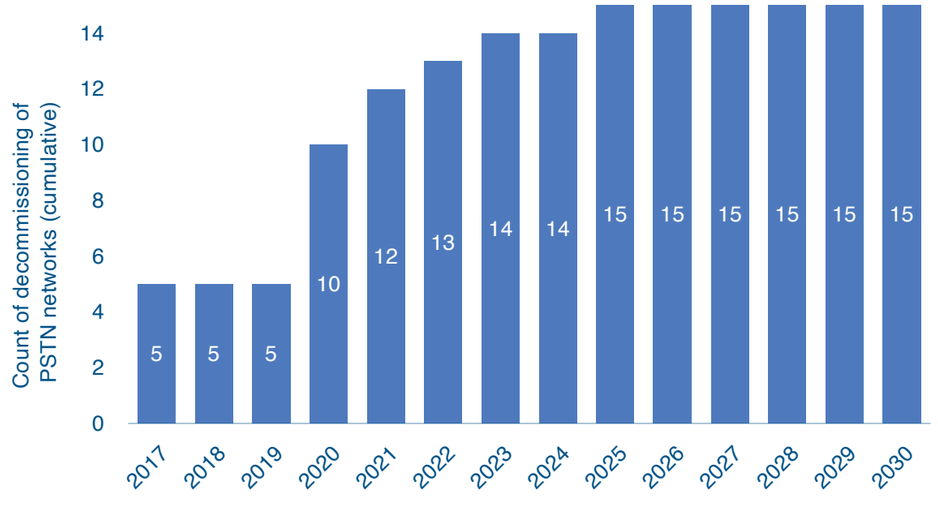
Source: Analysys Mason, 2023

Research suggests that MNOs maintaining a full suite of 2G, 3G, 4G and 5G services via separate base stations could lower their mobile network energy consumption by up to 40% if they switch off both 2G and 3G.[25] ETNO members that are planning to shut off their 3G networks are expected to complete this process by the end of 2028.

However, upgrading to FTTH and decommissioning copper networks and copper-based technologies could have a more profound impact on energy consumption than any remedy in the RAN. To decommission a legacy fixed network, operators must switch off (in roughly this order) PSTN/ISDN, exchange-based copper services, exchange facilities and all cabinet-based copper services (FTTC).

The use of fixed voice services is declining, and several operators have already migrated from PSTN to cheaper VoIP technologies. Indeed, all Deutsche Telekom's European subsidiaries have done so, as has A1 Telekom Austria. A PSTN switch-off is not conditional on copper decommissioning, but copper decommissioning requires a PSTN switch-off. Hence, most decommissioning efforts have initially focused on PSTNs. This in itself can reduce energy consumption by up to 10%. Decommissioning copper networks typically involves shutting down exchanges, which FTTH requires (generally 80%) fewer of. A fully modernised fixed access network would therefore account for under 10% of an integrated operator's energy usage. Moreover, new FTTH roll-out technologies and engineering techniques, such as shallow trenching (slot-cutting) and using existing aerial infrastructure (poles), could drastically reduce the carbon impact of the construction itself. However, these benefits will only be realised with the right policies.

FIG 3.17 : ***Cumulative number of decommissioned PSTNs, Europe, 2017–2030***



Source: Analysys Mason, 2023

[25] For more information, see Analysys Mason's *Decommissioning legacy networks will be key to reducing operators' energy usage*.

In the first quarter of 2023 Telenor became the first operator ETNO member to shut down its copper network actives (although in principle copper LLU will be maintained until early 2025). Telenor reported that decommissioning of the copper network in Norway saves it 14GWh of electricity consumption per year. Telefónica and Telia Company will be the next to shut down their copper networks in 2024 and 2026, respectively. Most other operators are aiming for a complete shut-off before or by the early 2030s.

FIG 3.18 : *Selected actual or planned confirmed copper shutdown dates, Europe*

Operator	Country	Year
Telenor	Norway	2023
Telefónica	Spain	2024
Telia Company	Sweden	2026
Altice Portugal (MEO)	Portugal	2028
Swisscom	Switzerland	2030
Slovak Telekom	Slovakia	2030
Orange	France	2030

Source: Analysys Mason, 2023

Hedging against energy price hikes while investing in renewables

Smart energy solutions will have a limited impact on overall energy consumption, and decommissioning takes time. Therefore, operators must think holistically and must examine opportunities to diversify their energy supply – especially domestically produced green energy solutions – to help protect themselves from rising and uncertain energy prices. While many operators have been examining opportunities to improve their environmental credentials and secure energy supply for several years, the urgency imposed by current climate circumstances offers a catalysing opportunity: policy makers are reducing barriers to adoption for green energy and demand for green energy technologies is driving innovation and price reductions. A number of operators in Europe have quickly committed to renewable energy use and have been early joiners to initiatives such as RE100[26].

Operators can choose from a range of renewable energy investment options including green energy tariffs, self-generations methods and power purchase agreements (PPA). Some ETNO members including Deutsche Telekom and BT (who have achieved significant decreases in scope 2 emissions (market-based definition) over the last few years) have signed more long-term PPAs and have increased their investment in self-generation methods.

Self-generation methods such as on-site solar cells or wind turbines can guarantee an energy supply in times of crisis. Generating energy on-site can also provide an opportunity to sell excess energy into the grid at times when local production exceeds demand and local storage capacity. That way 'energy consumers' can transform into producers and consumers. However, unless operators truly diversify into the business of power generation itself, self-generation is only likely to contribute a small proportion of an operator's total energy use. For example, TIM is building new photovoltaic plants with an installed power of around 10MWp (megawatts-peak). This is expected to meet 0.8% of its total energy consumption requirement.

[26] RE100 is corporate renewable electricity initiative, with over 400 of the world's most influential businesses each committed to procure 100% renewable energy. About us | RE100 (there100.org).

PPAs are an important renewable energy investment model for securing large energy supplies. PPAs are long-term contracts (usually 10–20 years) taken out by operators with energy suppliers. PPAs guarantee a more stable price for operators. They also facilitate the construction of energy-generating capacity by providing lenders with security and guaranteeing suppliers a stable price for their energy over the period of the contract. Operators partner directly with energy producers (rather than local utility companies), which allows for certainty of sourcing. The EU sees PPAs as one of the pillars of a reformed electricity market and is supporting the adoption of PPAs to encourage development of renewable projects throughout the continent.

Operators that are moving to make their networks dependent on renewable technologies are helping to fund a virtuous circle in which electricity generators have a better return on renewables and so maintain a higher level of investment and innovation.

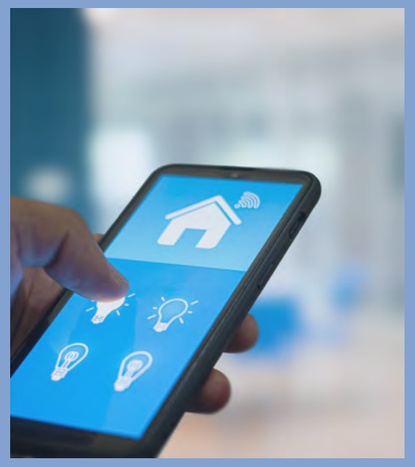
> **A successful transition to 5G and fibre requires the shutdown of older 2G/3G as well as of copper networks**

3-5 TELECOMS ROLE IN REDUCING GHG EMISSIONS IN OTHER VERTICALS

Telecoms operators can have an impact on their customers' GHG emissions through the solutions and services they provide. According to the Global e-sustainability initiative (GeSI), the telecoms industry (as well as the wider ICT industry) has the potential to enable 20% reductions in global GHG emissions by 2030[27]. Some operators use 'enablement factors' to measure how communications may offset the negative impact of each kilowatt hour of energy used or tonne of carbon dioxide from the communications user. Reducing or eliminating the use of transport and logistics by implementing remote communications is the clearest enablement use case; others include smart city, buildings, and metering solutions.

Example A: smart lighting

The Smart Lighting solution provided by Deutsche Telekom enables cities to manage resources efficiently by controlling their street lighting infrastructure. The solution involves deployment of a central, cloud-based lighting management application; and associated intelligent hardware that is installed in or in the immediate vicinity of the lighting fixtures. This enables the creation of a dynamic street lighting system that can manage the start and stop times of lighting cycles, define area-based brightness controls and situation-based event lighting. Retrofitting lights results in potential energy cost savings of up to 70%, and collected data can be used for research purposes.



Example B: smart energy storage

Elisa's Distributed Energy Storage (DES) project uses lithium-ion batteries and AI/ML to provide a clean, cost efficient and green energy solution capable of serving both telecommunications networks and electricity grid operators. The solution enables two key outcomes: real time load-shifting that automatically adjusts electricity consumption from the grid during different periods of the day and market participation that allows the sale of power back to the grid at times of need. Based on trials in Estonia and Finland, Elisa has calculated that the returns from the deployment of DES can represent more than 50% of a company's electricity costs.

Example C: data centre cooling and heat recycling

Telia Company's smart cooling solution Green Room concept reuses the large amounts of heat generated by servers and other IT equipment in data centres to heat nearby buildings. The solution also helps to cool data centres in a more energy efficient way. This concept was implemented in the Fredhäll university campus in Stockholm which uses recycled heat from Telia Company's nearby data centre to cover almost all of the campus' heating needs. The campus then recycles the excess heat with the help of heat pump. By replacing regular district heating, the setup enables reductions of several hundred tons of carbon emissions per year.

Example D: smart agriculture

TIM Italy has partnered with Tecnoalimenti, the Scientific and Technological Research Organisation that develops industrial projects for the agri-food sector, and Rurall, the technology platform that supports the sector's digital and ecological transition by using IoT sensors to collect data on farming activities such as milking processes and machinery to improve the productivity of the agricultural industry. All supply chain data is managed on one platform, using TIM's blockchain technology to notarise the data collected by the sensors, ensuing compliance with production standards and allowing farmers to track the origin of produce. This increases transparency on food production processes allowing customer to make more informed product choices.

