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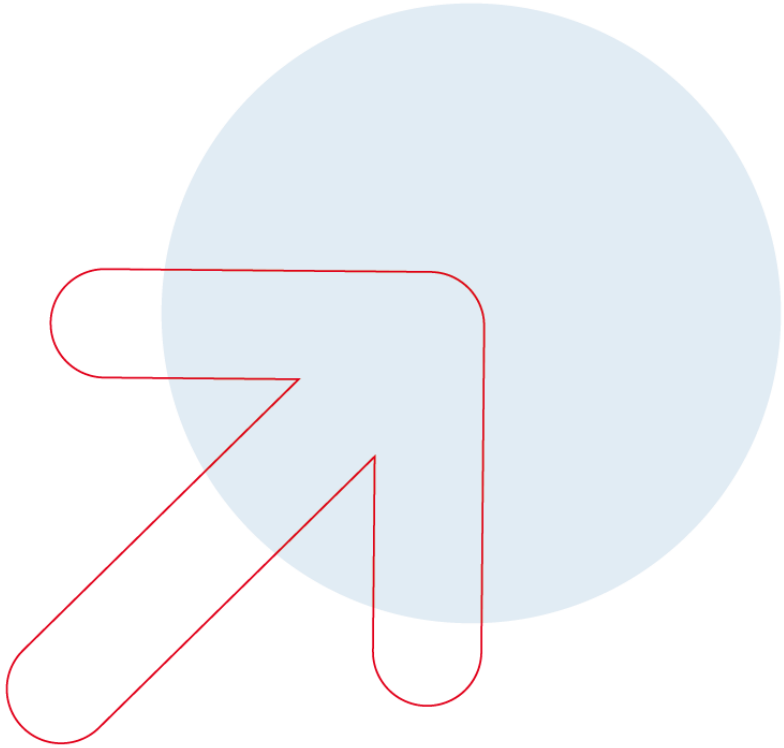

Sustainability of ECN in the Greek market

White paper

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1 Background and context

1.1 EU sustainability targets

Sustainability has been a key focus of the European institutions in recent years. The 2019 Communication on the European Green Deal,[1] and subsequent 2020 Communication,[2] set out a target for the European Union (EU) to achieve climate neutrality by 2050 with an interim target to reduce greenhouse gas (GHG) emissions by at least 55% by 2030 from 1990 levels. In June 2021, the Council and Parliament adopted legislation that enshrines these objectives into Europe's first Climate Law.[3]

Available literature[4] suggests that the ICT sector accounts for between 7 and 9% of global electricity consumption[5] and 2-4% of global greenhouse gas (GHG) emissions across its lifecycle[6]. ICT is not the primary contributor to environmental impacts in Europe or elsewhere, and has been identified as an enabler in reducing greenhouse gas (GHG) emissions in other sectors, for example through smart building, smart energy and transport initiatives.[7] However, the proportion of emissions coming from ICT could evolve in the coming years, as society becomes increasingly digitised and connectivity is integrated into an increasing range of activities and sectors. While some studies suggest that emissions from the ICT sector will remain largely stable,[8] and that the energy efficiency that will be achieved through digitisation of other sectors will outweigh impacts from the ICT sector itself,[9] others suggest that ICT could account for 14-24% global

1 EC (2019) – The European Green Deal, COM(2019) 640 final.
2 COM(2020) 562 final Stepping up Europe's 2030 climate ambition https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52020DC0562
3 https://data.consilium.europa.eu/doc/document/PE-27-2021-INIT/en/pdf
4 See also figures quoted in the EC 2024 White Paper "How to master Europe's digital infrastructure needs" chapter 2.3.5
5 Strategic Foresight Report 2022; EU Action Plan on Digitalising the Energy System
6 Figures as of 2020. WIK-Consult / Remboll 2022 Study for BEREC on Environmental impact of electronic communications https://www.berec.europa.eu/en/document-categories/berec/reports/external-sustainability-study-on-environmental-impact-of-electronic-communications
7 A summary of literature is included in WIK (2019) Analysis of the Danish Telecommunication Market in 2030 https://www.wik.org/fileadmin/Studien/2020/Analysis_of_the_Danish_TK_Market_in_2030.pdf
8 See for example Lundén, D. (Telia company); Malmodin, J.; Bergmark, P. (Ericsson Research); Lövehagen, N.: Electricity Consumption and Operational Carbon Emissions of European Telecom Network Operators. Sustainability 2022, 14, 2637.
9 GeSi (2015) - GeSI Mobile Carbon Impact, IEA (2017) - Digitalization and Energy. Ericsson (https://www.ericsson.com/4ab228/assets/local/about-ericsson/sustainability-and-corporate-responsibility/environment/accelerate-5g-report-27102021.pdf.) claims that connectivity is needed for climate solutions corresponding to approximately 550MtCO2e (equivalent to 15 percent of the EU's total emissions in 2017). Ericsson claims that by 2030, a further 55–170MtCO2e of emissions savings per annum could be enabled by selected 5G specific use cases applied as an illustration of its potential.

emissions by 2030/40.[10] Beyond climate change, it should also be noted that the ICT sector could also contribute to other environmental impacts including depletion of materials/minerals and water consumption.[11]

In this context, the European Green Deal Communication emphasises that the digital sector itself should be sustainable at its heart,[12] and the Commission's digital strategy[13] underlines the need for the ICT sector to "undergo its own green transformation" and proposes that by 2030, data centres and telecommunications "can and should become climate neutral." The 2023 European Declaration on Digital Rights and Principles for the Digital Decade[14] also includes commitments for Member States to support the development and use of sustainable digital technologies, incentivise sustainable consumer choices and foster sustainable and responsible corporate behaviour throughout the global value chain of digital products and services, promote the development, deployment and active use of digital technologies with a positive impact on the environment and promote sustainability standards and labels for digital products and services.

1.2 National initiatives to report on the environmental impact of electronic communications

In 2022, the Greek administration introduced a National Climate Law,[15] which seeks to promote the transition to climate neutrality in line with EU legislation on this subject. The Law requires[16] fixed and mobile telephony companies to submit by October 2023 a report on their carbon footprint for 2022. This report should include voluntary targets and actions to reduce or offset emissions, and should be updated annually.

Under the legislation, emissions should be calculated in accordance with the "2006 IPCC Guidelines for National Greenhouse Gas Inventories", as amended, and include direct greenhouse gas emissions and indirect greenhouse gas emissions from energy consumption, as defined in the "GHG Protocol WORLD RESOURCES INSTITUTE" or alternatively, according to the "ISO 14064 1:2018" standard, categories 1 and 2. Figures

10 Several studies show stable CO2e footprints despite increased bandwidth consumption e.g. Malmodin and Lunden (2018), Ministry of Transport and Communications, Finland (2020) - The ICT sector, climate and the environment. However, future projections vary with some having a more pessimistic outlook about the future contributions of ICT to global GHG emissions e.g. The Shift Project (2019) – Lean ICT – Towards Digital Sobriety, Andrea and Edler (2015), Belkhir and Elmeligi (2017)

11 BEREC Report on BEREC's role limiting the impact of the digital sector on environment (2022))

12 2019 European Green Deal

13 EC digital strategy „Shaping Europe's Digital Future" also provides the objective of climate neutrality for digital infrastructures. s.16 Data centres and telecommunications will need to become more energy efficient, reuse waste energy, and use more renewable energy sources. They can and should become climate neutral by 20 https://ec.europa.eu/info/sites/default/files/communication-shaping-europes-digital-future-feb2020_en_4.pdf

14 https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=OJ:JOC_2023_023_R_0001

15 National Climate Law (NCL): https://www.kodiko.gr/nomothesia/document/793411/nomos-4936-2022

16 Article 20: Measures to reduce emissions from businesses

should be audited by a body competent for the verification of reports concerning greenhouse gas emissions. The Natural Environment and Climate Change Agency[17] is responsible for implementing, maintaining and operating the publicly accessible electronic database. The platform was due to be available by May 2024, including APIs for telecom providers to automatically upload the data required by the Law.

The Law provides that the Ministry of Environment and Energy, following the consultation with the Scientific Committee on Climate Change which was set up to give advisory opinion on issues related to climate change, may examine the possibility of establishing emission reduction targets for specific sectors, which could include telecoms.

Another relevant initiative is the new National Circular Economy Action Plan,[18] which establishes a four-year roadmap (2021-2025) with 71 actions to boost sustainability.

Regulations regarding electrical and electronic waste include provisions for the recycling of large screens including monitors, TVs and laptops as well as small sized IT and telecom equipment including cell phones, routers, telephones and PCs.[19] These provisions are enforced by the Hellenic Recycling Agency (EOAN).

The collection of data is based on the Greenhouse Gas emission calculation standard “ISO 14064 Report Template” (posted on the website of the Ministry of Environment and Energy under Emissions calculation), which has been developed according to the ISO14064-1:2018 standard.

