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GS SUSTAIN

Telecoms: The Fibre & 5G decarbonisation debate

We see fibre and 5G as critical technologies necessary to reducing the Information and Communications Technology (ICT) sector's overall carbon footprint and enabling low-carbon technologies across the broader economy, which we believe remains underappreciated by investors today, as evidenced by Diversified and Wireless Telecoms at -15% and -24% underweight in ESG funds today. We see three factors that could shift this sentiment, such as: 1) greater recognition of direct energy efficiency improvements of fibre and 5G vs. existing technologies; 2) fibre and 5G as critical enablers for scaling the digital economy, supporting additional indirect carbon benefits via smart grids and other Internet of Things (IoT) applications; and 3) greater clarity for Telecom's eligibility under the EU Taxonomy, which could see fibre and potentially 5G as aligned (green), serving as a key catalyst for recognition of the sector's low carbon contribution in the years ahead.

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Executive Summary

With mobile data traffic expected to grow 4x between 2021 and 2027, according to the IEA, and internet traffic expected to double from 2020 to 2023, according to Ericcson, we believe the Telecom sector will find it difficult to scale while reducing or even maintaining its overall energy and carbon footprint. Current technologies in 4G and copper/cable networks are not expected to scale the increase in data traffic efficiently, leading to potential increases in Telecoms' share of global GHG emissions. We see fibre and 5G as critical to handling this rapid demand acceleration, and providing a vital solution to the sector's net-zero emissions pathway.

We see fibre broadband and potentially 5G as underappreciated technologies for decarbonisation 1) via improved energy efficiency vs. alternatives and 2) as critical enablers of IoT solutions offering additional carbon benefits — which can both fit into the existing EU Taxonomy framework for defining green activities. According to company data and industry reports, Fibre is 80% more energy efficient than copper networks and 5G is 90% more energy efficient per traffic unit of data processed than 4G (and still up to 37% more efficient vs. 4G when incorporating data growth and increases in 5G base stations needed). Additionally, IoT and smart digital solutions can potentially reduce global emissions by 15%, according to European Telecommunications Network Operators Association (ETNO). **Diversified and wireless Telecoms are currently 15% and 24% underweight in ESG funds, partially highlighting their underappreciated contribution to low-carbon outcomes, which could change going forward, in our view.**

Companies have highlighted their conservative approach to initial Taxonomy reporting figures, showing average eligibility of only 6.5%, which we see rising dramatically as greater clarity comes for the sector's coverage in the Green Taxonomy. There remains uncertainty from many corporates/investors on whether and where Telecoms fit into the existing Taxonomy. Concerns of under-representation relative to the potential decarbonisation impact are being raised by some Telecom companies in their Taxonomy reporting; therefore, this report aims to explain how we think Telecoms is relevant to the EU Taxonomy and where the sector fits in.

The EU Taxonomy — a classification system for sustainable economic activities — will significantly influence capital flows, cost of capital and valuations, in our view. We provide an assessment of where core wireless/fixed-line activities could fit into the EU Taxonomy and highlight Telefonica as a case study on eligibility and alignment exposure for Telecoms.

Telecoms require $630bn in annual capex to support infrastructure critical for achieving key SDGs and net-zero goals, as covered in our Green Capex series (Exhibit 1). According to ETNO, Europe will require €300 billion across fibre and 5G to fully upgrade existing networks by 2027. Our Green Capex series dives deeper into critical investments, enablers and beneficiaries to the Net Zero transition accompanied by water and infrastructure goals.

Exhibit 1: On average, corporate reported Taxonomy-eligible revenue is showing low levels of eligiblity
Corporate reported Taxonomy-eligible revenue from 18 GS covered Telecommunication Services companies currently reporting, FY 2021

Company Name	Total Eligible Revenue
Royal KPN	0.0%
1&1 AG	0.0%
Infrastrutture Wireless	0.0%
Freenet	0.1%
OTE Group	0.6%
Tele2	0.6%
Telenor	1.0%
Telia Co.	1.0%
Bouygues	*1.0%
Orange SA	1.4%
Deutsche Telekom AG	1.8%
Cellnex	2.4%
Telecom Italia SpA	4.0%
Grupa Pracuj	5.8%
Proximus NV	10.0%
Elisa Oyj	14.2%
United Internet AG	16.1%
Telefonica	51.6%
Average	6.5%

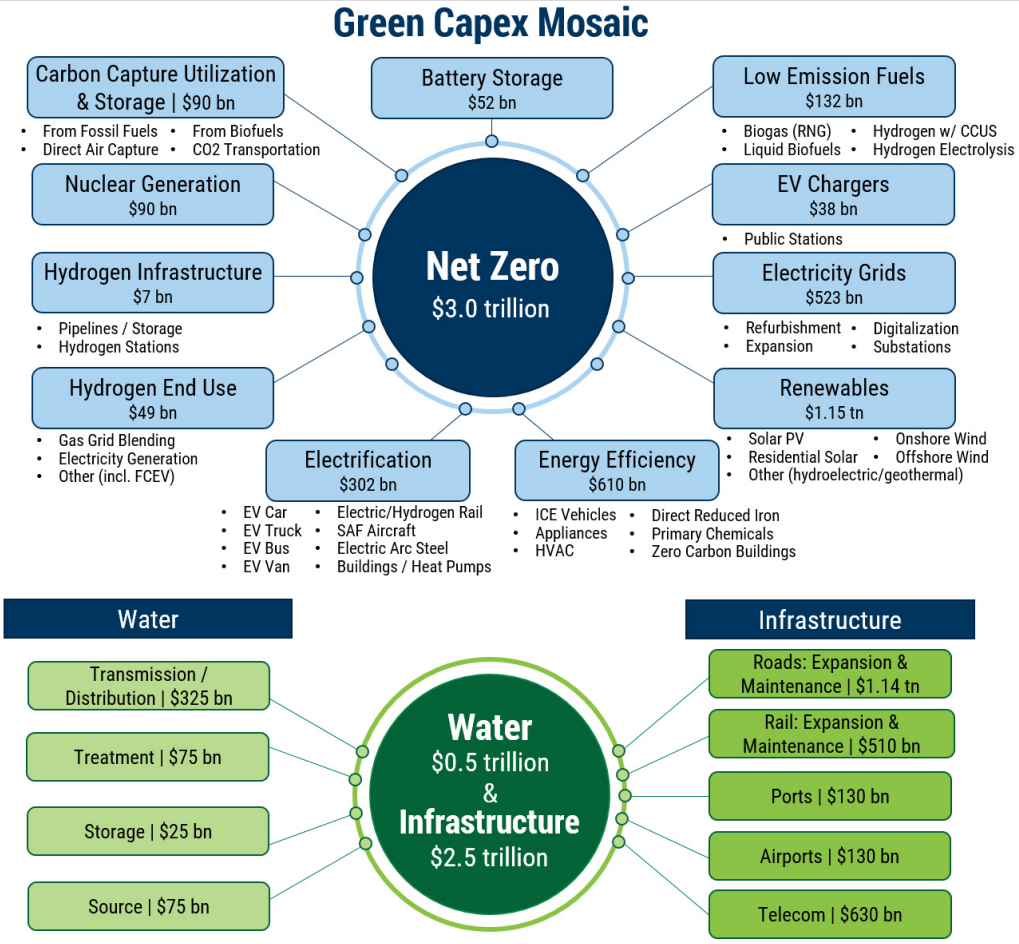
*1% of Bouygues's eligible revenue comes from its Telecom & Media (T&M) business. The T&M total eligible revenue is 35%, primarily coming from its construction business.