[27] For more information see the GeSI's SMARTer2030 report: GeSI SMARTer2030.

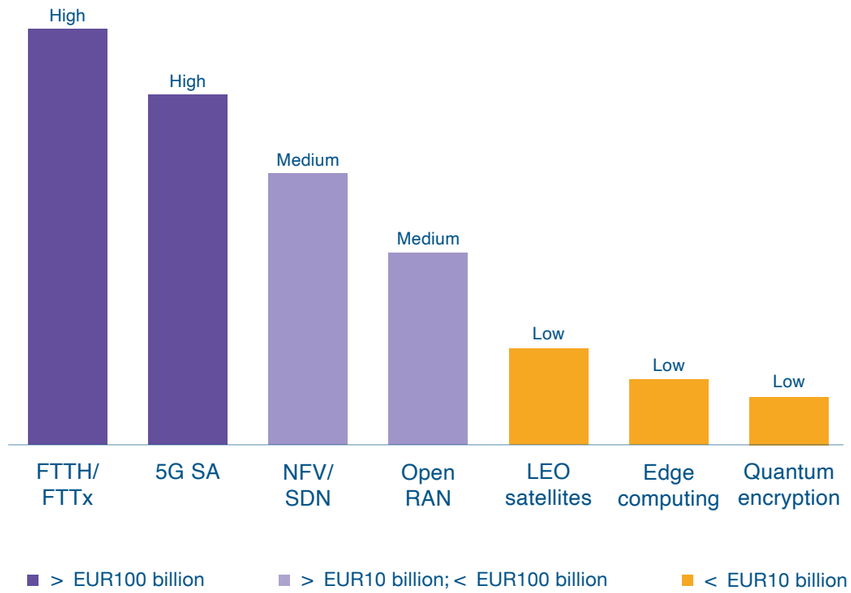
ETNO members play a key role in determining the pace of European technology innovation

Alongside the creation of the digital single market and effective regulation, heavy investment by ETNO members will be critical for ensuring rapid European innovation.

04

Investment of the order of several hundred billion Euros will be required in fundamental underpinning technologies, including extensive investment in FTTH and 5G networks (see **FIG 4.1**). The EU's Digital Single Market, which envisages digitalisation-driven innovation across industry and public services cannot be realised without this investment. Innovation also relies on telecoms operators to turn their networks into platforms for innovation by embracing cloud native architectures, adaptive business processes, high levels of automation, programmability, and the development of new network-as-a-service applications. These changes will also require extensive investment in new skills, and operators will also have to improve the energy efficiency and sustainability of their own operations, and those of their customers.

FIG 4.1 : ***High level assessment of investment requirements for European telecom operators, per technology trends (2023-2030)***



Scales are illustrative only and are not indicative of actual point estimates.

Source: Deloitte Consulting and Advisory[28] commissioned by ETNO, 2023

The following sections explore developments in a number of these areas.

[28] For more detail about the methodology see: https://etno.eu/news/all-news/778-future-connectivity-new-study-finds-radical-change-is-coming-and-highlights-investment-challenge.html

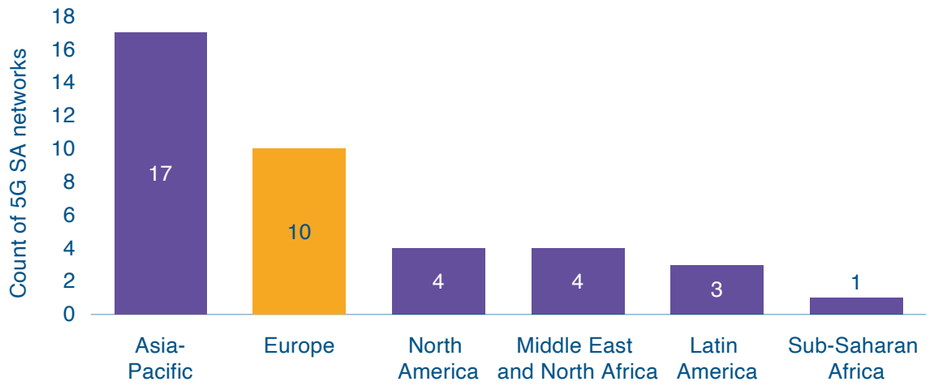
4-1 5G STANDALONE NETWORKS AND THE ROLE OF SLICING

There were about 140 commercial public networks supporting 5G in Europe as of August 2023, 93% of them running in non-standalone (NSA) mode. This mode continues to use the 4G packet core, whereas 5G standalone requires a new 5G or 4G/5G core.

While 5G NSA enhances the speed and quality of mobile broadband services, because it has larger spectrum allowances and wider channels than 4G, the SA core is needed to enable significantly new services and user experiences. The new core will be needed to leverage the next-generation capabilities that are being added to 5G in upcoming standards releases, which are collectively called 5G-Advanced. These include improved latencies and ultra-precise positioning, which could support various industrial control use cases; new IoT capabilities including 5G RedCap (a reduced capacity option for very simple devices); embedded AI/ML; and enhanced support for extended reality and other advanced user experiences.

Such capabilities can support business-critical applications that would help operators to expand their enterprise business and launch premium services, thereby greatly improving the 5G revenue model. However, progress towards SA has been slow globally. In Europe, only 10 5G networks are running with SA technology across a significant portion of the footprint[29] (see **FIG 4.2**).

FIG 4.2 : *5G SA commercial networks by geography, 3Q 2022*



Source: Analysys Mason, 2023

[29] https://www.analysysmason.com/research/content/data-set/5g-deployment-tracker-rma18/

This does demonstrate a slight quickening of the pace of deployment – a year ago, there were only four at-scale 5G SA networks in Europe, and that number was up by just one on 2021. We expect the pace of SA roll-out to accelerate significantly in 2024. Some operators do not foresee the need to implement SA in the current generation of 5G, especially if they do not plan to expand their enterprise business. But in a recent survey of European operators, 70% of those planning to adopt SA said they would start the roll-out before the end of 2025.

However, the low availability of SA in 2023 has restricted the variety of new services and user experiences that operators can offer, and that reduces their potential to monetise the networks in novel ways in order to increase overall revenue. That, in turn, can impact on national and regional goals for achieving 5G-enabled digitalisation.

One of the most important capabilities of the 5G core, in terms of its potential to support new experiences and revenue streams, is network slicing. This enables a portion of the network to be virtually separated from the rest and provisioned with specific capabilities to suit a particular application, industry or user group. For instance, operators have trialled slices that are dedicated to vehicular (V2X) or industrial control applications, which are configured to support far more demanding latency and reliability levels than a standard mobile broadband network.

Some early applications of slicing include the separation of fixed wireless access (FWA) traffic to ensure that high usage levels in FWA do not degrade the mobile experience. This is a relatively static form of slicing and does not require 5G SA, but the 5G core enables dynamic slicing in which the capacity and capabilities of a slice change in response to alternations in traffic or user requirement. Deutsche Telekom recently conducted a trial, with multiple vendor partners, of a dynamic 5G slicing platform that would provide flexible 5G services on-demand to enterprises. Another example is Orange, which has trialled the use of slices to support hybrid public/private networks in environments such as container ports.

However, while most operators that plan to deploy 5G SA in 2024-2025 cite slicing as a potential benefit, there needs to be significantly more clarity on how slices can be monetised effectively, before many MNOs will deploy at scale.

4-2 OPEN GATEWAY AND NETWORK-AS-A-SERVICE

The GSMA-led Open Gateway initiative was formally launched in February 2023. Open Gateway is a framework of common network Application Programmable Interfaces (APIs) designed to provide universal access to operator networks for developers. By offering up common APIs, Open Gateway transforms telecoms networks into developer-ready platforms, unlocking the full range of capabilities that mobile and fixed/Wi-Fi networks offer. The initiative is important in three key respects:

- It exposes an increasingly wide range of network capabilities to developers and industry verticals. These include APIs for device location/status, payment, identity and connectivity. In particular, it exposes the network-as-a-service capabilities of 5G SA. For example, a provider of an online gaming service could make use of an API that would detect if the network provides a sufficient quality (bandwidth and latency) to support its service and trigger a boost, ensuring a smooth experience for the end-user.

- It is a multi-operator collaboration in defining, as well as in pricing, APIs for developers, meaning that developers are not restricted to working with individual national networks, and that network operators have sufficient scale to reach a critical mass whereby they can monetise their network investments effectively. As of October 2023, Open Gateway had as members operating groups representing an estimated 60% of global mobile connections, including the following ETNO members: BT, Deutsche Telekom, KPN, Orange, Swisscom, Telefónica, Telenor and TIM.

- For the European telecoms sector it is of particular importance because it is a clear enabler of pan-European digital service provision.

4-3 OPEN RAN

Open RAN has attracted significant interest from operators around the world because it defines standard interfaces between different elements of the network, enabling equipment, cloud infrastructure and software from multiple vendors to be combined in a standardised way. Drivers to support Open RAN include: expansion of the RAN supply chain and innovation base; reduced risk of vendor lock-in; and a simplified route towards a virtualised RAN architecture.

European operators have been at the forefront of trialling Open RAN and driving a broad ecosystem, particularly the series of papers that have been published by Deutsche Telekom, Orange, TIM, Telefónica and Vodafone, which set out operator requirements for Open RAN in great detail.