Concerning emissions, the following emissions are required to be reported:

- direct emissions in fixed sources (cat. 1.1),
- direct emissions in mobile sources (cat 1.2),
- direct emissions of processes (cat 1.3),
- diffuse GHG emissions in anthropogenic systems (cat 1.4),
- direct emissions and removals from agriculture, forestry and land use (cat 1.5),
- indirect GHG emissions from imported electricity (cat 2.1),
- indirect emissions from imported energy other than electricity (cat 2.2)

This means that only Scope 1 and Scope 2 emissions are covered under Greek national legislation. This reporting does not cover all of the aspects recommended by JRC (cp. section 2.2), especially the Scope 3 emissions.

Concerning the calculation of GHG emissions, companies can choose between different sources for the conversion of energy to CO2 equivalents (Ministry of the Environment

17 NECCA, https://necca.gov.gr/en/home/
18 https://ypen.gov.gr/perivallon/kykliki-oikonomia/16052-2/
19 https://www.eoan.gr/%ce%b5%ce%bd%ce%b7%ce%bc%ce%ad%cf%81%cf%89%cf%83%ce%b7/%cf%84%ce%b9-%cf%85%ce%bb%ce%b9%ce%ba%ce%ac-%ce%b1%ce%bd%ce%b1%ce%ba%cf%85%ce%ba%ce%bb%cf%8e%ce%bd%ce%bf%cf%85%ce%bc%ce%b5/#ahs

document, National Inventory of GHG Emissions (NIR), IPCC Guidelines for National Greenhouse Gas Inventories, Implementing Regulation (EU) 2018/2066, Laboratory Analyses or others[20]). The GHG protocol, for example recommends using emission factors that are specific to the energy source and region. Therefore the requirements meet with those of the GHG protocol.

Finally, operators publish their annual sustainability reports as part of their standard annual reports, or as standalone reports. The methodologies or standards used in the reports differs, however (see further data at section 3.2).

However, the planned reporting requirements within ESRS (published by EFRAG in a draft version)[21] go beyond those of the Greek legislation, which may provide scope for further alignment of the reporting regimes.

1.3 Scope of report

This white paper seeks to provide an overview of the information available from literature and electronic communication providers regarding the carbon footprint produced by ICT in Greece, with a focus on telecom networks. The paper also provides preliminary suggestions on policy actions that could be taken to mitigate environmental impacts from telecom networks in line with Greek climate legislation, drawing on insights from other EU Member States.

2 Sources of environmental impact and relevant reporting indicators

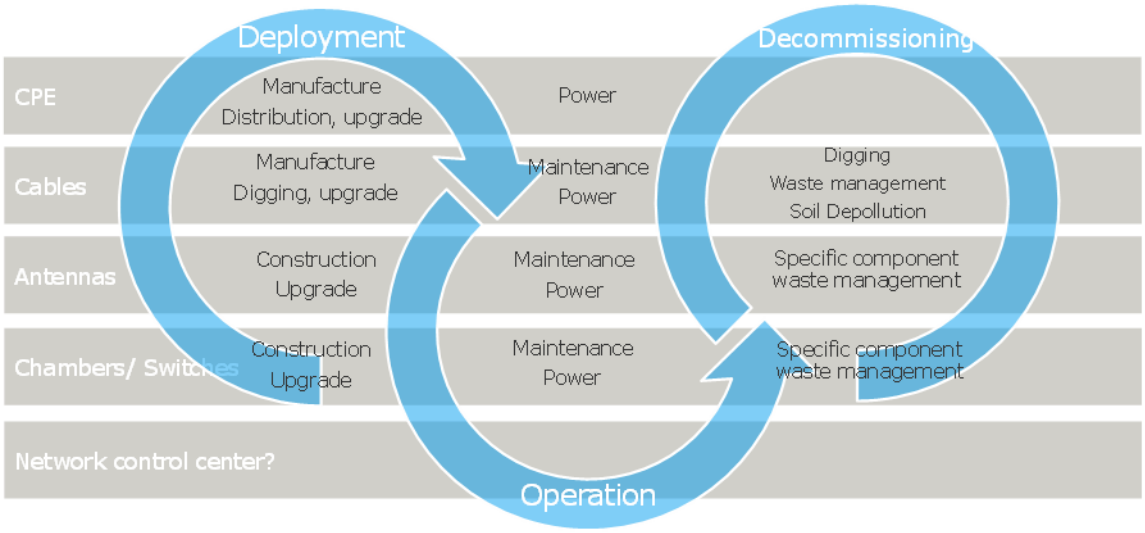
2.1 Sources of environmental impact

The lifecycle approach for assessing the environmental impacts of electronic communications networks involves evaluating the environmental effects at each stage of the network's lifecycle. This holistic view ensures that all potential impacts are considered, from the initial extraction of raw materials to the end-of-life disposal, as well as the energy consumed during the different phases (see Figure 2-1).

20 These different standards for the conversion of energy to CO2 equivalents are possible presets to choose from in the Excel sheet that the Ministry of the Environment provides for the calculation of emissions, cp. https://ypen.gov.gr/perivallon/klimatiki-allagi/ethnikos-klimatikos-nomos/efarmogi-ethnikou-klimatikou-nomou/, last accessed: 10/04/2024.

21 https://efrag.sharefile.com/share/view/s1a12c193b86d406e90b1bcd7b6bb8f6f/fo37c90b-9d9b-4432-a76b-27760cfcc01b

Figure 2-1: A lifecycle overview of the environmental impacts for electronic communications networks



Source: Ramboll and WIK-Consult[22]

The EU taxonomy reflects this holistic approach by considering a number of different environmental measures as follows:[23]

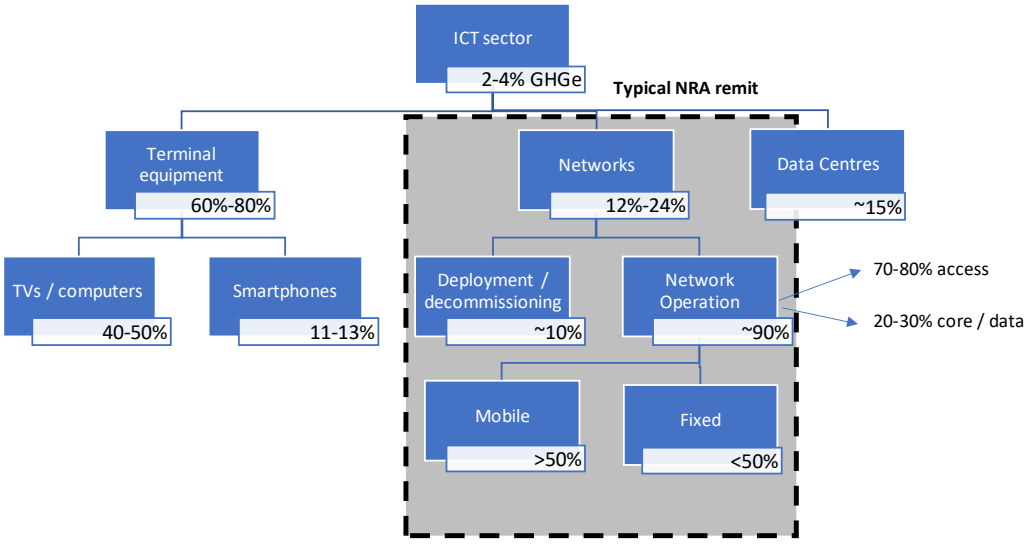
- Climate Change Mitigation
- Climate Change Adaptation
- Sustainable Use and Protection of Water and Marine Resources
- Transition to a Circular Economy
- Pollution Prevention and Control
- Protection and Restoration of Biodiversity and Ecosystems

As regards GHG emissions specifically, literature suggests that this is most significant during the operational phase of running electronic communications networks, and is greater for mobile networks than for fixed. However, the contributions to GHG emissions from the operation of electronic communications networks are significantly lower than those associated with electronic end-user devices, in particular larger screens such as TVs and laptops. Figure 2-2 shows the size of emissions from electronic communications networks compared with those arising from terminal equipment and data centres .

22 https://www.berec.europa.eu/en/document-categories/berec/reports/external-sustainability-study-on-environmental-impact-of-electronic-communications

23 See glossary at the end of this report for further explanations.

Figure 2-2: Breakdown of contributions to GHG emissions within the ICT sector



Source: Godlovitch et al. (2021), p. 2.