Source: Company data, Goldman Sachs Global Investment Research

The authors of this report would like to thank Katie McKenzie for her contribution to this report.

Exhibit 2: Fibre and 5G investment is critical to meet the $630bn in annual Green Capex needed from Telecom's contribution to net-zero and SDG goals

Critical technologies/focus areas and annual investment in the 2020s to achieve Net Zero, Infrastructure and Clean Water needs

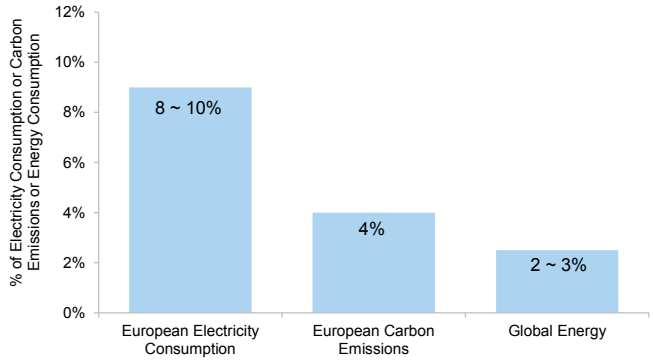


Source: IEA, McKinsey, OECD, Company data, Goldman Sachs Global Investment Research

The scale of energy usage and emissions for ICT

Current estimates suggest that the ICT sector is responsible for 8-10% of European electricity consumption, around 4% of European carbon emissions and consumes between 2-3% of global energy (Exhibit 3).

Exhibit 3: ICT is responsible for 8-10% of European electricity consumption, and 4% of carbon emissions, whilst the telecoms subsector is responsible for 2-3% of global energy consumption
% of ICT European Electricity Consumption/Carbon Emissions & Global Telecom Services Energy Consumption, 2020



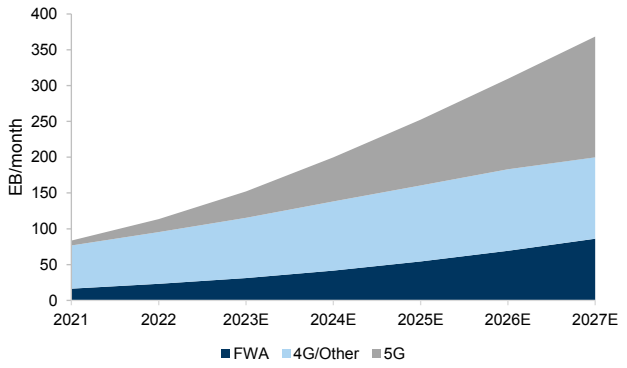
Source: European Commission

Data traffic is expected to rise dramatically, adding further energy consumption/emission challenges for the ICT industry. According to the IEA, global internet traffic doubled from 2017 to 2020 and is expected to double again by 2023 The nature of data transmission is also changing rapidly as mobile device data is expected to grow at triple the rate (+50% yoy) vs. wired and WiFi-only devices (+17% yoy) globally from 2018 to 2023. According to Ericsson, **mobile data traffic is expected to grow over 4x from 2021 to 2027 (Exhibit 4), highlighting the evolving energy/emissions challenges for global telecom companies.**

Currently, despite the rise in data traffic, ICT networks have been able to curb energy consumption given efficiency improvements largely coming from cloud-based data centres, and improvements in storage devices, network switches, and data centre infrastructure (Exhibit 5).

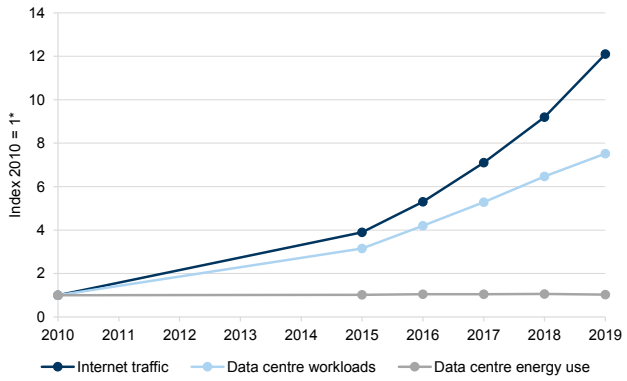
However, as data traffic is still expected to grow significantly and more traffic shifts towards mobile devices, new technologies will be needed to help curb energy consumption and ultimate emissions, particularly as Scope 2 emissions account for 92% of the Telecom industry's total emissions (Scope 1 & 2) (Exhibit 6). Current wireless and landline ICT networks will require significant technological advancements to manage data traffic and energy demand efficiently. We believe **fibre and 5G networks can replace existing networks as critical, energy-efficient solutions to growing data traffic demand, whilst reducing energy consumption.**

Exhibit 4: Mobile data traffic is expected to grow over 4x from 2021 to 2027, whilst FWA is also expected to increase, posing challenges for scaling wireless/landline networks…
World Fixed Wireless Access (FWA) and Mobile Data Traffic (4G/other & 5G) per month from 2021 to 2027



Source: Ericsson

Exhibit 5: However, data centres and network efficiency improvements have limited overall energy demand growth, even with the rapid surge in internet traffic
Global trends in internet traffic, data centre workloads and data centre energy use, 2010-2019

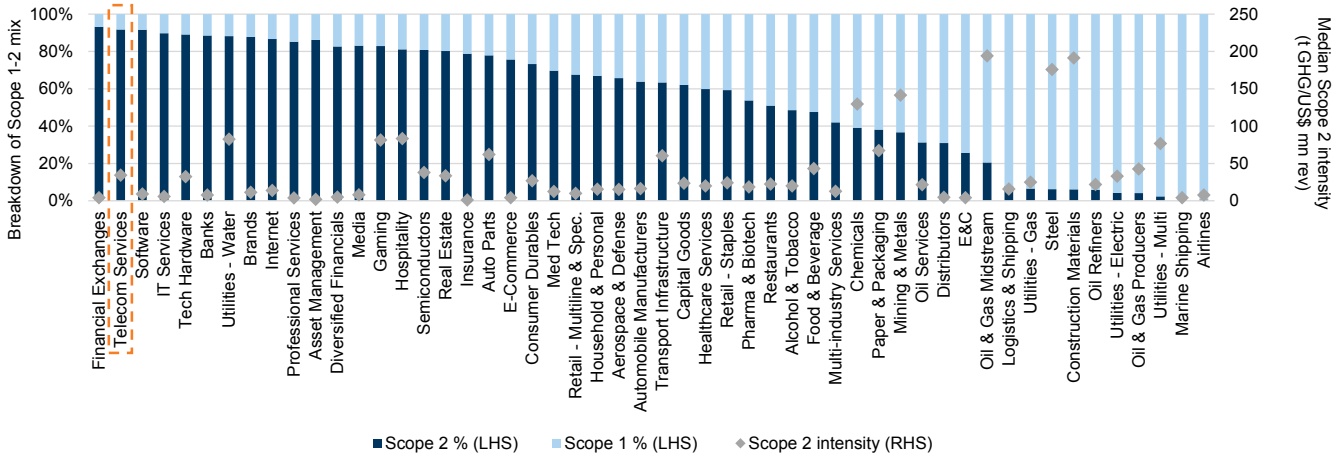


Indexed to 2010: Shows 2010 internet traffic, data centre workloads and energy usage as 1.