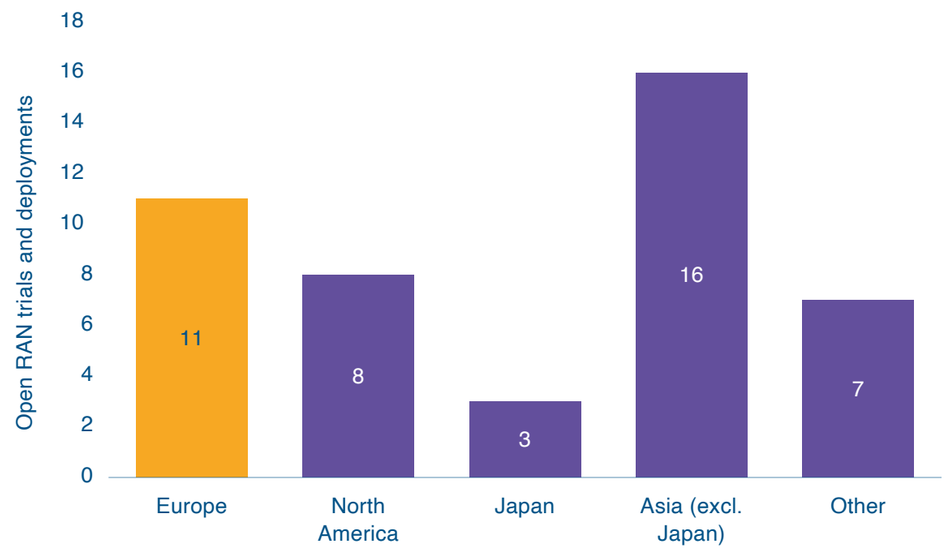
However, deployments of commercial Open RANs remain confined to greenfield operators, notably Rakuten Mobile in Japan and Dish Network in the USA, and to small-scale rural or enterprise networks. There are significant challenges for brownfield operators to deploy Open RAN in macro networks. These include coexistence with existing, traditional networks; the complexity and cost of systems integration in multivendor networks; and the immaturity of virtualised RAN platforms, especially for supporting very high-performance 5G technologies such as massive MIMO antenna arrays.

This year has seen significant effort to address these challenges. For instance, the O-RAN Alliance has defined an additional fronthaul interface that is optimised to support massive MIMO, and this was supported by several European operators, including Orange and Vodafone. Several organisations are working on pre-integrated Open RAN platforms that could simplify the configuration and deployment task. The newest one is OREX, which was developed by NTT Docomo of Japan and will be made available to other operators through the Telecom Infra Project[30].

Such advances should increase operators' confidence to deploy Open RAN commercially. Vodafone has rolled out the largest number of Open RAN sites in Europe so far. It is in the process of replacing 2500 UK sites with Open RAN in 2023-2026, and it recently started deployment in Italy also. It has set a target that 30% of its European macro sites should support Open RAN by 2030 and has trials in the Netherlands, Romania and Spain. Deutsche Telekom has also initiated a large-scale Open RAN deployment, planning more than 3000 Open RAN-compatible antenna sites in Europe by the end of 2026. Orange has pledged to mandate Open RAN compliance for any new procurements from 2025. TIM and Telefónica have also started to deploy some Open RAN sites.

Many operators indicate that they will initially work with a single vendor for the radio units, baseband units and RAN software, to simplify integration and supplier management, though cloud infrastructure may come from a third party. This has been true, for instance, of Verizon in the USA and Vodafone in the UK. But open interfaces will enable them to introduce additional suppliers in a second phase, when multivendor networks can be fully realised. Analysys Mason forecasts indicate that by 2028, about 52% of newly provisioned sites in Europe will support Open RAN interfaces, at least in the fronthaul, and of those, over 40% will be in multivendor networks. Some operators, such as TIM, will build their own telco clouds to support Open RAN, while others will use a third-party cloud, or even move RAN functions to the public cloud.

FIG 4.3 : *Open RAN trials and deployments in China, Europe, Japan, Asia (excl. Japan) and North America, 2023*



Source: Analysys Mason, 2023

[30] https://telecominfraproject.com

4-4 INTEGRATION OF SPACE AND 5G TERRESTRIAL COMMUNICATIONS NETWORKS

Traditionally, non-terrestrial networks (NTN) have played a minor role in the telecoms market in Europe. Some operators have partnered with satellite providers for communications services or cellular backhaul in remote areas such as ultra-rural communities or for marine applications, but overall the ecosystems have remained separate.

This situation is changing gradually because of two developments that could enable a closer technical and commercial relationship between terrestrial networks and NTN. One is the emergence, in recent years, of low-earth orbit (LEO) satellite operators such as SpaceX/StarLink. LEO satellites (LEOsats) are configured in constellations numbering several thousand individual satellites, are cheaper and simpler to launch and operate than satellites in higher orbits, and they support improved data rates and latencies. That may make them competitive with terrestrial operators in some scenarios, such as very rural (remote) broadband access.

More importantly, it opens up the potential for partnerships to address applications that require ubiquitous coverage, such as wide-area IoT and vehicular services, where users can be supported by a combination of 5G and satellite. Such applications could enhance the operator business case for extending cellular coverage via satellite alliances, by expanding that model beyond rural and remote connectivity.

Telefónica has agreed to be a worldwide partner for Starlink, which is developing a LEOsat constellation. Both operators will extend the reach of their 5G services to rural areas and wide-area IoT via satellite coverage.

Such partnership models may be enhanced by the second factor, the standardisation of direct-to-device connections from satellites to 5G handsets. This technology was devised as part of 3GPP's work on 5G/NTN integration in standards releases 17 and 18 and powerful smartphone makers including Apple have already announced support. This will significantly improve the economics of 5G/satellite services because mass-market devices can be used rather than expensive satellite phones or IoT devices. Speeds will be 3G-like (about 3-5Mbit/s or slightly higher).

The initial commercial launches of direct-to-5G technology have been to support emergency communications, or short message services for users in remote areas such as mountain hikers. Satellite analysts at Analysys Mason expect IoT applications to be the next area of commercial development, from 2024, followed by mobile broadband services for remote areas at a later stage.

Some of the space operators that have been developing technology and services for 5G/NTN include SpaceX, Lynk, Globalstar and AST SpaceMobile. All of these have indicated interest in partnerships with terrestrial mobile operators. On the vendor side, there are also interesting partnerships, such as one between Ericsson, Qualcomm and Thales.

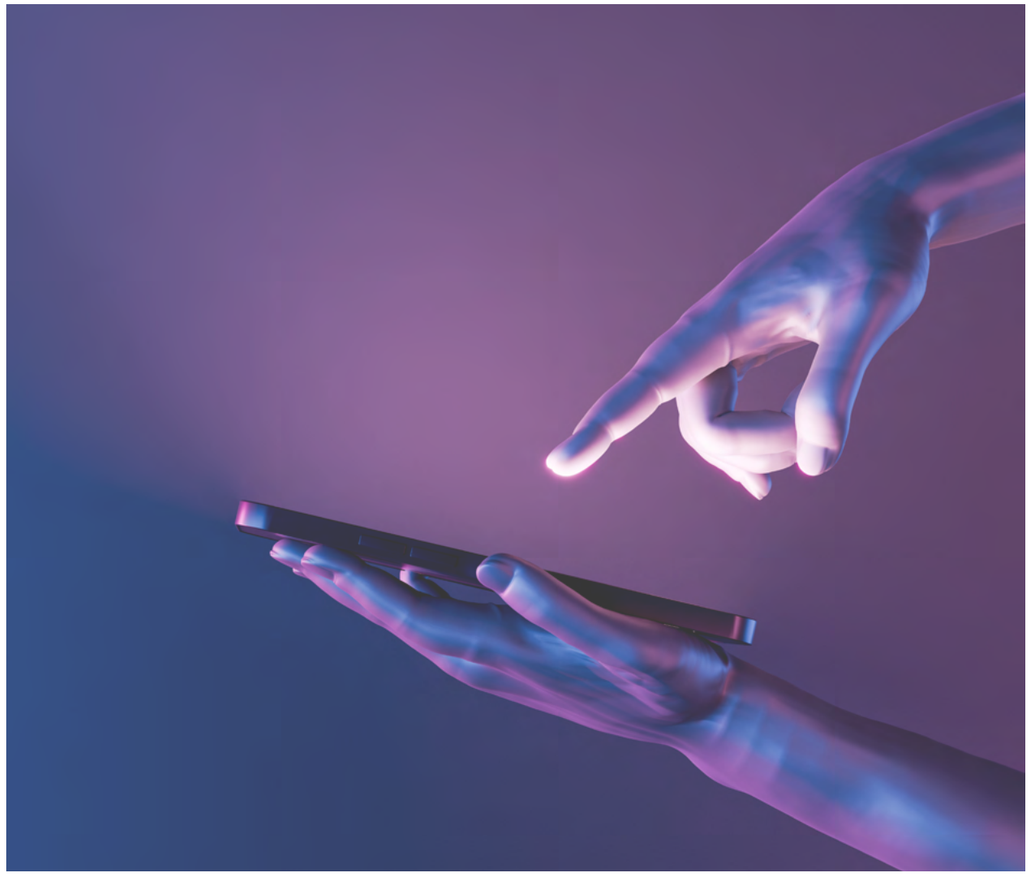
SpaceX and T-Mobile USA were the first to make a commercial announcement of direct-to-device services, centred on emergency messaging from remote areas. Handset makers Apple and Bullitt both offer similar applications from selected smartphones in Europe, but these are controlled by the vendors rather than by operators.

Deutsche Telekom and Telefónica both have LEOsat partnerships focused on IoT, which will make use of direct-to-device capabilities when commercial services go live. Deutsche Telekom is working with Intelsat and Skylo and plans to integrate the former's satellite/terrestrial business offering into its IoT portfolio, while using the latter's network for satellite-based narrowband IoT. Telefónica plans to use Sateliot's LEO network to support wide-area IoT applications such as agriculture.