The main GHG source from operating ECNs is the power supply of the active components. In fixed broadband lines these are (for access networks):[24]

For VDSL2-Vectoring:

- DSLAM – DSL Access Multiplexer
- Vectoring calculating unit
- Connection into the core network
- Air conditioning

For DOCSIS 3.0:

- Cable modem termination system – CMTS
- Fibre node including A/B/C-Line Amplifier
- Connection into the core network
- Air conditioning

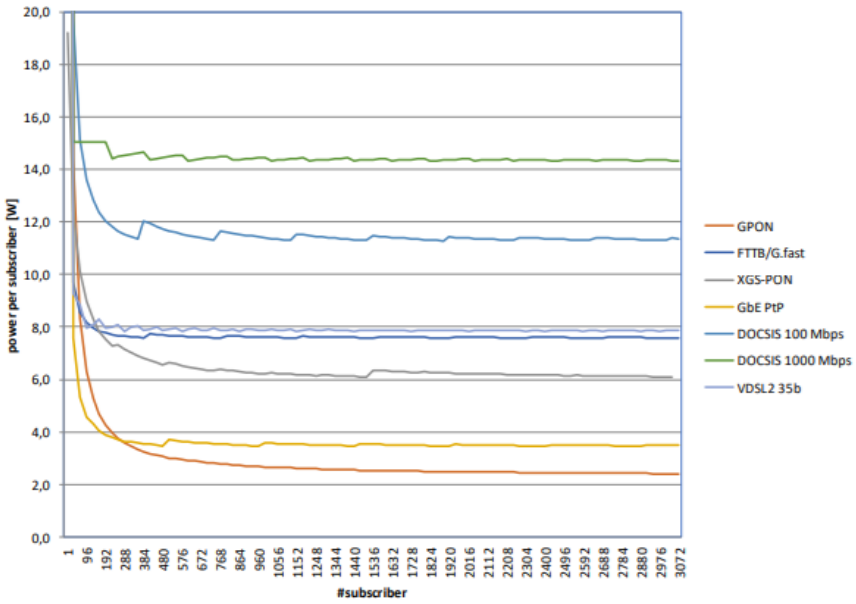
For FTTH:

- Optical line termination
- Central office equipment
- Connection into the core network
- Air conditioning

In a study for Germany, Obermann (2022) compared the different technologies. The result is shown in Figure 2-3.

24 Cp. for this enumeration: Breide et al. (2021).

Figure 2-3: Power consumption of the different access technologies per subscriber as a function of number of subscribers.



Source: Obermann (2022), p. 11.

The result shows a clear advantage of fibre technologies in terms of energy consumption[25].

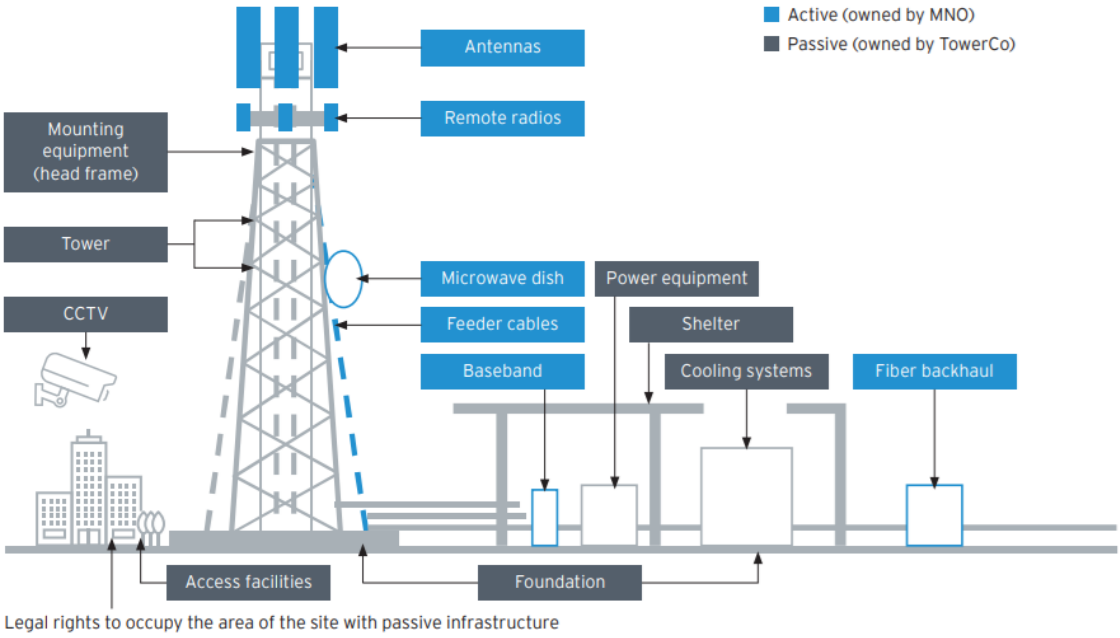
In mobile networks, the main part of the power consumption depends on the frequency transmission by the Radio Unit (RU).[26] Other essential elements are the Radio Remote Head (RRH) and the base station. The main function of the Remote Radio Head is to modulate, amplify and transmit the radio signal before sending it to the base station's central control unit (often referred to as the baseband unit).

Compared to older mobile communications technologies, where the antenna was often directly connected to the base station, the use of a remote radio head allows for more flexible placement of the antenna and thus optimized radio coverage and capacity distribution.

Figure 2-4 shows the structure of a mobile site, in this case separated into components to which an independent site operator (TowerCo) and a mobile network operator (MNO) have access.

25 In the study, GPON, XGS-PON and GbE PtP are referred to as FTTH technologies.
26 Cp. for this section Soerries et al. (2023) p. 67 ff..

Figure 2-4: Active and passive equipment on a typical tower site



Source: Wolf und Loewer (2020), p. 6.

The literature has identified a number of measures that may increase energy efficiency in mobile networks, especially with 5G:[27]

- Virtualization of network functions can reduce BBU's power consumption
- Automatic wake-up or sleep of the base station, including switch-off.
- Use of massive MIMO
- Support by AI

5G networks use network slicing and virtualization to allocate resources dynamically based on demand, which helps in optimizing energy usage. By creating virtual networks that share the same physical infrastructure, 5G can efficiently manage and distribute network resources.[28]

The physical layer of 5G is designed to be ultra-lean, which means it avoids unnecessary transmissions and keeps energy consumption low when there is little or no data to transmit. [29] Advanced sleep modes, where parts of the network can shut down or go into low-power states when they are not in use, are implemented. This can reduce the overall energy consumption of the network.[30]

27 Sörries et al. (2023), p.71 ff.
28 Al-Quzweeni et al. (2019).
29 Rinaldi et al. (2021), p. 5175
30 Salahdine et al. (2021).

The use of massive MIMO (Multiple-Input Multiple-Output) technology and beamforming in 5G networks helps to direct the signal precisely to where it is needed, which reduces the energy wasted in broadcasting signals over a wide area.[31]

AI enables dynamic adjustment of network resources based on real-time traffic conditions. This ensures that energy consumption is minimized during low traffic periods and resources are efficiently utilized during peak times.[32]

2.2 Reporting of environmental impact from ECN

2.2.1 Key indicators

There is as yet no common standard for the measurement of environmental impacts from ICT. However, various workstreams have been established that could contribute to developing a common standard for the publication of key sustainability metrics.

BEREC (2023) has published a "Report on Sustainability Indicators for Electronic Communications Networks and Services." It contains the results of a survey among National Regulatory Authorities (NRAs) and industry players.

The report classifies 19 indicators into three groups (A, B and C). Group A contains ten indicators that are "already collected by NRAs and with high or medium relevance for surveyed companies"[33] These are: [34]

- *Energy consumption,*
- *Carbon emissions - Direct emissions*
- *Carbon emissions - Energy indirect emissions*
- *Carbon emissions - Other indirect emissions*
- *Energy efficiency*
- *Use of renewable energy (rate)*
- *Distribution or utilisation of recycled/refurbished/reused products*
- *Expected lifetime*
- *Water usage/consumption and*
- *Raw materials depletion (mineral).*

BEREC (2023) also highlights challenges with the lack of harmonised set of indicators, noting that the use of diverse indicators often leads to different results in studies even when they deal with the same issue.[35] According to BEREC it is therefore essential, to

31 Kunthia et al. (2023)
32 Haidine et al. (2021)
33 BEREC (2023), p.58.
34 BEREC (2023), p.58 ff .
35 BEREC (2023), p. 51.

develop multi-criteria and life cycle analysis “to have an exhaustive vision of the environmental footprint of a sector”.[36]

A further conclusion is, that “the environmental impact assessment indicators mostly collected and published by companies are those related to their energy consumption […] and carbon footprint […].”[37] This may neglect other important environmental impacts.

In an effort to develop standardised solutions, the European Commission (JRC) recently produced a report [38] which identifies 19 indicators, of which six are categorised as “must have”. These are:[39]

- *Energy consumption*
- *Energy efficiency*
- *Use of renewable energy (rate)*
- *GHG scope 1 emissions*
- *GHG scope 2 emissions*
- *GHG scope 3 emissions*
- *E-waste production and*
- *Distribution or utilisation of recycled/ refurbished/ reused products*

The indicators are the outcome of studies, ongoing activities of stakeholders and regulators as well as drawing on research by BEREC. The work is intended to provide input for a planned Code of Conduct for telecommunications networks which is due to be published in Q4 2025.[40]

In France, the national Regulator ARCEP is already collecting information on sustainability from the telecommunication companies. As far as GHG emissions are concerned, they use the GHG protocol[41] as a standard. They request data on:[42]

- GHG emissions (scope 1 and 2),
- energy consumption of networks (by technology) and
- mobile phones volumes (sold, collected, recycled and repackaged)

The second data collection decision published end of 2023 includes data centres and device manufacturers.[43]

36 BEREC (2023), p. 52.
37 BEREC (2023), p. 53.
38 EU Commission (2024).
39 EU Commission (2024), p. 12ff.
40 EU Commission (2024), p. 14.
41 See chapter 2.1.
42 BEREC (2023), p. 29.
43 BEREC (2023), p. 29.