Source: IEA

Solving for energy efficiency will be crucial to the Telecom sector's decarbonisation pathway, as 92% of Telecom Services emissions are from Scope 2 with only 8% from Scope 1 (Exhibit 6). Scope 2 emissions are indirect GHG emissions from electricity, steam, heat, or cooling and occur at the facility where they are generated. In the case of wireless networks, energy consumption comes from base station operations to transmit the 4G/5G signals, whilst for fixed networks energy consumption is generated from copper transceivers / nodes.

Exhibit 6: Scope 2 emissions via energy consumption drive 92% of the Telecom industry's emissions, behind only Financial Exchanges as % of total emissions (Scope 1 & 2)
Breakdown of Scope 1-2 mix by sector and total GHG intensity - figures indicate sector median within the MSCI ACWI based on latest GS SUSTAIN data.



(1) Scope 2 only includes location-based emissions; (2) the chart illustrates 13 sectors out of 52 sector classifications on our SUSTAIN framework.

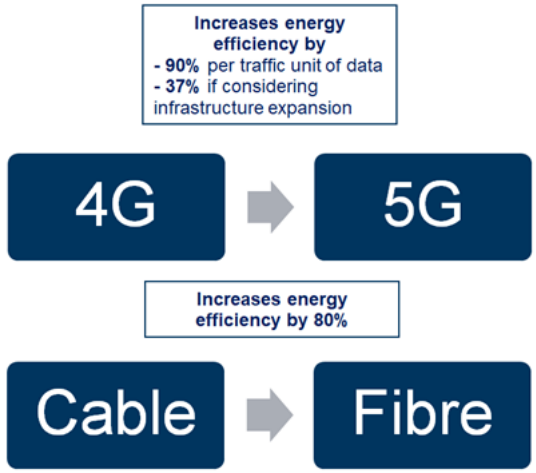
Source: Bloomberg, Refinitiv Eikon, Goldman Sachs Global Investment Research

Fibre and 5G: Critical technologies for Telecoms' net-zero pathway

With data traffic increasing significantly, Telecoms are reliant on expanding new technologies to limit their GHG emissions. Telecoms' contribution to decarbonisation will come largely in three forms, in our view: 1) direct operational improvements in 5G and fibre applications, helping to improve energy efficiency by 90% per traffic unit of data processed for 5G compared to 4G, and by 80% for fibre vs. copper networks (Exhibit 7); 2) direct expansion/access of renewable energy, and; 3) indirectly, by serving as a critical enabler towards decarbonising and scaling the digital economy, which can support additional indirect environmental benefits via the smart grid and other IoT applications.

Existing copper and cable networks are transitioning to fibre, and an evolutionary progression from 4G to 5G is occurring. These incoming networks have energy efficiency advantages along with improved capacity and data transmission speeds compared to alternatives. Globally, both 5G and fibre are seeing increasing penetration, with caveats by region (Exhibit 8 & Exhibit 9). These technologies are shifting the weightings of ICT emissions breakdowns over the next decade (Exhibit 10) and will be critical for managing the industry's overall energy usage and ultimate carbon footprint. **1) mobile networks emissions are expected to decrease, due to the rollout of 5G network; 2) emissions are also reducing through renewable energy efforts across the sector; 3) whilst fixed networks are increasing from 9% to 25% of industry total emissions (Exhibit 10).** Contributing factors to the increased weighting of fixed networks' emissions include: a) the limited rollout of fibre, largely in the US hindering the energy efficient advantages; b) the rapid urbanisation of the developing world, leading to increased demand for ICT and telecom services; c) large growth in data traffic demand (c.40% CAGR in 2021-27), meaning that although next-generation technologies improve efficiencies, aggregate power consumption will increase; d) dual-running fibre/copper networks will lead to increased energy consumption until policy / pricing incentivise consumers to switch or until uptake is forced.

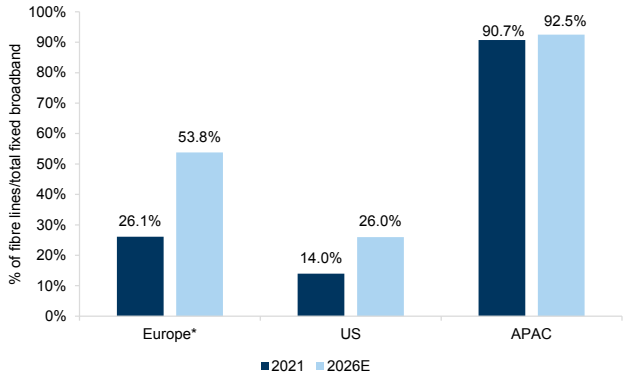
Exhibit 7: Energy efficiency of fibre vs cable and 5G vs 4G



Source: EU Commission, Company Data

Exhibit 8: APAC is leading in fibre rollout (expected to be 92.5% by 2026), with significant expected improvements in Europe, whilst the US lags behind

% of fibre lines as part of total fixed broadband lines

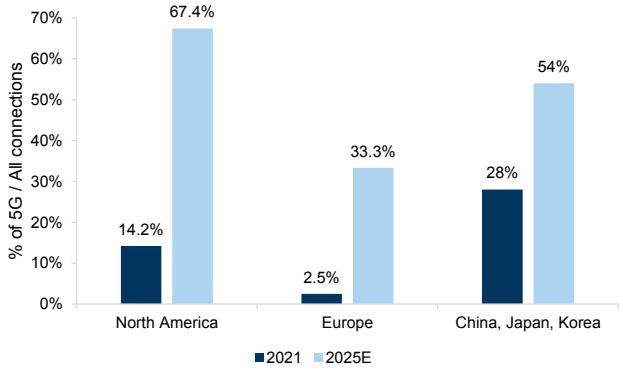


*Europe fibre penetration measured as % of European FFTH/B household penetration.

Source: Prysmian, FFTH

Exhibit 9: 5G penetration in Europe is currently lagging NA & Asia and is expected to continue to fall behind, although penetration will likely significantly increase for all regions

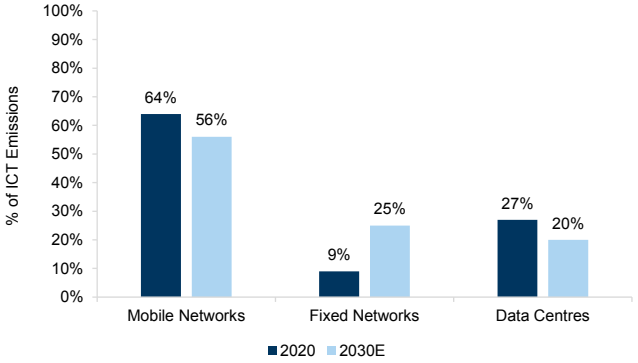
5G connections as % proportion of all connections, 2021-2025E



Source: GSM Associates

Exhibit 10: Mobile networks & data centres % of emissions are expected to decrease (by 8% and 7% respectively) over the next decade, whilst fixed networks' proportion of ICT emissions is expected to increase by 16%