The timing and scale of many direct-to-device service launches will depend on several current uncertainties being addressed, including the level of demand and willingness to pay for these capabilities, and regulatory approval and rules to use terrestrial spectrum from space.

There are two spectrum options. One is to use MNOs' existing spectrum, as SpaceX and T-Mobile are doing, among others, though this requires regulatory approval and has some performance challenges. The other is to use spectrum assigned to mobile satellite services, such as Globalstar's, an approach that addresses the regulatory and performance issues, but relies on smartphone chipset makers supporting the new Release 17/18 capabilities.

The European landscape may be further changed with the planned launch of the European Union's Iris^2 satellite constellation, which is designed to support military and civilian services and increase the bloc's infrastructure self-sufficiency and security. Deutsche Telekom and Orange are members of a consortium, led by Airbus and several satellite players, which will deploy the LEOsat network between 2024 and 2027.

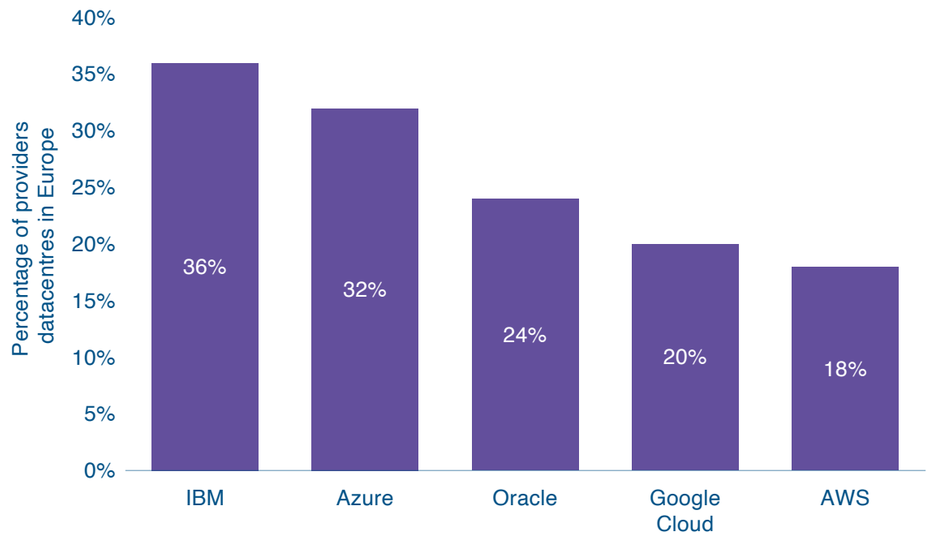


4-5 OPERATORS AND CLOUD

Cloud computing has revolutionised the digital processes of many consumers and enterprises, which can use third-party compute and storage facilities instead of investing in their own servers, and can pay for their usage on a pay-as-you-go basis. The cloud has also had a significant impact on telecom operators' businesses. 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. Some operators also offer cloud processing and storage services to their customers.

The rising use of cloud computing has driven an increase in deployment of data centres. Some operators maintain their own servers and telco clouds, but others are relying on public cloud providers'(PCPs') infrastructure and services. PCPs are the biggest deployers of cloud infrastructure in data centres, and in recent years their data centre footprint has grown particularly rapidly in Europe (**FIG 4.4**). For instance, Microsoft recently announced its first cloud region in Italy and Google said it would expand its presence in Belgium with three new data centres.

FIG 4.4 : ***Percentage of leading public cloud providers' data centres that are in Europe, 2023***



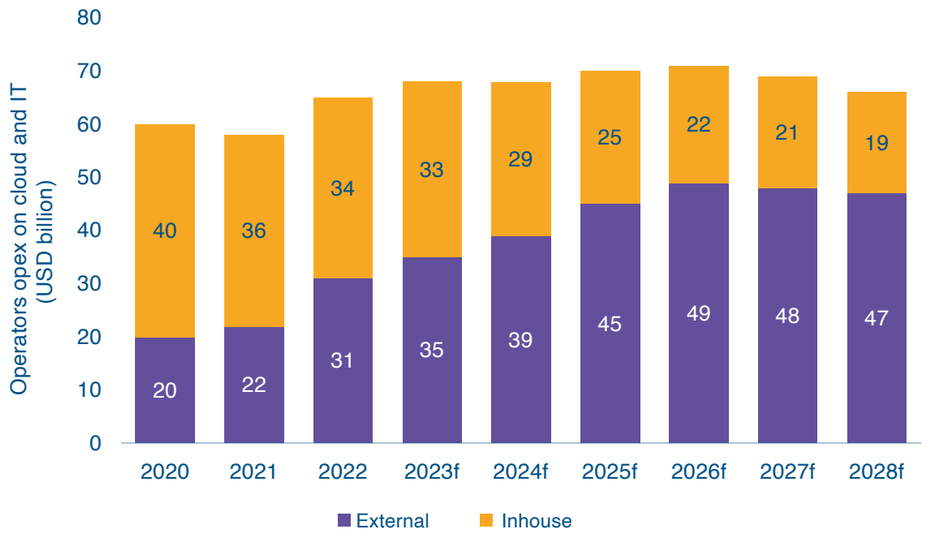
Source: Analysys Mason, 2023

A particular concern for Europe has been data sovereignty; AWS has revealed plans to build a European Sovereign Cloud, a network of data centres that would be operated quite separately from its other centres, and could be used by government agencies and regulated enterprises such as operators.

ETNO operators are also working together under the EC-sponsored framework of the Important Projects of Common European Interest to drive investment in a European distributed cloud. In November 2022, five European operators – Deutsche Telekom, Orange, Telecom Italia, Telefónica and Vodafone – launched Project Sylva, which aims to define an open telco cloud stack under the auspices of the Linux Foundation. The European Commission approved EUR1.2 billion of state aid from 7 countries for the project in December 2023.

Operators' rising use of the cloud is driving increased spending on cloud computing and other IT functions such as data analytics, all of which support increased virtualisation and complexity of networks. As many operators shift their cloud spending from inhouse resources to PCPs, there will be a consequent shift of spending, away from capex and inhouse operations, and towards opex directed at external providers such as PCPs.

FIG 4.5 : ***Operators' cloud and IT opex, in-house and external, worldwide, 2020–2028f***



Source: Analysys Mason, 2023

Inhouse cloud and IT spending will decline by 53% between 2020 and 2028. This is despite the increasing use of advanced data and IT functionality such as AI, which may still be led by inhouse teams. However, the significant cost of buying and running data centres and hardware will be moved to third parties, and spending on external cloud and IT services will rise by 135% in the same time period. This spending on public cloud services will be particularly intensive up until 2026, as many operators move a significant portion of their processes to third-party cloud. After that year, the growth in external cloud opex should flatten as operators complete their migrations and competition drives costs down.

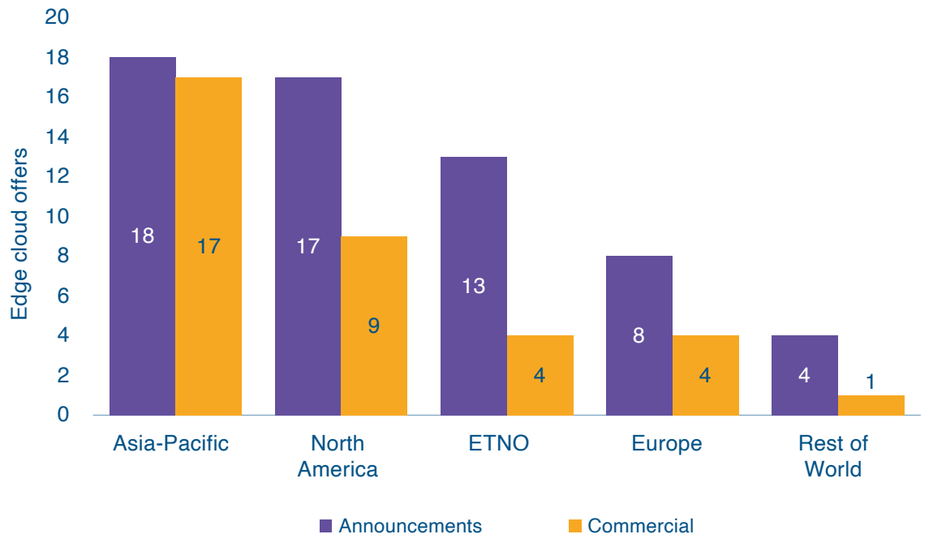
4-6 INVESTMENTS IN EDGE CLOUD COMPUTING

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 EC's Digital Decade programme, the EC is targeting 10 000 edge nodes across the EU by 2030 in order to support a wide range of new or enhanced digital services.

While many operators have been reducing their own investments in centralised telco cloud, this pattern could be reversed in the edge cloud because operators already own and manage many locations that are well-suited to edge nodes. These range from central offices or metro switching centres, which could support a city-wide edge, to cell sites, which could enable an even more distributed edge layout, with micro-data centres close to towers. Some operators, as well as neutral hosts, expect to lease their edge infrastructure to partners including PCPs, as well as using the sites for their own purposes, such as launching low-latency connectivity services for enterprises or consumers, or hosting network functions for a highly distributed vRAN.

There has been a sharp increase in the number of edge offerings that operators have announced round the world (**FIG 4.6**). In Europe, eight commercial offers are available, half from ETNO operators, and a further 21 have been announced. That is up from three commercially available services last year. The leading region is Asia-Pacific, with 17 commercial offers and a further 18 announced or in pilot.