2.2.2 Reporting conventions

There are a large number of reporting conventions that can be applied by businesses when reporting on sustainability. Those which are most relevant to ICT are discussed below.

2.2.2.1 GHG protocol

The GHG Protocol claims to be the most widely used accounting tool for emissions worldwide for quantifying and managing greenhouse gas emissions. [44] It is therefore more an accounting standard for GHG emissions, while the other standards discussed in this report have the character of reporting standards. The GHG Protocol was developed through a partnership between the World Resources Institute (WRI) and the World Business Council for Sustainable Development (WBCSD).[45] The protocol provides a standardized framework for businesses and governments to measure and manage their greenhouse gas emissions. It enables organizations to identify emission reduction opportunities, set emission reduction targets, and track progress over time. Overall, the GHG Protocol plays a crucial role in facilitating transparency, comparability, and accountability in greenhouse gas reporting and mitigation efforts globally.

2.2.2.2 Global Reporting Initiative (GRI)

The Global Reporting Initiative (GRI) is an international independent standards organization that helps businesses, governments, and other organizations understand and communicate their environmental, social, and governance (ESG) impacts. Founded in 1997[46], the GRI developed the first and most widely used sustainability reporting framework, which provides guidelines for reporting on economic, environmental, and social performance. The GRI Standards are updated regularly through a multi-stakeholder process to ensure relevance and applicability across various sectors and regions. The framework covers a wide range of topics, including greenhouse gas emissions, labour practices, human rights, and community engagement. According to their website they are “used by more than 10,000 organizations in over 100 countries, [so] the Standards are advancing the practice of sustainability reporting, and enabling organizations and their stakeholders to take action that creates economic, environmental and social benefits for everyone. As confirmed by 2022 research from KPMG, the GRI Standards remain the most widely used sustainability reporting standards globally.”[47]

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44 https://ghgprotocol.org/standards#:~:text=GHG%20Protocol%20supplies%20the%20world%27s,support%20their%20missions%20and%20goals, last accessed: 03/05/24.
45 https://ghgprotocol.org/about-us, last accessed: 03/05/24.
46 https://www.globalreporting.org/about-gri/mission-history/, last accessed: 03/05/24.
47 https://www.globalreporting.org/about-gri/, last accessed: 03/05/24.

2.2.2.3 Sustainability Accounting Standards Board (SASB)

The Sustainability Accounting Standards Board (SASB) is an independent, nonprofit organization that sets standards for sustainability accounting and reporting. Founded in 2011, SASB aims to provide a framework for companies to disclose financially material sustainability information to investors in a standardized and comparable manner.

SASB standards are industry-specific, focusing on the sustainability issues that are most relevant to each sector. The standards cover a wide range of topics, including environmental, social, and governance (ESG) factors, that may have a material impact on a company's financial performance.

The SASB standards are among the most commonly used reporting standards worldwide. SASB are particularly frequently used in North and South American countries. A 2022 KPMG survey finds that 49% of the world's 250 largest companies by revenue (the G250) and 33% of the 100 largest companies in 58 countries (5,800 companies, known as the N100) use SASB standards.

The standards include:

- Industry descriptions
- Disclosure topics (describing specific sustainability-related risks and opportunities with respect to an industry's activities)
- Key figures on disclosure topics

SASB standards were developed for a total of 77 industries, including the telecommunications industry. The requirements for telecommunication companies are: In terms of the “Environmental Footprint of Operations”:

(1) Total energy consumed,
(2) percentage grid electricity and
(3) percentage renewable.

In terms of “Product End-of-life Management”:

(1) Materials recovered through take-back programmes, percentage of recovered materials that were
(2) reused,
(3) recycled, and
(4) landfilled.

2.2.2.4 ISSB

The International Sustainability Standards Board (ISSB) was founded by the IFRS [48] foundation in 2021.

The ISSB standards take into account the idea of convergence between reporting standards and build heavily on existing (mostly voluntary) reporting frameworks and standards for sustainability. Against this background, the ISSB is committed to improving interoperability with other international standards and facilitating (possible) adoption. This should enable companies to avoid "double reporting" according to multiple standards. However, to facilitate interoperability, reporting requirements can be introduced that apply to individual countries or are aimed at broader stakeholder groups.[49]

"IFRS S2 is effective for annual reporting periods beginning on or after 1 January 2024 with earlier application permitted as long as IFRS S1 General Requirements for Disclosure of Sustainability-related Financial Information is also applied. The objective of IFRS S2 is to require an entity to disclose information about its climate-related risks and opportunities that is useful to users of general purpose financial reports in making decisions relating to providing resources to the entity."[50]

2.2.2.5 European Sustainability Reporting Standards (ESRS)

The ESRS have been introduced in the course of the implementation of the Corporate Sustainability Reporting Directive (CRSD) on EU level. The CSRD is the successor of the Non-Financial Reporting Directive (NFRD). While the EU taxonomy creates a uniform understanding of 'green' or 'sustainable', the CSRD expands this understanding at the company level by requiring comprehensive reporting on sustainability practices.[51]

Companies that fulfil at least two of the following three conditions comply with the CSRD (and are referred to as "large companies"):

- €50 million in net turnover
- €25 million in assets
- 250 or more employees

Non-EU companies that have a turnover of above €150 million in the EU will also have to comply.

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48 IFRS stands for "International Financial Reporting Standards".
49 https://www.ifrs.org/groups/international-sustainability-standards-board/, last accessed: 20/05/2024.
50 https://www.ifrs.org/issued-standards/ifrs-sustainability-standards-navigator/ifrs-s2-climate-related-disclosures/, last accessed: 20/05/2024.
51 https://sustainabilityand.com/de/aktuelles/blog/eu-taxonomie-csrd-und-sfdr-erklaert#:~:text=Durch%20die%20EU-Taxonomie%20wird,nach%20umfassender%20Berichterstattung%20über%20Nachhaltigkeitspraktiken., last accessed: 20/05/2024.

The ESRS cover ecological, social and governance issues and also address overarching issues. For the environment, the following aspects are taken into account:

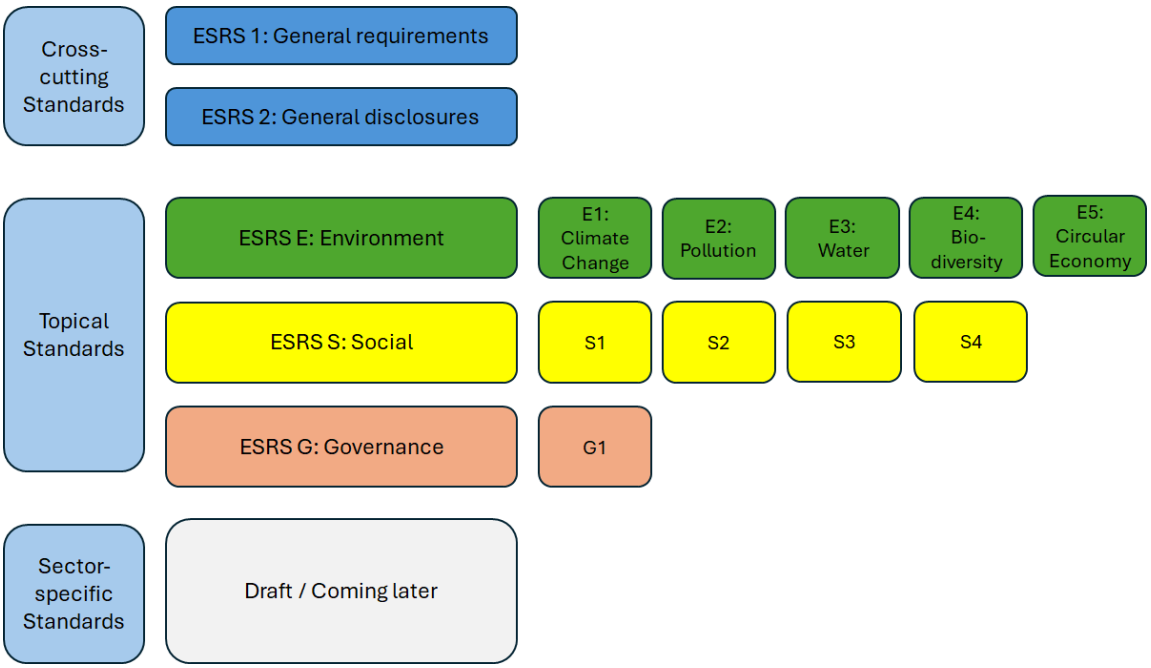
- Climate change
- Pollution
- Water and marine resources
- Biodiversity and ecosystems
- Resource use and circular economy

According to CSRD, in 2025 a large company's first CSRD report will be due based on the company's 2024 fiscal year environmental performance. Small and medium enterprises (SMEs) must start reporting for 2026.[52] For them, the following conditions apply:

- Balance sheet total of EUR 4 million or above
- Net turnover of EUR 8 million or above
- Average of 50 or more employees during the financial year

The ESRS do not contain industry-specific requirements yet, although there exist drafts for different industries. Figure 2-5 gives an overview on the construction of the ESRS with focus on environmental aspects.