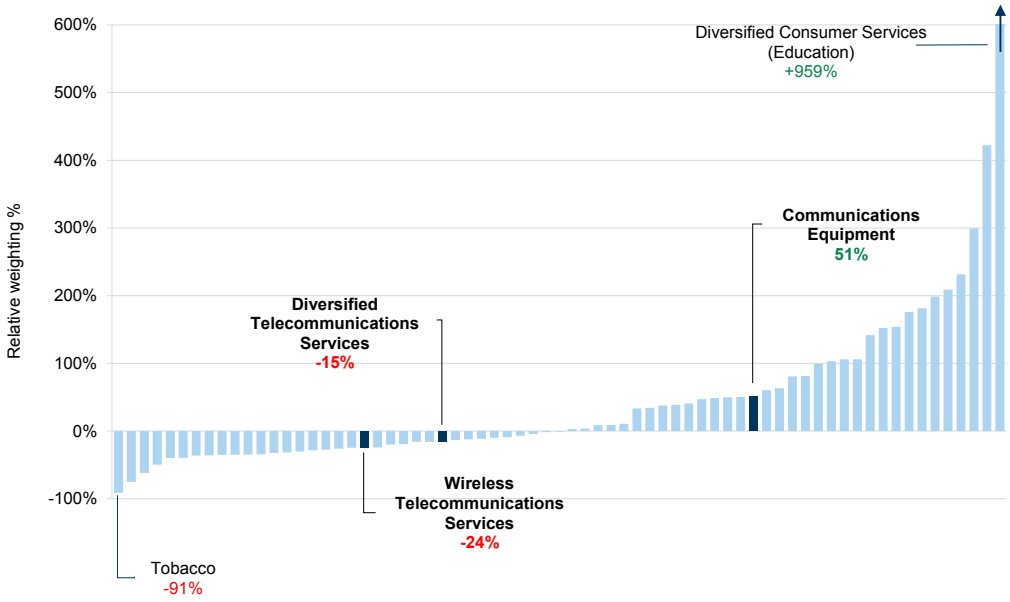
ICT Emissions Breakdown from 2020 to 2030E



Source: BT

Despite direct and indirect carbon benefits offered by Telecoms, the sector is underweight within ESG funds, as diversified and wireless telecommunications services are underweighted by 15% and 24%, respectively. However, the infrastructures behind communications services are gaining some recognition (51% overweight). Therefore, we believe Telecoms has an opportunity to utilise these decarbonising technologies, like communications equipment stocks have, to gain representation in the ESG universe.

Exhibit 11: Telecommunications are underweighted in ESG fund holdings, while communications equipment providers are 51% overweight
Communication Services and other select GICS 3 sub-sectors average relative over/underweight in >4,500 ESG funds versus weight in the MSCI ACWI, June 2022



Source: Morningstar, Refinitiv Eikon, Goldman Sachs Global Investment Research

NTT Group: A case study on Telecoms' contribution to country and global GHG emissions

NTT is Japan's Telecoms company, operating in the fields of integrated ICT and communication networks.

Nippon Telegraph and Telephone (NTT), Japan's largest Telecoms company, has set some ambitious GHG emission reduction targets for firm reductions, along with estimating country-specific and global impact emission reductions, enabled by its technologies.

By 2030, NTT aims to reduce its GHG emissions by 80% and be carbon-neutral by 2040. The adoption of next-generation technologies, Innovative Optical and Wireless Network (IOWN), which includes photonics networks and digital twin computing, is estimated to reduce the company's GHG emissions by 55% by 2040, with the remaining 45% driven by renewable energy and offsets. NTT's 5G technology has been operating without GHG emissions from October 2021 due to the ratio of 100% renewable energy/total energy consumption being greater than the ratio of the number of 5G subscriptions / phone subscriptions. NTT has said that the rollout of these technologies beyond telecommunications, along with its own GHG emission reductions, will lead to **over a 4% reduction in Japan's GHG emissions by 2040 and over a 2% emissions reduction globally.**

Fibre: The fastest, greenest and most energy-efficient broadband technology available

Fibre rollout will be critical to the Telecoms green transition — providing high speed, scalable and reliable broadband with low energy consumption and GHG emissions. Fibre networks have been recognised as the **most efficient networks** in nearly every scenario, reducing the energy footprint vs copper by 85%, according to Telefonica. Once the switch from copper-broadband services to fibre is complete, TalkTalk estimates that its full-fibre network will be up to 80% more energy efficient with less active hardware technology required to boost the signal and significantly reduced line faults in a fibre world. According to Europacable, at speeds of 50Mbps fibre networks consume 56kWh vs. 88 kWh for DOCSIS (cable networks), **translating into carbon emission of 1.7 tons of CO_2 per year per capita for fibre compared to 2.7 tons for cable networks.** The higher the speed of connectivity, the greater the energy and carbon benefit fibre can produce.

However, global Telecoms are facing a rollout issue. Although it is estimated that fibre will make up 92.5% of APAC's fixed broadband by 2026, it will only make up a quarter of US fixed broadband (Exhibit 8) — According to industry experts, this is due to the US facing significant issues with fibre broadband access, as the majority of Americans will not have access to fibre in their homes by 2026. However, a federal proposal released this year shows the first steps towards a wide-scale rollout of fibre which, if implemented, could prevent the growth of the fixed networks proportion of emissions within the sector.

Fibre is essential to enabling the Future of Work/telecommuting that delivers additional direct low-carbon benefits. While more difficult to quantify, the improvement in network speeds and reliability should deliver real economy carbon improvements by enabling the Future of Work and hybrid working environments, reducing the need to travel/emit carbon. Reliable internet networks were critical for supporting the work-from-home shift during COVID, which saw global CO_2 emissions decline nearly 6% due to less commuting and travel; we see fibre networks as critical to enabling the expected increase in telecommuting/hybrid work environments in the future, with 84% of people who worked from home in the UK during the pandemic planning to use a hybrid work structure in the future. **Fibre broadband therefore serves as a necessary technological advancement to enable new technologies and business models that can drive further carbon benefits**.

Puts and takes to the 5G energy-efficiency and low-carbon debate

There remains a debate over the ultimate increase/decrease in total energy usage of 5G versus existing 4G and 3G networks. On one hand, absolute energy usage is expected to increase for 5G networks as data traffic shifts towards mobile devices and additional base stations are needed (vs. 4G), while the ultimate energy efficiency per unit of data transmitted vs. existing networks is expected to increase significantly. We assess the key stats and debates below.

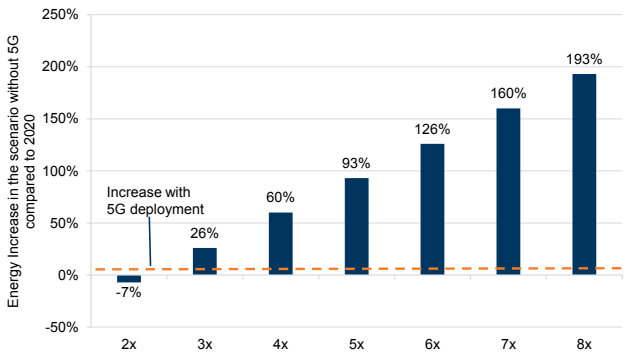
Initially, according to the European Commission, 5G deployment will increase total energy consumption due to the need for additional supporting infrastructure. 5G will require c.1.4 to 2x more 5G base stations/towers vs. existing 4G base stations due to the high radio frequency and limited network coverage of high band 5G caused by the higher frequency being used. 5G has 3 key bands: 1) **low** – which covers a wide area but has less capacity; 2) **mid** – a good balance of coverage and capacity, suitable for both suburban and metro areas; and 3) **high** – high capacity but shorter transmission range, i.e., works for stadiums full of thousands of people, but not in suburban areas; therefore, more base stations are required to scale this band of 5G, hence increasing overall energy consumption. **Growth in data will also add to the absolute energy demands of 5G networks.**