FIG 4.6 : ***Announced and commercialised edge cloud offers, by global region, 2023***

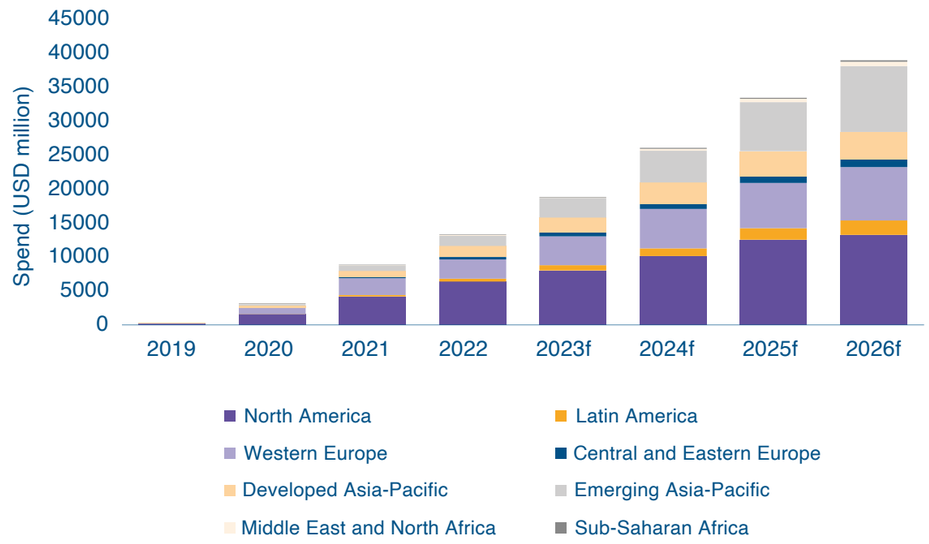


Source: Analysys Mason, 2023

Telefónica Tech has been an active operator in announcing edge partnerships and services, including its Security Edge offer with Netskope, and its agreement to work with 5G enterprise firm Pente to support integrated edge computing and 5G.

There is a significant market opportunity for enterprise edge services, and operators have the opportunity to capture a share of these new revenues. Enterprise spending on edge cloud computing is expected to grow rapidly worldwide and will exceed USD38 billion (EUR36 billion) by 2026 (**FIG 4.6**). In Europe, spending will reach almost USD9 billion in 2026 though the largest market will be North America.

FIG 4.7 : ***Enterprise spending on public edge computing services, by region, worldwide, 2019–2026***

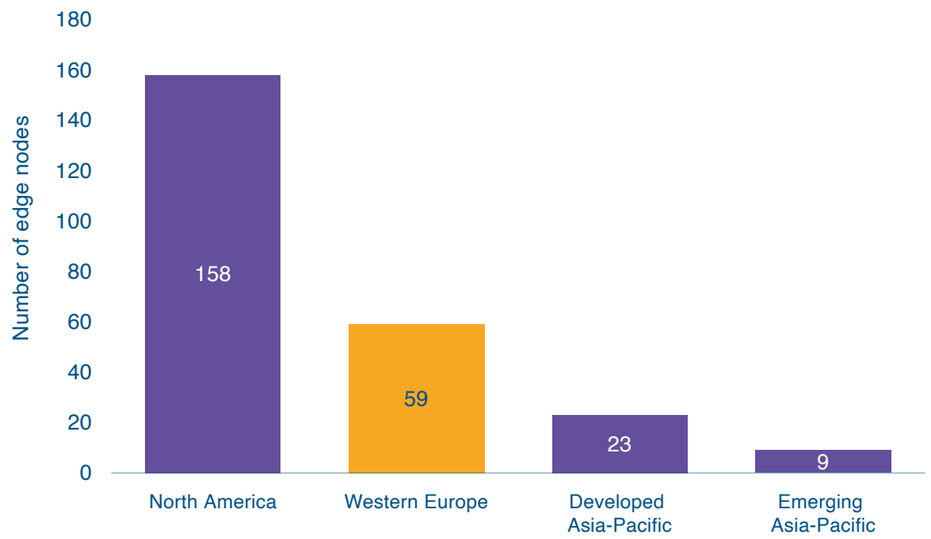


Source: Analysys Mason, 2023

	2019	2020	2021	2022	2023f	2024f	2025f	2026f
North America	102	1496	4153	6340	7980	10100	12500	13200
Latin America	0	70	242	425	780	1150	1675	2145
Western Europe	61	891	2431	2850	4235	5760	6675	7820
Central and Eastern Europe	0	46	154	310	525	760	980	1110
Developed Asia-Pacific	24	329	935	1620	2256	3130	3680	40500
Emerging Asia-Pacific	0	209	754	1520	2856	4650	7210	9715
Middle East and North Africa	0	20	68	125	120	340	485	615
Sub-Saharan Africa	0	4	14	25	48	84	152	196

North America and Western Europe are the two leading regions for edge nodes and the largest number of new additions in 1H 2023 were also in these two regions. In Europe, the number of countries with differing regulatory regimes has driven demand. Two of the most active edge investors, Atlas Edge and Proximity DC are building interconnect edge nodes in the region as they are looking to host consumer-facing applications in their data centres. Some operators are working with PCPs to deploy edge compute in their networks. An example is Vodafone's partnership with AWS Wavelengths, which was expanded from the UK and Germany to Spain this year.

FIG 4.8 : ***Live operator edge nodes by region, 1H 2023 (publicly disclosed)***



Source: Analysys Mason, 2023

> **Edge cloud is at the heart of network virtualisation: Europe currently counts 4 edge cloud offers and 59 live edge nodes**

4-7 OPERATORS' ROLE IN XR

Extended reality (xR) is expected to underpin a new generation of user experiences and applications that will merge the digital and physical worlds to an unprecedented degree, paving the way for the metaverse and 6G.

Operators are involved in the development of xR on several levels. Most obviously, xR applications require connectivity that is very fast and reliable, has low latency, and is available ubiquitously. Operators whose fixed and mobile networks support those requirements may expect to play a significant role in the value chain, and some will provide xR-optimised connectivity, for instance through 5G network slicing.

Many operators are also creating platforms and partnerships that will enable them to monetise xR in other ways too, through applications, enterprise services and devices, or by building entire ecosystems. Telefónica has been cooperating with Qualcomm since September 2022 on an xR ecosystem which will encourage developers to create applications that use the operator's fixed and mobile networks and run on Qualcomm-based devices.

This has evolved into the larger Alaian Alliance, which aims to attract and encourage start-ups to develop xR applications that make use of 5G or fibre networks. Eight further operators have joined the group including Europe-based Bouygues Telecom, Cellnex, KPN and Wind Tre.

In August 2023, BT launched a testbed to develop and trial a range of xR applications for home, business, healthcare and entertainment environments. These immersive experiences will be rendered in graphical processing units in the cloud and delivered over BT's 5G network. Car retail, education, sports broadcasting and medical imaging are the first applications to be tested with partners.

Orange has also recently launched an initiative to explore new xR and metaverse opportunities, and is particularly focusing on enterprise applications, and on use cases that would have a positive environmental impact. Speaking of striking a "balance between the impact on society and the planet", Orange has used its 'Eternal Notre-Dame' immersive experience to demonstrate how businesses could use xR to develop new approaches in sectors such as training and automotive, while reducing activities such as travel that leave a carbon footprint.

Some of these operator activities take place under a 'metaverse' banner, but the full-blown metaverse vision is unlikely to materialise until the late 2020s. By focusing on near-term xR applications for consumers and businesses, operators and their partners can generate more immediate revenues, while gaining knowledge and experience to help them evolve their platforms towards next-generation use cases.

The applications that prove easiest to monetise will be partly defined by the evolution of devices. Apple's Vision Pro, Meta's Quest and Microsoft's enterprise-focused Hololens are among the new generation of xR headsets, though the need for relatively bulky and expensive headgear is one of the potential constraints on uptake of XR.

Some operators are not confining their efforts to near-term xR use cases but also looking further ahead. For instance, Deutsche Telekom is leading the German 6G Native Extensions for xR Technologies (NeXt) research project, which aims to define a network architecture for testing of future 6G-based xR use cases. The first two applications to be submitted are an anti-collision system for drones in airports and interactive transmission of real-time 3D holographic video.

4-8 PLAYING A LEADING ROLE IN THE DEVELOPMENT OF 6G

5G is still being rolled out in Europe, but the next generation of mobile network is currently being researched and defined. 6G is likely to be the main new mobile technology by the late 2030s. It is currently being created by a combination of vendors, operators, governments and academic researchers. ETNO members are playing a key role.

The EC has shown considerable interest in the development of 6G and has steadily increased its financial support for research projects. 35 6G projects were named to receive a combined total of EUR250 million of funding via the EC's Horizon Europe programme in October 2022. This funding falls into four distinct streams.

- Stream A targets the further development of 5G and focuses on Open RAN- and AI-based edge platforms that will help with the roll-out of 6G.
- Stream B supports entirely novel research projects that will not be commercialised for many years. These aim to produce new architectures for 6G systems and to improve non-terrestrial networks and low-latency communications.
- Stream C is assisting three projects that are developing smart networks and services (SNS) infrastructure that can act as a 6G enabler.
- Stream D will fund experimental SNS deployments throughout Europe that are intended to enable real use cases to be tested in vertical sectors such as healthcare and manufacturing.

Multiple operators have stressed that they do not expect 6G to be as revolutionary as 5G. BT and Vodafone announced in March 2022 that they believe that 6G will rely on the same underlying orthogonal frequency division multiplexing technology as 5G. Others believe that 6G will focus on specific use-cases; for example, Orange's March 2022 6G white paper focused on the potential industrial and environmental challenges that the new generation of mobile technology can solve.

Ensuring that European technology sovereignty is preserved throughout the development and adoption of 6G is a key aim for both ETNO members and the EC. This will require strong European contributions to the standardisation process as well as the development of a world-class research programme that helps to forge 6G technology that is in line with European values.