Figure 2-5: ESRS standards



Source: WIK.

52 ttps://www.brightest.io/csrd-corporate-sustainability-reporting-directive#:~:text=Starting%20January%201%2C%202024%20CSRD,total%20assets%20or%20balance%20sheet

The sector-specific requirements will align with the NACE classification of industries. [53] This means that for the telecommunication industry the following NACE numbers are relevant:[54]

- J.61.10 Wired telecommunications activities
- J.61.20 Wireless telecommunications activities
- J.61.30 Satellite telecommunications activities
- J.61.90 Other telecommunications activities

In the draft, the telecommunication sector is part of the sector “Media & Communication” (TMC) in the group “Technology”.

2.2.2.6 Methodological Comparison

The ESRS is part of the European Union’s Corporate Sustainability Reporting Directive (CSRD) and aims to standardize sustainability reporting across the EU. The other standards mentioned previously, relate to the ESRS as follows:

- GHG Protocol: ESRS has a broader scope covering all ESG factors, while GHG Protocol focuses exclusively on GHG emissions. ESRS uses double materiality[55], whereas GHG Protocol focuses on accurate measurement and reporting of emissions.
- GRI: Both cover a wide range of ESG topics, but ESRS is mandatory for certain companies in the EU and emphasizes alignment with EU policies. GRI is voluntary and globally recognized, focusing on stakeholder inclusiveness.
- SASB: ESRS has a broader scope and mandatory for large EU companies, while SASB focuses on financially material issues for investors, with industry-specific standards.
- ISSB: Both ISSB and ESRS aim for comprehensive sustainability reporting, but ESRS focuses on EU-specific policies and double materiality, while ISSB targets global investor needs with an emphasis on integrating sustainability with financial reporting.

Each standard has its unique focus and methodology, tailored to different purposes and audiences, from regulatory compliance (ESRS) and emissions accounting (GHG Protocol) to broader sustainability impacts (GRI) and investor-focused disclosures (SASB and ISSB).

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53 The NACE classification (Nomenclature of Economic Activities) is a European statistical system used to categorize economic activities across member states. It provides a standardized framework for comparing and analyzing business activities within the EU for statistical and regulatory purposes.

54 EFRAG (2022), p. 39.

55 Double materiality means that companies need to consider and report both how sustainability issues impact their financial performance and how their operations impact society and the environment.

Comparability of numbers for the same field across the different standards can thus be challenging due to differences in scope, calculation methodologies, and reporting guidelines.

Table 2-1 gives an overview on the general differences between the different standards.

Table 2-1: Comparison of different reporting standards

	GHG Protocol	GRI	SASB	ISSB	ESRS
Scope	Comprehensive GHG accounting and reporting framework.	Comprehensive sustainability reporting covering broad ESG factors.	Industry-specific standards focused on financial materiality.	Sustainability-related financial disclosures.	Comprehensive ESG reporting with alignment to EU policies.
Environmental Categories Reported	GHG emissions only.	GHG emissions, water, biodiversity, waste, energy, and more.	GHG emissions, water use, waste, energy use, biodiversity (varies by industry).	Primarily GHG emissions, with some context on broader environmental impacts.	GHG emissions, water, biodiversity, waste, energy, land use, circular economy, pollution prevention, resource efficiency
Special treatment of telecommunication industry	No.	No	Yes, Telecommunication Services SASB Standard	No	Planned
Emission Scopes Covered	Scope 1, Scope 2, and Scope 3.	Scope 1, Scope 2, and Scope 3.	Scope 1, Scope 2, and industry-specific Scope 3.	Scope 1, Scope 2, and Scope 3 (financial impact focus).	Scope 1, Scope 2, and Scope 3.
Primary Focus	Accurate measurement and reporting of GHG emissions.	Broad sustainability impact and stakeholder inclusiveness.	Financial materiality of sustainability issues by industry.	Financial impacts and risks related to sustainability.	Double materiality (impact on company and society/environment).
Calculation Methodology	Detailed guidelines for emissions calculation.	References GHG Protocol for GHG emissions calculation.	Industry-specific guidelines with additional metrics.	Aligns with GHG Protocol, adds financial context.	Aligns with GHG Protocol, adds EU-specific requirements.
Reporting Requirements	Detailed quantitative data on GHG emissions.	Quantitative data with qualitative context and sustainability strategy.	Quantitative data with industry-specific context.	Quantitative data with emphasis on financial implications.	Quantitative data with qualitative context, including EU policy alignment.
Emissions Factors	Standardized emission factors (e.g., IPCC, EPA).	Standardized emission factors (e.g., IPCC, EPA).	May include additional industry-specific emission factors.	Standardized emission factors (e.g., IPCC, EPA).	Standardized emission factors (e.g., IPCC, EPA), with EU-specific adjustments.
Use Cases	Widely used by corporations, governments, and NGOs.	Used by a wide range of organizations globally.	Primarily used by investors and financial analysts.	Used by investors and financial market participants.	To be used by EU companies, especially large and listed ones.

This means that ESRS aligns with some protocols such as the GHG Protocol and the IPCC guidelines. It is very likely that the ESRS will become the most important standard for companies in the coming years, at least when the sector-specific requirements are finally determined.

Further standards that only apply to telecommunication companies, are published by ITU and ETSI.

The International Telecommunication Union (ITU), a specialized agency of the United Nations, has established several standards and recommendations focusing on sustainability. Some key ITU standards on sustainability are:

- ITU-T L.1100 - Procedure for recycling rare metals in ICT products
- ITU-T L.1300 - Best practices for green data centers
- ITU-T L.1310 - Energy efficiency metrics and measurement methods for telecommunication equipment
- ITU-T L.1400 series - Overview and general principles of methodologies for assessing the environmental impact of ICT:
  This series provides methodologies for assessing the environmental impact of ICTs, including life cycle assessments and carbon footprint calculations.
- ITU-T L.1500 - Framework for information and communication technologies and adaptation to the effects of climate change:
  This framework outlines how ICTs can support adaptation to climate change, including monitoring, data collection, and early warning systems.
- ITU-T L.1600 series - ICT and environmental sustainability: This series includes various recommendations for reducing the environmental impact of ICT operations, such as energy management, sustainable design, and resource efficiency.

The European Telecommunications Standards Institute (ETSI) has developed various standards related to sustainability, particularly focusing on improving energy efficiency, reducing environmental impact, and promoting the use of renewable energy sources in the ICT sector.

These are some examples:

- ETSI EN 305 200-1 - Energy management; Global KPIs for energy management:
  This standard defines global Key Performance Indicators (KPIs) for energy management in ICT sites and networks, including data centers.
- ETSI EN 303 470 - Measurement methods and limits for energy consumption in broadband fixed network access equipment:
  This standard specifies methods to measure the energy consumption of broadband fixed network access equipment and sets limits to promote energy-efficient designs.

- TSI TS 105 174 - Assessment of mobile network energy efficiency:
  This technical specification provides guidelines for assessing the energy efficiency of mobile networks, encouraging the implementation of energy-saving measures and the use of renewable energy.

3 Available data on ECN emissions and targets in Greece

3.1 References from literature

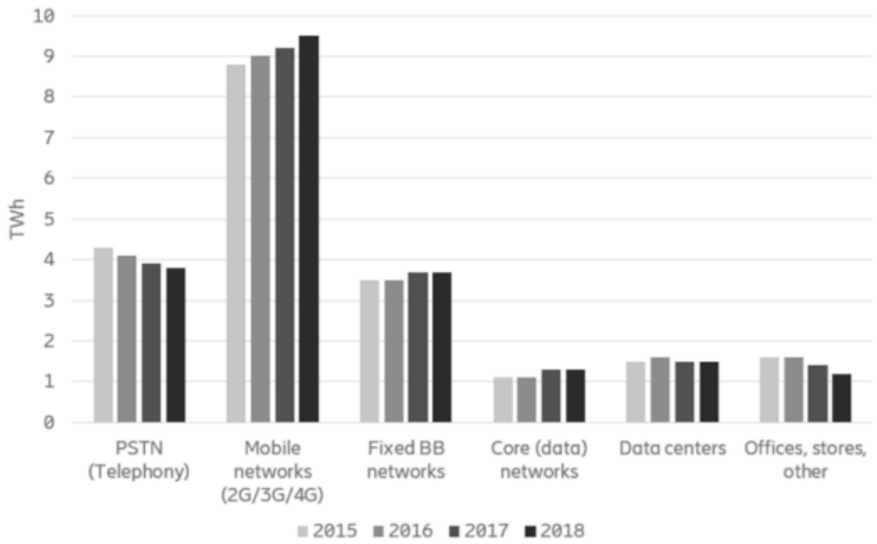
There is limited information available about the energy consumption and GHG emissions of Greek telecommunication companies in literature.

Lundén et al. (2022, p.1) show “operational electricity consumption and greenhouse gas emissions for different European telecom network operators during 2015–2018. These results are also compared to data for 2010–2015.” According to the authors “the study provides an extensive primary data set, collected from European Telecommunication Network Operators (ETNO) members, covering operations in Europe and beyond, providing data with higher granularity than publicly available sources.”[56] One of the network operators included in the analysis is the Greek operator COSMOTE which now belongs to the OTE Group (cp. Section 3.2.2).