However, the European Commission has stated that 5G will bring significant improvements for energy consumption per traffic unit, with Telefonica and Nokia finding that 5G is 90% more energy efficient per traffic unit than 4G, highlighting that the technology will be critical for handling the expected increase in data traffic. According to Axon, **using a case study in Belgium, despite the initial increase in energy consumption, a 5G network is estimated to still consume up to 37% less energy than 4G networks, helping to mitigate excess emissions**. The full benefit of 5G vs. 4G will depend heavily on expectations around data growth by 2030 (Exhibit 12 & Exhibit 13). Contributing factors to assess the ultimate energy efficiency of 5G vs. 4G networks include:

- **The maturity and ultimate data throughput of the 5G network.** According to Orange, a 5G antenna initially consumes 3x the amount of energy of 4G antennas, but as 5G can handle significantly higher data throughput, its energy consumption per unit of data is estimated to only be 10% of 4G by 2025 and 5% by 2030 as traffic grows.
- **Retirement rate of outdated infrastructure,** as 5G replaces 2G/3G/4G networks, it should bring further energy benefits.
- **New energy efficiency features** such as 'sleep mode' allow IoT devices to extend battery life and use less energy by transmitting less.
- **Yet, 5G is expected to lead the mass small cell deployment** (up to 1000 small cell per square km in environments like stadiums), pressured by significant expected data traffic growth (over 4x between 2021 and 2027), increasing power consumption and CO2 emissions.
- **5G is expected to catalyse the introduction of new technologies raising energy consumption, but also enabling additional low carbon benefits.** Increases in

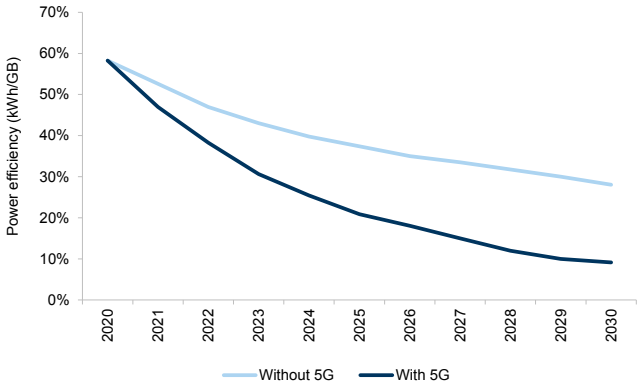
initial energy consumption of new IoT, edge servers, and smart devices will be offset by carbon benefits from smart grid solutions (Exhibit 15).

Exhibit 12: Absent 5G, absolute energy consumption expected to increase dramatically across various data growth scenarios
Energy increase expected in scenarios without 5G compared to 2020 baseline



Source: Axon

Exhibit 13: 5G deployment could lead to a 70% reduction in power consumption per bit by 2030 vs. non-5G networks
Energy efficiency per bit in access networks with 5G vs. without 5G, 2020 - 2030E



Source: Axon

Potential rollout roadblocks: The 5G 'Not In My Back Yard' and health debate

Although 5G enables the climate transition and is highly energy efficient, there are concerns surrounding the health impacts of 5G that could limit its rollout. A rise in activism from communities aiming to ban 5G infrastructure, particularly near homes, is occurring worldwide. Concerns surround the lack of a full investigation into the potential 5G impact on health prior to the mass rollout of the technology globally, specifically regarding exposure to radiofrequency radiation.

An appeal to the EU in 2017, backed by >390 scientists and medical doctors, requested a temporary ban of 5G deployment until a scientific evaluation of potential negative consequences to health were investigated; the EU has not responded to the request. However, some regions, including Brussels, Italy and India, have taken independent actions to limit electromagnetic radiation, often slowing the rollout of 5G. **The Belgian government halted its 5G pilot in Brussels in 2019, due to unknown health concerns and 5G's inability to meet the city's radiation rules; only recently has it considered easing the restrictions...**

...given that there are currently no known health risks linked to 5G, according to Cancer Research UK. Regardless of outcomes confirming the safety of 5G, the perception of safety issues could become a more meaningful roadblock to the rollout of the technology in local communities.

Fibre and 5G will also serve as critical enablers to new low-carbon technologies and business models

In addition to direct energy efficiency gains, studies suggest that 5G and the fibre-enabled large-scale uptake of smart digital solutions across the economy can reduce global CO_2 emissions by 15%, given other sectors rely on Telecoms to enhance their operations, i.e., smart gas meters being supported by the Internet of Things (IoT) and 5G. **Together, 5G and IoT could enable the reduction of UK emissions by 17.4 million tonnes of CO_2 per year**. IoT cannot scale using 4G networks, whilst 5G

provides quicker and more reliable connectivity that will unlock a vast IoT ecosystem. 5G can enable various energy-efficient, carbon-reducing technologies and solutions, including smart buildings (i.e., automated heating), smart work (i.e., video conference and digitalised offices) and smart travel (i.e., route optimisation) (Exhibit 14).

Exhibit 14: Smart grid solutions could reduce global emissions by c.8% by 2030 (in a high-emission-reduction scenario)
Smart solutions global GHG emission reduction potential across medium- and high-reduction scenarios by 2030

ICT solution category	Medium reduction scenario	High reduction scenario
Smart grid	1.6%	3.9%
Smart buildings	0.9%	1.4%
Smart transport	0.6%	0.6%
Smart travel	0.9%	0.9%
Smart services	1.6%	1.6%
Total	**5.6%**	**8.4%**

Source: Ericsson

EU Taxonomy & Telecoms: Key debate for assessing eligibility and alignment

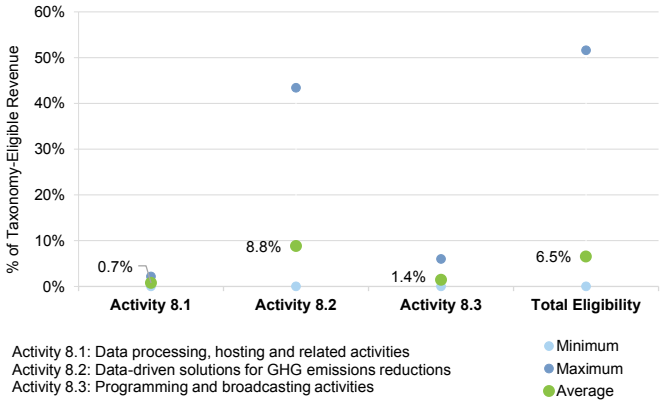
Given the nascency of the EU Taxonomy, there is confusion around the process of reporting and whether core Telecoms activities are covered as eligible under the Taxonomy. Of the Telecoms companies which have reported their eligible revenue, some think that the majority of their core business activities are not yet included under the Taxonomy...

...however, we believe that the Taxonomy does cover core business activities of Telecoms companies, including both fixed and mobile networks, under economic activity 8.2, "Data-driven solutions for GHG emissions reductions", given the activity covers NACE sector "J61: Telecommunications" and in the description states *"**ICT solutions** aimed at collecting, **transmitting**, storing data…where those activities are **predominantly aimed at the provision of data** and analytics **enabling GHG emission reductions**"*. Additionally, the activity description mentions 5G as an ICT solution that is potentially aligned.