The low returns of the industry are incompatible with the vision of open strategic autonomy

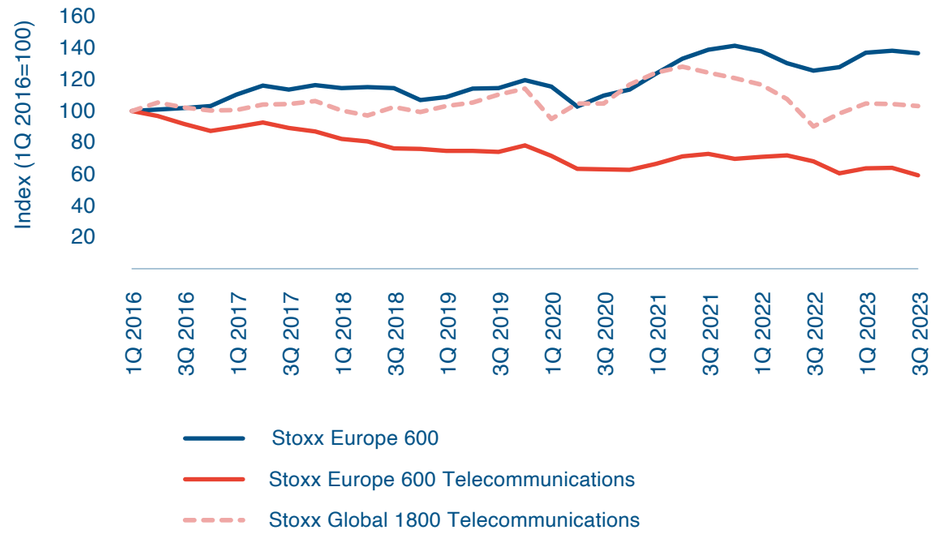
There is no end in sight for the slide in the financial performance of European telecoms operators. European telecoms operators are among the largest European-owned entities in the digital value-chain, and their continued financial weakness makes them less able to develop skills and services in Europe, and makes them prey to takeover and break-up by entities whose values may not be aligned with a European vision for strategic autonomy.

05

5-1 THE GAP BETWEEN EUROPEAN TELECOMS STOCKS AND BROADER MARKET INDICES CONTINUES TO WIDEN

Compared with 1Q 2016, European telecommunications stock has lost 41% of its value. This compares with a gain of 37% for a basket of European stock, and a loss of 9% for global telecommunications stock.

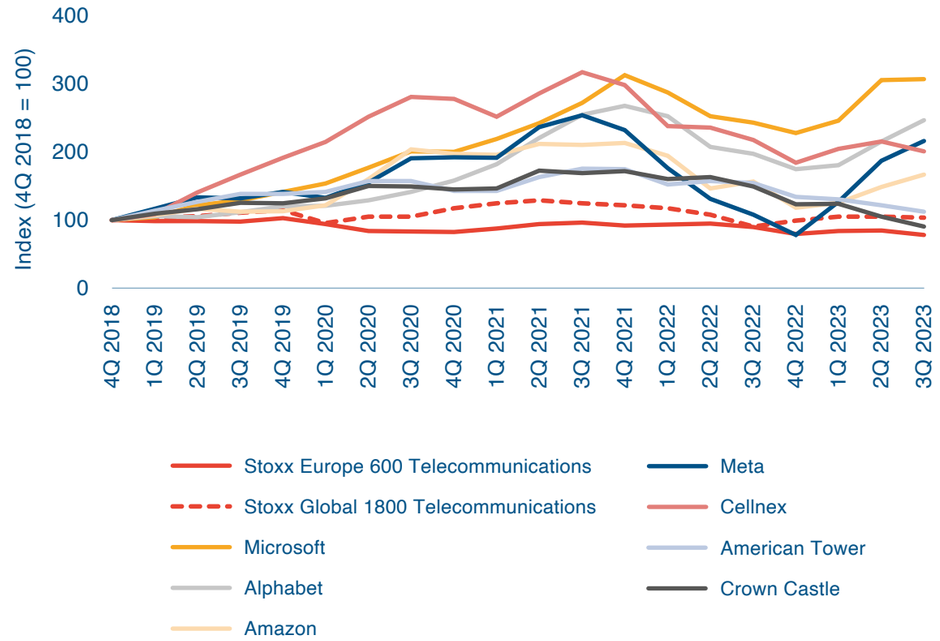
FIG 5.1 : ***Stoxx Europe 600 index, Stoxx Europe 600 index for telecoms and Stoxx Global 1800 index for telecoms, where the value in 1Q 2016 is set to 100, 1Q 2016-3Q 2023***



Source: Qontigo

Operators are generally concerned that part of their historical value as service providers is being lost to CAPs. However, another part of operators' value has also been lost to communications infrastructure businesses, owners mainly of passive infrastructure such as towers and fibres. Some of this latter loss of value has actually been the result of operator sell-offs, in particular of towers. **FIG 5.2** 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. The hyperscale businesses regained most of the value they lost in the second half of 2022, which had appeared to be a market correction. The value of infrastructure businesses, which three years ago were gaining as telecoms stock remained at best flat, has fallen away in the past two years.

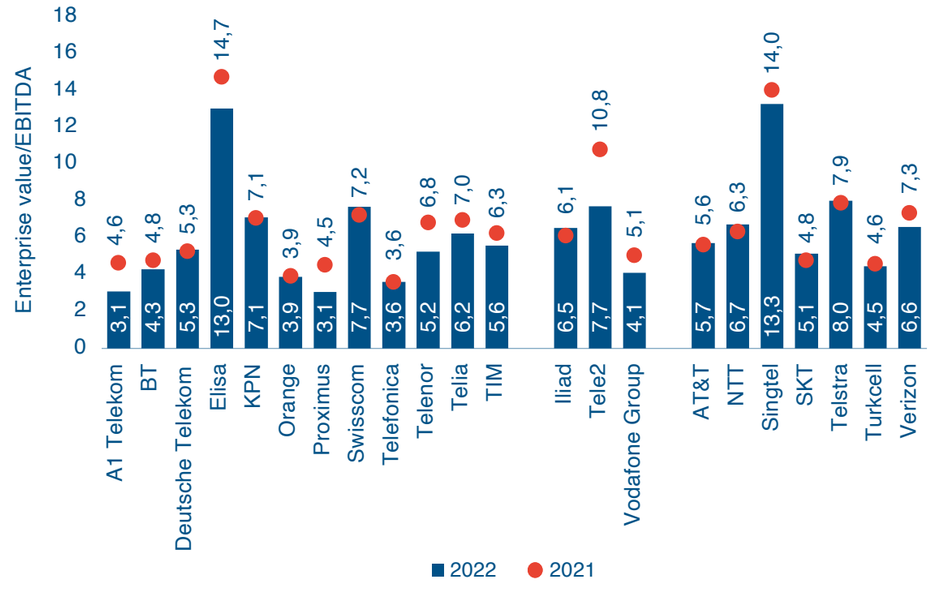
FIG 5.2 : ***Stoxx Europe 600 index for telecoms, Stoxx Global 1800 index for telecoms and stock values for hyperscalers and towercos, where the value in 4Q 2018 is set to 100, 4Q 2018–3Q 2023***



Source: Qontigo

Enterprise values over EBITDA (last twelve months) for most ETNO members continued to slide in 2022, although this was generally true for other European and global telecoms businesses. There is little faith in the markets about European telecoms operators' ability to grow sustainably.

FIG 5.3 : ***Enterprise value/EBITDA, ETNO members and other operators, worldwide, end of the last full financial year***

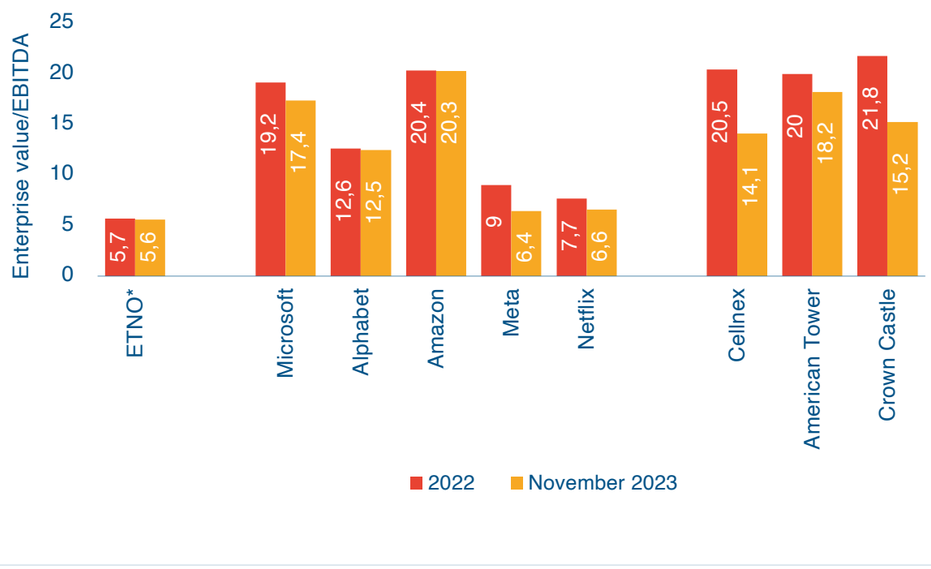


Source: Analysys Mason, 2023

Tech companies continue consistently outperforming European telecom stocks. Compared with Q1 2016, European telecommunications stock has lost 41% of its value

Over the course of 2023 the unweighted average value for ETNO members has remained roughly the same, although none of the benchmarked hyperscalers or the benchmarked infrastructure businesses actually gained in 2023 either.