One outcome of the study was, that for all fifteen companies in total, the energy consumption increased for fixed and mobile networks between the years 2015 and 2018 (cp. Figure 3-1).

56 Lundén et al. (2022), p.1.

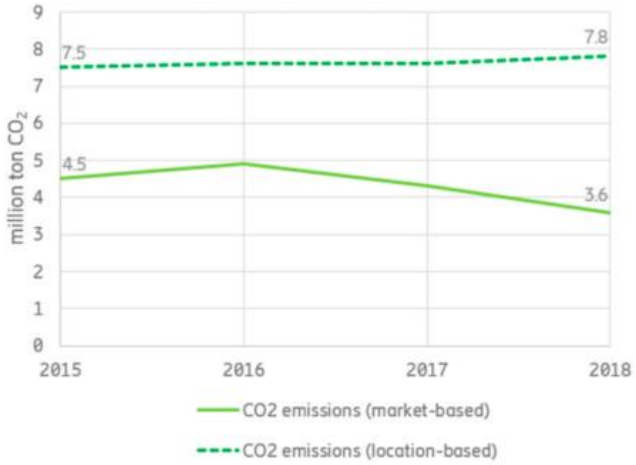
Figure 3-1: 15 European Telecommunication Network Operators' total aggregated electricity consumption from 2015 to 2018.



Source: Lundén et al. (2022), p.9.

In terms of GHG emissions a similar trend is visible when applying the location-based approach (cp. Figure 3-2).[57]

Figure 3-2: 15 European Telecommunication Network Operators' total aggregated CO2 emissions from 2015 to 2018.



Source: Lundén et al. (2022), p.8.

57 The location-based approach for calculating GHG emissions refers to the method of estimating emissions based on the average emissions intensity of the electricity grid in a specific geographical area. It uses regional or national grid emission factors to account for the CO_2 emissions associated with electricity consumption, reflecting the energy mix (such as coal, gas, renewable sources) that powers the local grid where the electricity is used. This approach contrasts with the market-based approach, which accounts for emissions based on the specific energy contracts or renewable energy certificates a company may hold.

However, the study contains limited information about the Greek situation.

Balarasa et al. (2017) [58] describe how it is possible to increase energy efficiency in data centres. They refer to two of the largest data centres located in Athens, that serve two major Hellenic banks. Recommendations on possible measures to increase energy efficiency include – for the:

- "entire facility (e.g. audit facilities, ensure effective regular maintenance, install blanking plates where there is no equipment to reduce hot air re-circulating through gaps in the rack, turn off lights),
- software or IT equipment (e.g. contained hot or cold aisles, use of energy star compliant hardware),
- electromechanical (E/M) equipment (e.g. airflow management and design, installation of draught excluders or cover plates to eliminate air leakage in racks, equipment segregation, separate environmental zones according to equipment operating conditions, variable speed fans, low energy lighting, temperature and energy monitoring)"

In their calculations the authors found that it was possible to decrease the Power Usage Effectiveness (PUE) from by 0.38 points (from 2.49 to 2.11 in Data Centre 1) and 0.23 points (from 1.89 to 1.66 in Data Centre 2).[59]

The research may be relevant for Greek telecom operators as well as other operators of data centres. Some of the considered operators in section 3.2 are already taking such measures.

3.2 Information from ECN operators

Greek fixed and mobile operators already publish certain data concerning their environmental footprint. The following sections provide an overview of the data that is available in the sustainability reports of the three largest fixed and mobile telecommunication companies concerning GHG emissions,[60] and offer further insights based on answers provided by the operators to a questionnaire distributed in the context of this report in June 2024. as well as data that is reported by operators to the Greek Natural Environment Climate & Change Agency (N.E.C.C.A.). .

In general, standards that were used for preparing the sustainability reports by the operators differs from the method for submitting data to N.E.C.C.A., for example, the GRI (Global Reporting Initiative) and SASB (Sustainability Accounting Standards). The difference to the N.E.C.C.A approach, which relates to the ISO14064-1:2018 standard, is the following: ISO 14064-1:2018 provides a detailed, standardized approach for

58 Balarasa et al. (2017), p. 111.
59 Balarasa et al. (2017), p. 114.
60 EETT (2023), p. 31 and 37.

calculating GHG emissions, requiring organizations to use specific activity data (e.g., fuel consumption, electricity use) and apply scientifically established emissions factors to calculate CO_2 equivalents. In contrast, GRI allows organizations flexibility in choosing their own calculation methods or referencing third-party standards like ISO or government guidelines, without prescribing a specific approach. SASB focuses on sector-specific metrics and leaves the choice of calculation methods to the discretion of companies, as long as the disclosures are financially material; it does not provide detailed guidance on how emissions should be calculated. ISO 14064-1 requires precise calculations for both direct and indirect emissions across organizational boundaries, while GRI and SASB focus more on transparent reporting of emissions data, regardless of the calculation method. This makes ISO 14064-1 more prescriptive and method-driven compared to GRI and SASB's more flexible, disclosure-focused frameworks.

Furthermore, the GHG Protocol and ISO 14064-1:2018 differ in certain respects in the calculation of greenhouse gas emissions. The GHG Protocol allows flexibility in choosing emission factors, offering broad guidelines and focusing on categorizing emissions into three scopes: direct (Scope 1), indirect from electricity (Scope 2), and other indirect (Scope 3). ISO 14064-1:2018 is more prescriptive, requiring specific methodologies for calculating emissions based on organizational boundaries, using nationally or internationally recognized emission factors. The GHG Protocol is more adaptable to different organizational contexts, while ISO 14064-1 provides a more structured and standardized approach to ensure consistency across reports. Both standards aim for accurate reporting but differ in their rigor and flexibility.

3.2.1 NOVA

Founded in 1995, NOVA is an operator that offers a wide range of pay TV, broadband internet, mobile and fixed telephony services and serves approximately 5 million subscribers.[61] It belongs to the united Group that in 2022 bought Wind Hellas and merged it with NOVA.[62]

GHG emissions

In terms of CO2 emissions, the following information has been published in NOVA's sustainability report.[63] The report differentiates between Scope 1, 2, and 3 emissions as can be seen in Figure 3-3. These figures are reported for the first time.

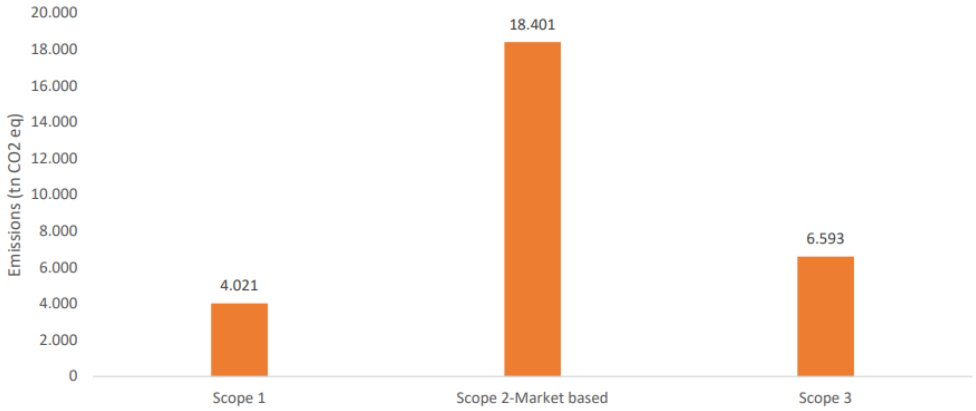
61 https://pitchbook.com/profiles/company/11841-40, last accessed 13/05/24, https://www.gsma.com/get-involved/gsma-membership/gsma_orgs/wind-hellas-telecommunications-s-a/#:~:text=Nova%20is%20the%20company%20that,of%20Nova%20with%20Wind%20Hellas., last accessed 13/05/24.

62 https://united.group/united-group-completes-acquisition-of-greek-telecoms-operator-wind-hellas/, last accessed 13/05/24.

63 The following information is taken from NOVA's sustainability report 2022 (NOVA, 2023).

In terms of electricity consumption it is stated that mobile networks consume most (46.18 %) and fixed networks 30.90 % of the electricity used, while data centres need 19.35 %. The remainder is used by offices (3.53 %) and shops (0.04 %). However, the report gives no information on the energy sources that produce the electricity.[64]

Figure 3-3: Scope1, 2 and 3 emissions by NOVA

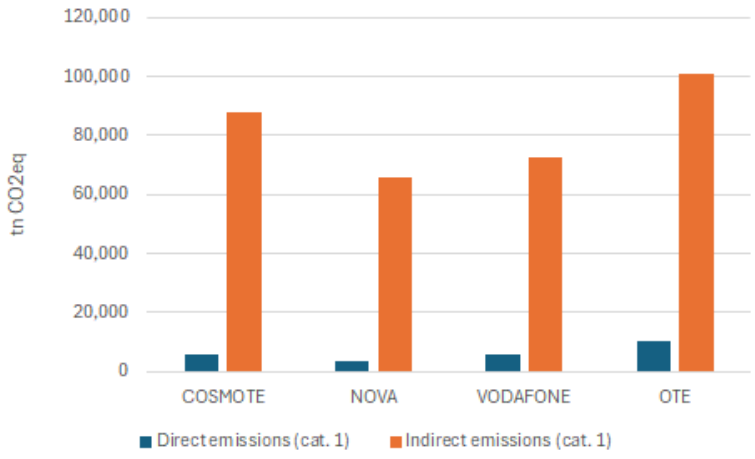


Source: NOVA (2023), p. 41.