Current eligibility figures from 18 Telecoms companies are significantly lower than expected, with only 6.5% of turnover reported as Taxonomy-eligible vs. our estimate of c.75% (including fixed and mobile networks) (Exhibit 15)**.** Many companies have highlighted the lack of consensus around the coverage of core activities and thus reported conservative figures (such as United Internet), while highlighting that Taxonomy figures may change next year upon further guidance. However, as described above, we believe the current Taxonomy covers core telecom activities and that eligibility and alignment figures should be materially higher, including mobile (with 5G potentially eligible and aligned) and broadband networks (with fibre as eligible and aligned). The European Telecommunication Network Operators' Association (ETNO) is currently lobbying for clarification on the topic and inclusion of a new activity that more clearly covers ICT solutions' core operations. **Given the initial lack of clarity, we expect correct interpretation and reporting to take at least 2-3 years before Taxonomy figures are fully comparable.**

Some companies have reported ranges of eligibility, which can more accurately reflect the contribution of ICT solutions to the climate change mitigation Taxonomy objective. Telefonica currently reports a minimum and maximum range of eligibility, with the maximum range including transmission revenues covering fixed networks (fibre and copper) and mobile (2G, 3G, 4G, and 5G) networks. The company currently reports a minimum of 9% and maximum of 51.6% of revenue and 1.31% to 67.6% of CapEx as eligible. For more detail, see the grey box below. **Failure to include and report on fixed and wireless networks as eligible (and aligned where appropriate) would significantly hamper the Telecom sector's inclusion in the EU Taxonomy and limit ultimate recognition amongst investors to the contribution the sector can make towards decarbonisation objectives, in our view.**

Exhibit 15: Current reporting on Telecoms' Taxonomy eligibility is mixed, offering a wide range in outcomes
Range and average of % Taxonomy-eligible revenue for key Telecom Taxonomy activities and overall eligibility reported by 18 GS covered European Telecoms Companies



Source: Company data, Goldman Sachs Global Investment Research

We believe fibre and 5G life-cycle carbon benefits could align the Telecoms to the existing Taxonomy performance criteria for "data driven solutions for GHG emission reductions". As described above, the activity includes "transmission" and "provision of data" where "the ICT solution demonstrates substantial life-cycle GHG emissions savings compared to best performing alternative solutions/technology". On this basis, fibre and potentially 5G could qualify as aligned based on existing evidence of their life-cycle benefits versus existing technologies. Additionally, any 5G applications that allow for connectivity of IoT devices that enable low-carbon outcomes can also qualify as aligned per the activity description (Exhibit 19).

However, assessing potential alignment remains difficult based on a lack of granular data from Telecom companies. The key challenge for investors is Telecom companies do not provide a breakdown of their revenue/capex for convergent services, i.e., % from fibre or 5G, and some do not provide a business services breakdown, i.e., mobile and fixed. A lack of available data makes it challenging for investors to accurately calculate Telecom companies' aligned revenues/capex, meaning the sector will not get the appropriate recognition under the Taxonomy.

The primary reason for this lack of disclosure is that figures can be difficult for corporates to calculate: **1) 5G is most challenging** as a 5G-contracted customer's phone will connect to 3G/4G networks if the area is not 5G covered, making it difficult to calculate the exact % of revenue coming from 5G; **2) Fibre networks currently often combine with copper,** making it difficult to differentiate revenue in some cases and **3) Most Telecom companies only disclose the number of houses covered by fibre and not those opting into fibre contracts.**

Case Study: Telefonica's EU Taxonomy Reporting

Telefonica is a Spanish multinational telecommunications company that provides mobile services, fixed-line telephone business and digital services. The company has been committed to digitalisation over the past decade and expanding services in IoT, the cloud, 5G and fibre broadband.

We assess Telefonica's EU Taxonomy reporting in its 2021 Annual Report, which serves as an illustrative example of both a narrow and expansion view of Taxonomy eligibility for both turnover and CapEx.

Taxonomy-eligible revenue is the proportion of revenue covered under economic activities of the EU Taxonomy over total revenues.

Telefonica's Taxonomy-Eligible Revenue

Telefonica reports a range of eligible revenues across relevant economic activities. The company reports a *minimum* level of turnover eligibility of 9% (includes only digital services, i.e., cloud services & IoT) and *maximum* eligibility of 51.6% including digital services & data transmission revenues from fixed (fibre and copper) and mobile services (2G to 5G) (Exhibit 16), which we believe correctly captures the eligible activities largely under activity 8.2, "Data-driven solutions for GHG emissions reductions".

Taxonomy-eligible CapEx is the proportion of CapEx associated with assets or process covered under the Taxonomy's economic activities.

Telefonica's Taxonomy-Eligible CapEx

For CapEx, Telefonica reports a minimum of 1.31% and maximum of 67.6% as eligible. **Telefonica primarily considered investments into projects surrounding fixed and mobile networks such as fibre and 5G, when calculating its maximum eligible CapEx (Exhibit 16).** The company also took into account investments related to the access, infrastructure and transmission of its services.

Telefonica's eligible revenue and CapEx are highest under activity 8.2. (Exhibit 16) which, as discussed, includes fixed and wireless services as eligible and 5G and fibre as potentially aligned, in our view.

Exhibit 16: Telefonica's Taxonomy-eligible activities, revenue & CapEx

Taxonomy activities		Telefonica activities	Eligible Revenue	Eligible CapEx
Climate Change Mitigation	**8.1** Data processing, hosting and related activities	Activities related to cloud services and data centres	2.2%	0.1%
Climate Change Mitigation	**8.2** Data-driven solutions for GHG emissions reductions	- Digital services related to data collection, transmission and analysis that enable the reduction of emissions arising from other activities - Digital solutions that support data transmission, such as 5G - *For CapEx only:* Acquisition of spectrum for deployment of mobile technologies embedded in digital solutions	0.8% ~ 43.4%	0.01% ~ 66.3%
Climate Change Adaptation	**8.3** Programming and broadcasting activities **13.3** Motion picture, video and television programme production, sound recording and music publishing activities	Services related to the programming and broadcast of television content	6%	1.2%
Total 2021			9.0% ~ 51.6%	1.31% ~ 67.6%

Source: Company data

Our estimations of Telefonica's potentially Taxonomy-Aligned Revenue & CapEx

Telefonica's Estimated Taxonomy-Aligned Revenue - inconclusive

Within its Taxonomy-eligibility reporting, Telefonica states that minimum revenue eligibility includes **digital services** (i.e., cloud and IoT) and the maximum value includes

both digital services and **data transmission solutions** (fixed and mobile). The maximum eligible revenue was 51.6% (Exhibit 16), whilst the minimum eligible revenue was 9%. Therefore, we can assume 42.6% (maximum minus minimum) will give us the data transmission % of eligible revenue which covers mobile (3G, 4G, 5G) and fixed networks (copper and fibre).