FIG 5.4 : *EV/EBITDA multiples, ETNO members, selected hyperscale CAPs and major telecoms infracos, worldwide, 2022 and 24 November 2023*



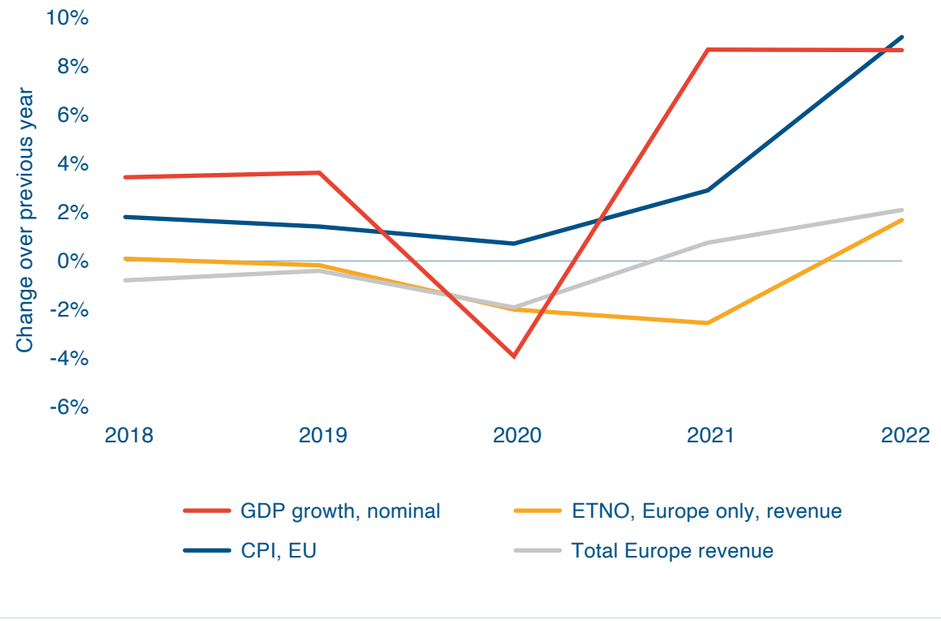
Source: Analysys Mason, 2023

The business model used by most operators globally seeks to benefit from tying the provision of physical connectivity to the service layer. The physical layer mostly consists of network infrastructure such as towers and cables, plus physically distributed active network assets, whereas the service layer increasingly resides in software. Markets appear to regard this vertically-integrated approach as an inefficient means to maximise the value of the physical assets. The problem for this model is compounded in Europe because pro-competition regulation can have the effect of neutralising whatever advantage investment in those physical assets confers. Hence a consequence, markets tend to regard European telecom operators as even more hobbled in their ability to monetise the investments they make.

5-2 THE FINANCIAL FUNDAMENTALS REMAIN DIFFICULT

Revenue growth, in nominal terms, for ETNO members in their European operations, and for whole European telecoms sector, is substantially below GDP growth, and it is substantially lower than the rate of inflation.

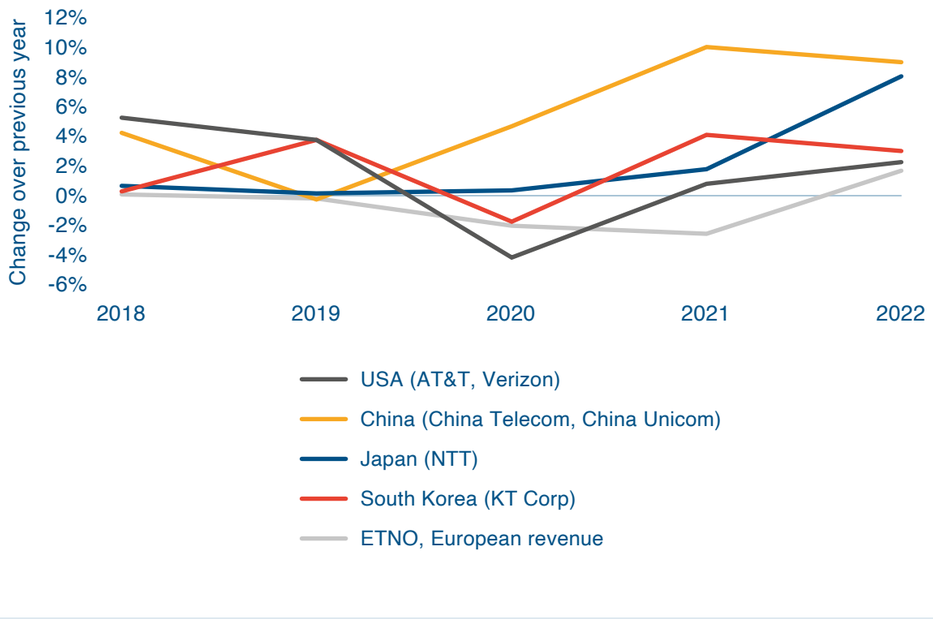
FIG 5.5 : *ETNO members' European revenue growth, total Europe telecoms revenue growth, CPI, and nominal GDP growth, Europe, 2018-2022*



Source: Analysys Mason, 2023

Revenue growth in European operations has, since 2018, also fallen short of most of the comparator operations in other countries.

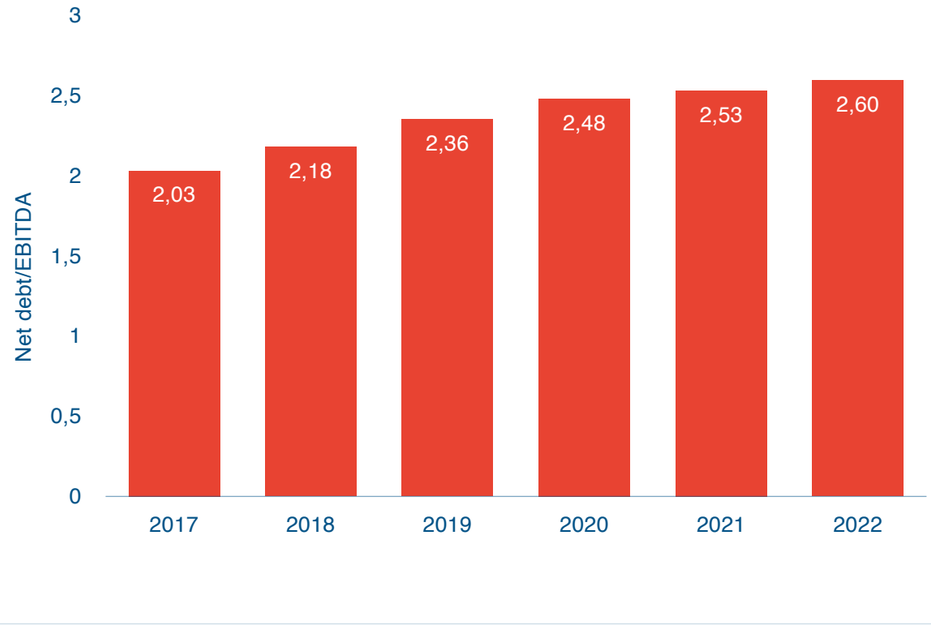
FIG 5.6 : *ETNO member European revenue growth and comparator operator revenue growth, 2018-2022*



Source: Analysys Mason, 2023

ETNO members' ability to reduce net debt is stymied by weak revenue growth, although improved efficiency has brought hard-won EBITDA margin gains. Sales of assets such as towers has not reduced aggregate debt to EBITDA ratios: in fact in 2022 they continue their shallow upward trend.

FIG 5.7 : *Net debt/EBITDA, ETNO members at the group level, 2017–2022*



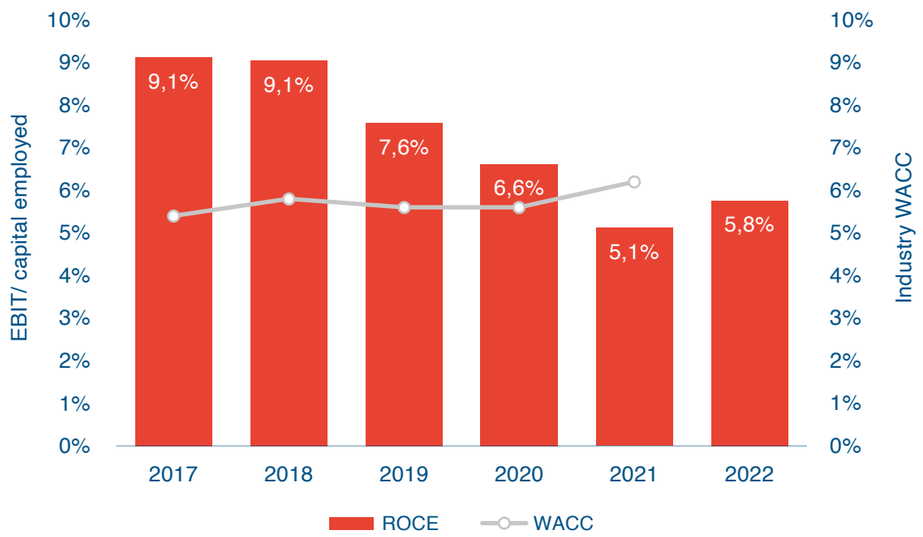
Source: Analysys Mason, 2023

Initiatives to improve the balance sheet are more than offset by the need to invest further in new FTTH and 5G networks. Initiatives tend to involve sales of assets that may turn out to yield strategic direction to third parties. These sales are not simply of towers but also major stakes in FTTH, and in both cases these can involve yielding ownership of active equipment as well as passive assets. Partnerships with cloud providers may further weaken operators' ability to determine their own strategic direction.

FTTH is the largest capex burden, but FTTH network assets have a far longer useful asset life than most mobile assets that operators own, and hence once transformation of the fixed access network from copper to FTTH is complete, free cash flow should improve greatly. This is likely to happen only towards the end of the decade. The cost of servicing debt has also risen as interest rates have risen.