According to data submitted by NOVA to N.E.C.C.A, direct emissions for 2022 were 3714 tn CO2eq and indirect emissions accounted for 65817 tn CO2eq. Scope 3 emissions are not required to be reported. These figures differ from the numbers in the sustainability report (cp. Figure 3-3).

Figure 3-4 shows the emissions reported to N.E.C.C.A. for the year 2022 for all voperators.

Figure 3-4: Scope 1 and 2 emissions reported to N.E.C.C.A (2022)



Source: Own figure based on N.E.C.C.A. (2023).

64 NOVA (2023), p. 39

Scope 1 emissions are smaller than Scope 2 emissions for all operators. This is in line with the sustainability reports, except for OTE. For the reasons see section 3.2.2.

Information from questionnaire

Based on responses provided to a questionnaire distributed in Q2 2024, NOVA has further elaborated that Scope 3 emissions are estimated based on the following monitoring indicators:

- Purchased goods & Services,
- Capital goods,
- Fuel & energy activities,
- Upstream Transportation,
- Waste generated in operations,
- Business travel,
- Employee commuting,
- Upstream leased assets,
- Use of sold products,
- End of life treatment of sold product,
- Downstream leased assets,
- Franchisees.

A lifecycle assessment has not been conducted on any of the products / services yet.

Sustainability targets

Regarding targets from the latest sustainability report, the following update was given (cp. Table 3-1).

Table 3-1: NOVA: Environmental targets

	Target	Date	Update	Progress
Reduction of electromagnetic radiation	Through indicative electromagnetic radiation measurements, we ensure that mobile site radiation emissions do not exceed the respective limits set by the Greek law. In case of any deviation, further corrective actions are implemented.			
Reducing emissions by replacing 30% of the total fleet with electric, plug-in and hybrid vehicles.	In Y2022, 54 cars replaced with 2 pure Electric (EV) and 52 Hybrid (PHEV & MHEV) vehicles. In Y2023 with the addition of two more PHEV vehicles, or fleet included: 2 EV (electric), 38 PHEV (Plug-In Hybrid) & 16 MHEV (Mild-Hybrid) vehicles.	End Y2023	The goal for 2024 is to increase "green" vehicles by 2 EV, 12 PHEV & 13 MHEV.	2 EVs, 8 PHEV & 11 MHEV have already been received
Use of technological solutions to protect the environment and biodiversity of Greece	It is a system for crisis prevention and management in through artificial intelligence tools and cutting-edge technology that uses cutting edge technological solutions to help early detection of potential wildfires.			
Recycling of telephone sets and other electrical equipment.	In collaboration with Recycling S.A. we have set up collection bins across all Nova shops enabling all customers that visit a Nova Shop to drop off their old devices.			

In its sustainability report, NOVA further notes that it has taken the following measures to reduce emissions:[65]

- Installation of metering devices in buildings with a high consumption to control and monitor the energy flow and foster energy efficiency, e.g. improving Power Usage Effectiveness (PUE) in data centres.
- Design of an energy saving investment plan for the next three years. It aims to improve the electricity infrastructure, including investment proposals for independent power generation infrastructure in specific buildings.

65 NOVA (2023), p. 41

3.2.2 OTE Group

Under the brand COSMOTE the OTE Group offers fixed-line and mobile telephony, broadband services, pay-TV and integrated ICT solutions.[66] However, the sustainability report includes more companies belonging to the OTE Group:[67]

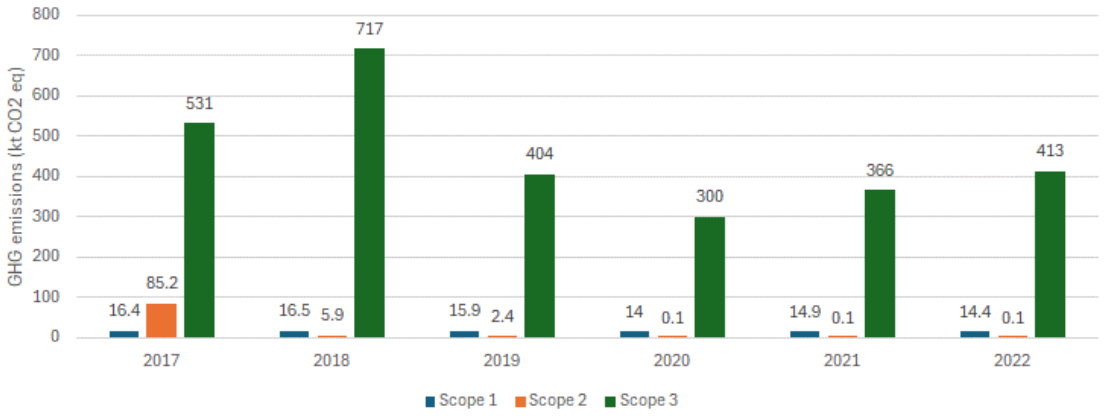
- OTE, COSMOTE, GERMANOS, CTS, OTE Globe, OTE Academy and COSMOTE e-Value (all with headquarters in Greece)
  Telekom Romania Mobile Communications (with headquarters in Romania)

GHG emissions

In terms of CO2 emissions, the information in OTE's sustainability report is published for the years 2017 - 2022. The report differentiates between Scope 1, 2, and 3 emissions.

The figures for 2017 to 2022 are shown in Figure 3-5.

Figure 3-5: GHG emissions of the OTE Group between 2017 and 2022 in kt CO2 eq



Source: Own figure according to numbers by NOVA (2023), p. 81.

In terms of energy consumption it is stated that mobile networks consume most (47 %) and fixed networks 31 % of the energy used, while electricity in buildings accounted for 12 %. The remainder is used by road transportation (6%), electricity generators (6%) and space heating (1 %).

Data submitted to N.E.C.C.A was the following: Direct emissions for 2022 were 10226 tn CO2eq (5687 tn CO2eq for COSMOTE) and indirect emissions accounted for 100731 tn CO2eq (65817 tn CO2eq for COSMOTE). Scope 3 emissions have not to be reported.

OTE explains the differences in reporting for the year 2022 as follows. According to OTE, the scope 2 emissions in its sustainability report have been calculated based on the market-based approach (in accordance with the GHG Protocol), and therefore

66 https://www.cosmote.gr/cs/otegroup/en/omilos_ote.html, last accessed 13/05/24.
67 OTE Group (2023), p. 5.

agreements with suppliers to cover consumption, with Guarantees of Origin from Renewable Energy Sources (RES) are taken into account. This results in the related emissions being excluded. Specifically, the OTE Group states that it has secured, "from its electricity providers for 2022, Guarantees of Origin (GOs), assuring that the listed amount of electricity consumption has been produced from Renewable Energy Sources. The GOs secured (Greece and Romania) and the Direct Purchase of RES electricity (Romania) cover 100% of the 2022 electricity consumption of the Group. In terms of total energy consumption, this corresponds to 90% at Group level (88% in Greece)"[68] In contrast, according to the Greek Climate Law, emissions are calculated based on the emission factors corresponding to the remaining energy mix of the country. This means that the Guarantees of Origin procured by the OTE Group are not taken into account, according to the data of DAPEEP,[69] which has the authority to carry out the relevant calculations (both for the remaining energy mix and for the emission factor corresponding to it). These different approaches lead to different results.

Information from questionnaire

Based on responses provided to the questionnaire, OTE clarifies that it has not yet conducted a lifecycle assessment regarding its products and services.

OTE provides additional updates regarding the Scope 3 emissions, that may be elaborated in its sustainability report for 2023.[70] It reports that in 2023, OTE Group's total energy consumption was 512 GWh, with electricity accounting for nearly 90% of the total. Energy use decreased by 8% compared with 2022, primarily due to reductions in telecom network activities. Improvements in energy efficiency and network modernization helped offset increased data traffic and subscriber growth. OTE Group's direct and indirect GHG emissions were significantly lower in 2023, with a notable 87% reduction in market-based Scope 1 and 2 emissions compared to 2017. Indirect (Scope 3) GHG emissions were estimated at 482 kt CO2 equivalent, with upstream and downstream activities contributing 47% and 53%, respectively. Emissions reduction measures focus on suppliers and customers, emphasizing energy-efficient product procurement and circular economy principles. OTE Group participates in the EU's "Code of Conduct on Energy Consumption of Broadband Equipment" to enhance energy efficiency in broadband devices. Additionally, using advanced collaboration tools has reduced Scope 3 emissions related to employee commuting and business travel.