Spain currently has 85% fibre penetration and 59% 5G penetration. Given Telefonica is the market leader, it could be assumed the company accounts for the majority of both fibre and 5G penetration; **however, with the company not providing fixed and mobile network revenue splits, it remains challenging to estimate a credible turnover alignment figure.**

Telefonica's Estimated Taxonomy-aligned CapEx

Telefonica designated 45% of its total investment in 2021 to new generation networks, primarily to fibre and 5G developments/rollout. Therefore, **we can assume that 45% of its CapEx associated with 5G and fibre could be Taxonomy-aligned.**

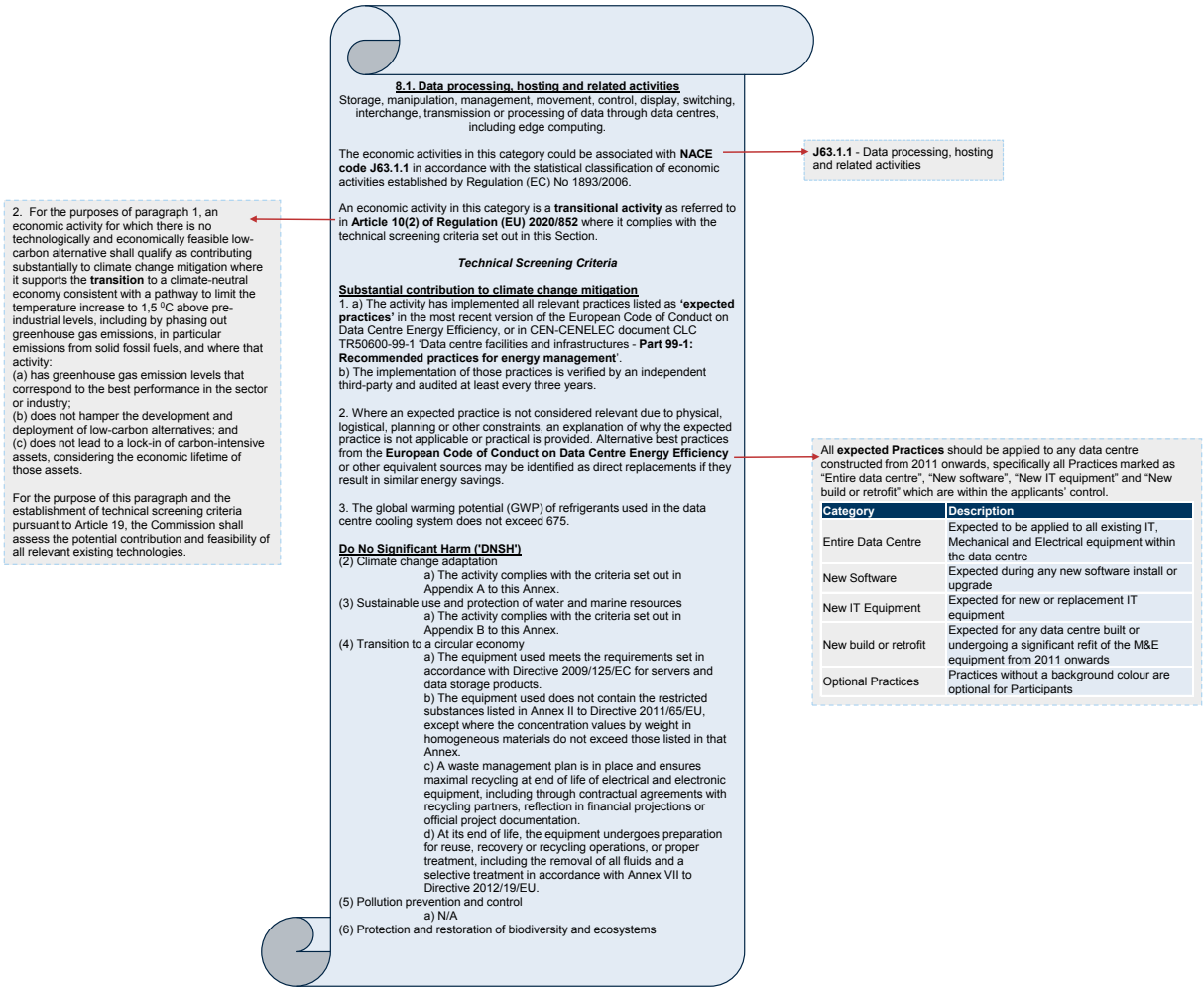
Exhibit 17: Proportion of Revenue & CapEx from 5G & Fibre Broadband

	Taxonomy-aligned Revenue	Taxonomy-aligned CapEx
5G	More info required	45.0%
Fibre		
Total	**-**	**45.0%**

Source: Company data, Goldman Sachs Global Investment Research

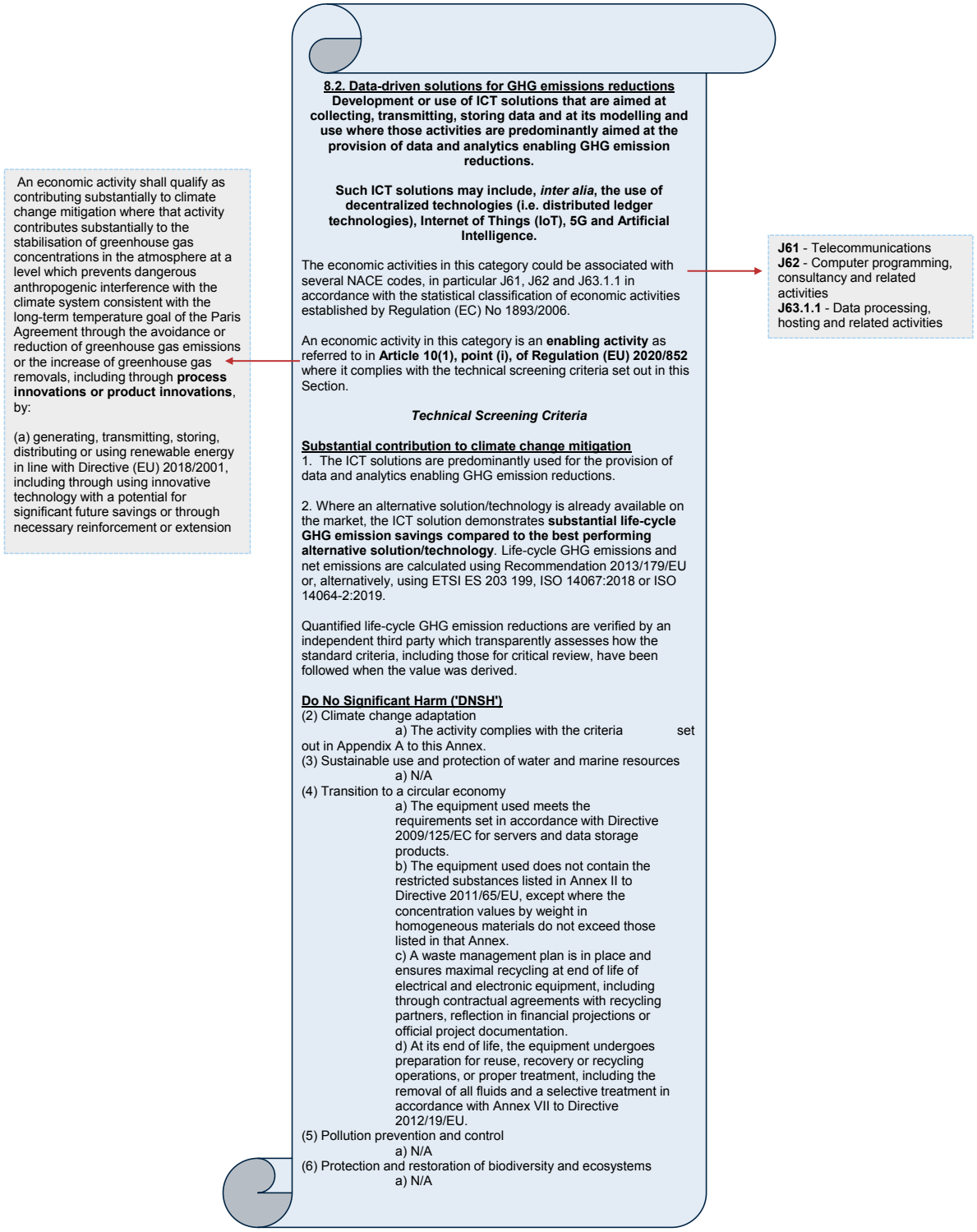
Appendix: Main Activities of the EU Taxonomy relevant to Telecoms