Return on capital employed, at a group level, rose by 0.7 percentage points in 2022, a small reverse (founded on improved margins) of a steeper decline from 2017. The figure of 5.8% is close to the weighted cost of capital for the telecoms industry.

FIG 5.8 : *Aggregate ROCE, ETNO members, 2017–2022, and Industry WACC*

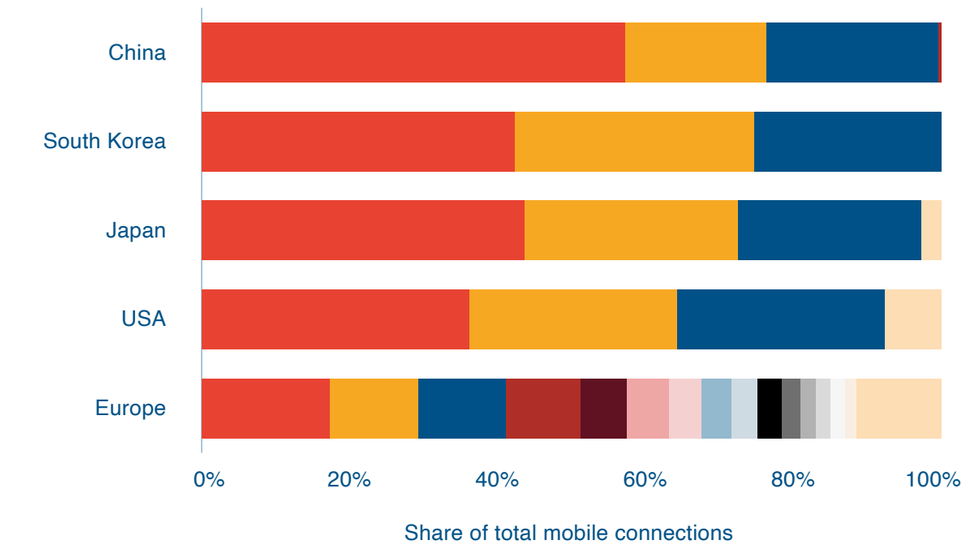


Sources: Analysys Mason, ETNO and Telefónica elaboration on figures by Credit Suisse (2022), BCG for ETNO (2021), JP Morgan (2020)

5-3 RETAIL TELECOMS IN EUROPE IS A LONG WAY FROM A 'DIGITAL SINGLE MARKET'

If European telecoms is treated as a single market, it looks highly fragmented. The four largest mobile operator groups account for only just over a half of all mobile subscriptions.

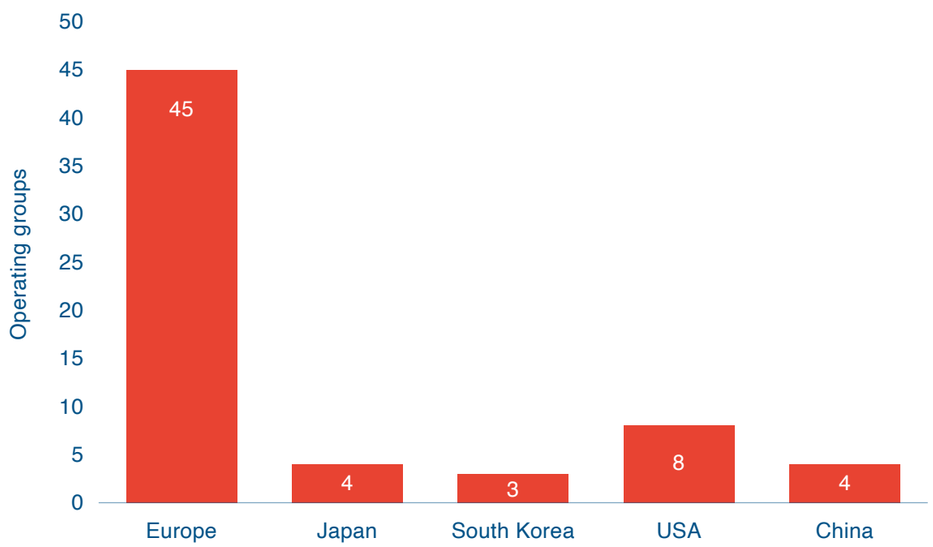
FIG 5.9 : *Share of mobile connections, network operator level, 2Q 2023*



Source: Analysys Mason, 2023

There was, at 2Q 2023, a total of 45 mobile operators in Europe with over 500 000 subscribers. The USA had just eight, and China, Japan and South Korea fewer still. All MNOs in Europe are confined to a subset of markets, and there is no truly European level MNO.

FIG 5.10 : ***Large mobile operating groups (MNOs > 500 000 connections end 2Q 2023)***



Source: Analysys Mason, 2023

Decades of pro-competition policy and regulation have shaped a market where, uniquely, competitive telecoms players have a choice of different entry-points.

- In mobile, through pro-competition spectrum policies that preserve, or in some cases create, four-operator market structures, and through pro-MVNO regulation.
- In fixed, through heavily tariff-regulated bitstream, through virtual and physical unbundling, and through physical infrastructure access. Deregulation of the local access market is very slow despite strong increase in new infrastructure-based competition in many geographies.

5-4 OPERATORS ARE HAMPERED IN THEIR ABILITY TO SERVE THE NEEDS OF CITIZENS AND TO MEET THE ASPIRATIONS OF EUROPEAN POLICY

Continued low returns make the investment needed to achieve the 2030 Digital Decade targets more challenging, especially in the current economic climate where further public subsidies are less likely. We foresee FTTH coverage falling short of the 100% coverage threshold by some 21 million premises by 2030 within the EU. 5G coverage remains well behind other developed economy countries and regions.

Decades of pro-competition policy and regulation shaped a market where uniquely competitive telecoms players have a choice of different entry points. This means the European retail telecoms market is highly fragmented. Despite broad aims by the European Commission to create a single digital communications market, there are currently few if any signs of market-driven consolidation of the sector in Europe.

The growing trend of separation of network-facing and customer-facing businesses, plus the technological advances in network virtualisation, open up new opportunities for European service-layer consolidation. But those same trends deliver a potent threat; it could be that external non-European players will be most financially fit to exploit them, and that European telecoms operators will have to cede more value to them. In the area of enterprise private networks, Microsoft Azure, AWS (Amazon), and indeed European vendor Nokia, sell direct to enterprises with private 5G core solutions within their own multi-access edge compute solutions. These use a mix of telco LTE/5G, shared (e.g. CBRS in the USA) or unlicensed spectrum-based access (Wi-Fi). In mainstream consumer mobile, there are as yet no virtual network operators in Europe owned by hyperscale type businesses. However, Amazon is reported to have been in talks with US MNOs, including new player Dish Network, with the aim of launching as an MVNO potentially tied to its Amazon Prime subscriptions. Google already has an MVNO in the USA that, initially at least, was tied to more than one host MNO. These large players already have many of the assets across Europe that would enable them to launch Europe-wide mass-market telecoms services. Yielding control – and skills – to outside entities could seriously damage the European aim of open strategic autonomy and could dent any hope of a renaissance of innovation and investment in new digital communications technologies.

There is an ongoing policy debate on whether CAPs should contribute to the costs of networks from which they benefit, costs that are currently shouldered by the European telecoms sector. The European Digital Rights and Principles Declaration from January 2022 established that all market actors that benefit from the dividends of the digital economy should make a “fair and proportionate contribution” to digital network investment. The debate will shape the longer-term strength of the European telecoms sector, as well as its overall investment capacity.

It is therefore of note that in the USA, a bill has been introduced that seeks to shift some of the burden of network expansion to larger CAPs. The Lowering Broadband Costs for Consumers Act, introduced in November 2023, is a bill that seeks new sources of funding for the American Universal Service Fund (USF), which funds broadband buildout in rural and tribal areas, connections for schools, hospitals, and libraries, plus a low-income affordability programme. The bill, if passed, will empower the US NRA, the Federal Communications Commission (FCC), to assess CAPs that account for more than 3% of total US internet traffic and earn more than USD5 billion in annual revenue for USF contributions. The funds would not necessarily be derived from network usage fees, even if they are based on a threshold of traffic, and if the financial measure is used rather than the network usage threshold, they would in effect be a tax.

USTelecom, an association of US broadband operators including the largest incumbent local exchange carriers (ILECs), has argued that the proposed legislation would help ensure “the USF’s long-term impact and sustainability by modernising its contributions system to include the dominant Big Tech companies, which benefit significantly from the broadband connectivity made possible by the Fund.”[29]

Notwithstanding the issue of meeting the Digital Decade targets, there are further reasons, with strategic implications for Europe, to be concerned about the health of the European telecoms sector. Low valuations make the telecommunications sector more susceptible to aggressive M&A and potential hostile approaches from non-European actors. Some of these may have little interest in developing a digital advantage for Europe. Some may wish to break up the vertically integrated model, weakening the ability of those players to invest in skills to pioneer technology, especially vis-à-vis global competitors, and reducing telecoms operators to geographically fragmented physical connectivity providers.

The threats are real. The directions that the industry is moving in run counter to the vision of ‘open strategic autonomy’, whose aim is to find a new balance between security and competitiveness that will ensure the EU’s future ability to ‘act autonomously when and where required and to work with partners wherever possible’.

European markets are too fragmented. In 2023, Europe counted 45 large mobile operators, as opposed to 8 in the US, 4 in Japan and 3 in South Korea

[32] https://www.ustelecom.org/statement-on-introduction-of-lowering-broadband-costs-for-consumers-act-of-2023/

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Albania

Austria

Belgium

Bosnia and Herzegovina

Bulgaria

Croatia

Cyprus

Denmark

Finland

France

Germany

Greece

Hungary

Iceland

Italy

Lithuania

Luxembourg

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