Exhibit 18: Description & Technical Screening Criteria of Taxonomy Activity 8.1 - Data processing, hosting and related activities



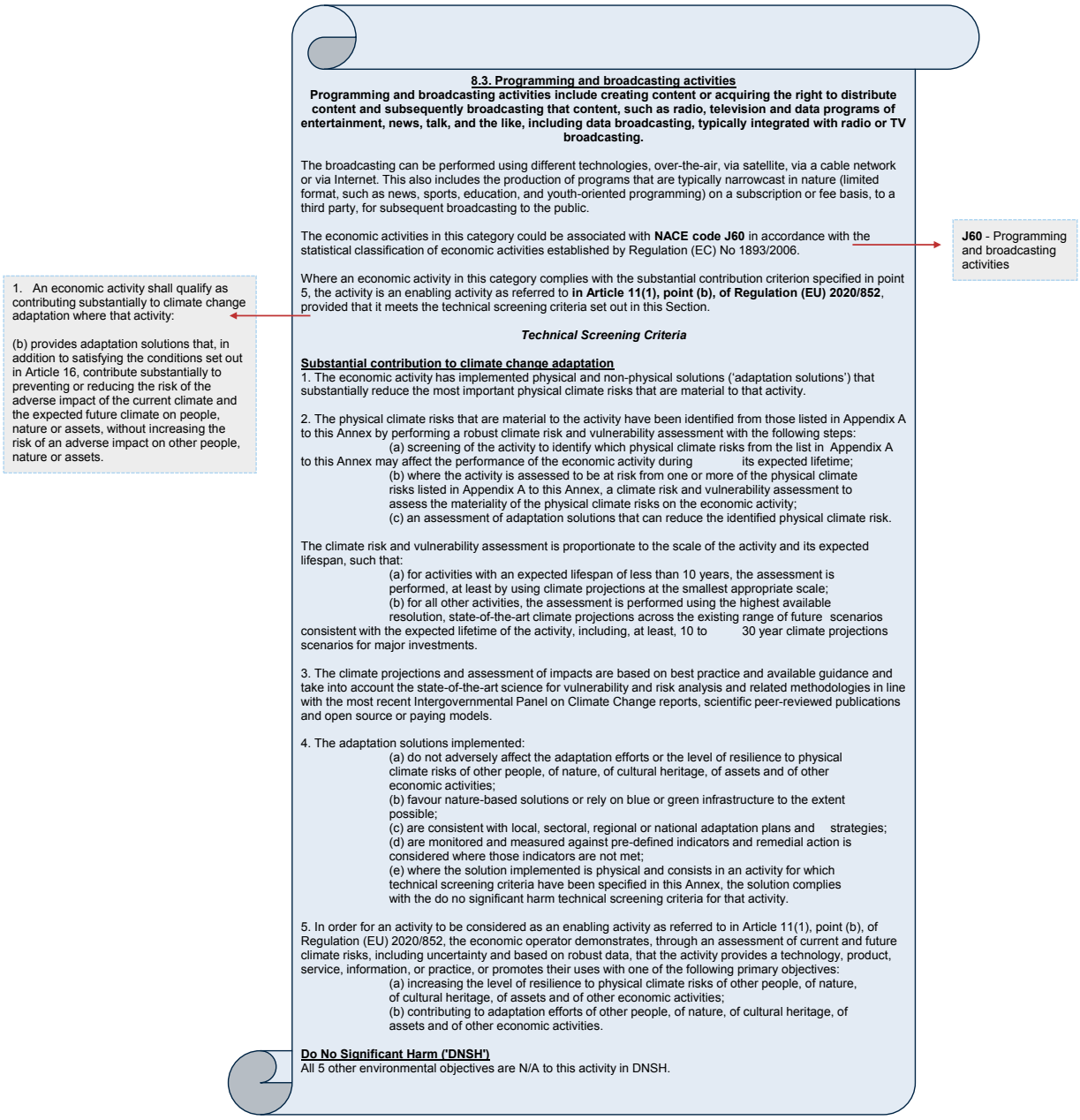
Source: European Commission

Exhibit 19: Description & Technical Screening Criteria of Taxonomy Activity 8.2 - Data-driven solutions for GHG emission reductions



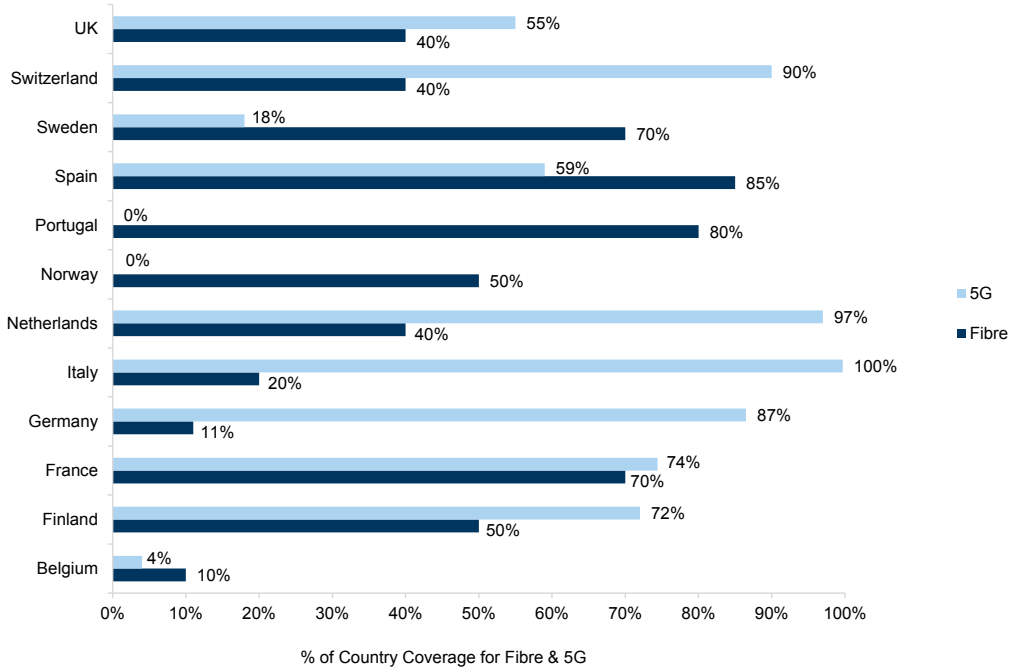
Source: European Commission

Exhibit 20: Description & Technical Screening Criteria of Taxonomy Activity 8.3 - Programming and broadcasting activities



Source: European Commission

Exhibit 21: European Breakdown of Fibre & 5G Coverage



Source: Goldman Sachs Global Investment Research

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