Sustainability targets

OTE notes in its sustainability report that it has set certain target and commitments, based on those of their shareholder Deutsche Telekom Group:[71]

68 OTE Group (2023), p. 78.
69 https://www.dapeep.gr/
70 OTE Group (2024), p. 58.
71 OTE Group (2023), p. 33.

- Net Zero for direct and indirect energy consumption including up to 95% reduction by 2025 (2017-2025).
- 100% Renewable electricity (2021 onwards).
- 25% Emission reduction per customer for value chains emissions (2017-2030).
- Net Zero emissions across the value chain by 2040

In response to the questionnaire, OTE provided the following update regarding the targets set and progress in meeting them (Table 3-2).

Table 3-2: OTE Group: Environmental targets

	Target	Date	Update	Progress
Renewable Energy	100 %	2021		100%
Scope 1 and scope 2 GHG emissions from energy consumption	Zero	2025	NO	
Reduction of value chain (scope 3) emissions per customer	25 %	2030	Withdrawn and replaced	
GHG emissions (scope 1, 2 and 3)	Zero	2040	NO	
ICT waste to landfill	Zero	2022	NO	100%
Mobile devices from take-back schemes (OTE Greece)	400,000	2024	NO	79%
Sustainable packaging for own branded newly launched (by the 2nd semester 2022) and devices.	100 %		NO	
Retain the elimination of single use plastic items in major buildings (OTE Greece)	100 %	2022	NO	100%
Paper use	25% reduction to 2020.	2023	YES	100%

3.2.3 Vodafone Greece

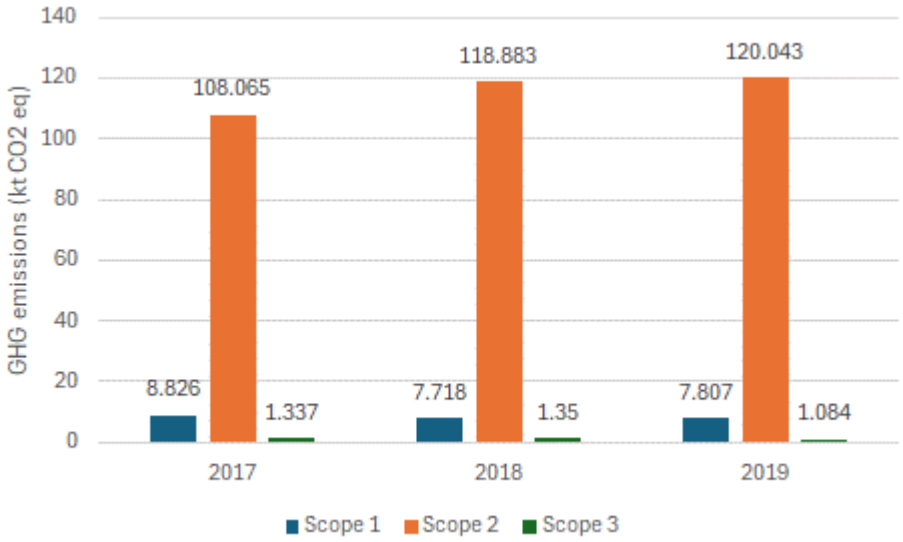
Vodafone Greece is a subsidiary of the Vodafone group, serving 4.1 million mobile and 1 million fixed line broadband customers.[72]

GHG emissions

The last sustainability report of Vodafone Greece dates back to the year 2021. In the report, in contrast to the report in the 2019, no figures for climate change and energy are published. The figures for Scope 1 to 3 emissions in the years 2017 to 2019 are shown in Figure 3-6.

72 Vodafone Greece (2022), p. 7.

Figure 3-6: GHG emissions of Vodafone Greece between 2017 and 2019 in kt CO2 eq



Concerning energy consumption, the figures apply to networks, shops and offices in total.

For 2022, Vodafone Greece submitted the following data to N.E.C.C.A: Direct emissions for 2022 were 5804 tn CO2eq and indirect emissions accounted for 72400 tn CO2eq. Scope 3 emissions are not required to be reported. Because of the different years of reporting, no direct comparison of these figures with those in the sustainability reports are possible. In general, Vodafone Greece uses the GRI standard to calculate emissions. See section 3.2 for general differences to the N.E.C.C.A. approach.

Information from questionnaire

In response to a questionnaire distributed in Q2 2024 Vodafone Greece clarified that for the measurement of Scope 3 emissions, it calculates its emissions for upstream and downstream transportation and distribution using a hybrid approach of spend-based and product specific data. “In 2022 we improved our calculation methodology to enable emissions from capital goods and transportation and distribution to be reported separately from purchased goods and services. Prior to 2022, emissions from capital goods were included in the data reported for purchased goods and services together with emissions from all transportation and distribution. As the methodology for measuring Scope 3 GHG emissions is still developing and industry standards may change, we will continue to evolve our methodology, and this may result in in a need to amend or update our disclosures and/or our ESG ambitions, goals, commitments and/or targets or our evaluation against these.”

In terms of the application of a lifecycle assessment, Vodafone uses a hybrid approach to calculating Scope 3 category 1 emissions. “For the majority of purchased goods and

services, we use a spend-based approach whereby our procurement spend on each product category is multiplied by a corresponding environmentally extended input-output ('EEIO') emission factor (drawn from third-party EEIO datasets).For a sub-set of purchased goods, specifically mobile phone devices purchased from original manufacturers for retail to our customers, we use a product-specific approach. In this case, the units of product purchased are multiplied by a corresponding cradle-to-gate product carbon footprint ('PCF'). The PCF data is drawn from EcoRating datasets. Additionally, for a sub-set of purchased services procured from 20 service-based suppliers, we use a supplier-specific approach. Our procurement spend on each supplier is multiplied by the supplier's organizational carbon footprint intensity (market-based Scope 1 and 2 plus upstream Scope 3 emissions) in tCO2e/mUSD. This information is disclosed through publicly available 2023 Climate Disclosure Project ('CDP') disclosures."

Targets to improve sustainability

According to its sustainability report, targets set by Vodafone Greece are to reduce GHG emissions by 50% in 2022 and to be climate neutral in 2040 including the whole value chain. The electricity supply was planned to be 100 % from RES in 2022.[73]

Based on information provided in response to the questionnaire, Vodafone Greece has provided the following update regarding sustainability targets (cp. Table 3-3).

Table 3-3: Vodafone Greece: Environmental targets

	Target	Date	Update	Progress
Renewable Energy	100 %	2022		Achieved
GHG emissions	50 % reduction	2022		Achieved
Scope 1 emissions	Zero	2030	2028	
Scope 2 and 3 emissions	50 % reduction	2030	Same	
Scope1, 2 and 3 emissions	Zero	2040	Same	
Network waste reuse, resale or recycling	100 %	2022		Achieved

Remark from the authors: All information in the table is related to the Vodafone Group, except the target for renewable energy.

73 Vodafone Greece (2022), p. 68. It is stated that "Vodafone Greece already covers 100% of its needs from green energy sources in its core network, in all the company's data centers,as well as in the mobile and fixed networks, where it directly controls the supply of electricity to the network."(p. 69)

4 Measures taken by ECN operators to limit environmental footprint

The three operators report on several measures they have taken to limit their environmental footprint in the context of their Sustainability reports. In addition, in the questionnaire of June 2024 all operators were asked about actions taken and associated impacts in the following fields:

- Deployment of fixed network infrastructure
- Migration to more energy efficient fixed technologies
- Recycling and refurbishment of fixed networking equipment
- Promotion of recycling and reuse of end-user fixed equipment
- Sustainable deployment of mobile network infrastructure
- Migration to more energy efficient mobile technologies
- Recycling and refurbishment / reuse of mobile networking equipment
- Promotion of recycling and reuse of customer mobile equipment
- Use of renewable energy.

The answers are summarized in section 4.1.[74] Furthermore, a question on the consideration of environmental profiles of business customers and investors was asked. The answers are shown in section 4.2.

4.1 Actions and impacts

4.1.1 Overview of actions

Table 4-1 provides an overview of the actions taken by the three largest ECN operators in Greece to foster sustainability, based on responses provided to a 2024 questionnaire and information provided in sustainability reports. It reveals that significant progress has been made by all three operators in sourcing electricity from renewable sources both for procured electricity and through the use of solar panels to power base stations. OTE and Vodafone Greece also report taking measures to improve energy efficiency e.g. by installing more efficient generators to power base stations, and pursuing energy saving measures including the deactivation of capacity layers in low traffic periods.

Actions have also been taken to foster the re-use and recycling of networking and end-user equipment, although this appears to be more recent and less well-developed for NOVA compared with OTE and Vodafone Greece.

Concrete steps have been described regarding efficient mobile deployment (including through RAN sharing between Vodafone Greece and NOVA) and migration to more energy efficient mobile networks (e.g. progress towards 3G switch-off by Vodafone

74 If no detailed answers are specified, no (clear) answers were given.

Greece). However, fewer steps have been reported regarding migration to energy-efficient fixed (FTTH) networks and efficient fixed network deployment techniques.

Further details are provided about the actions taken and reported impacts in the following sections. It should be noted however that in most cases only qualitative indications of impacts have been reported.

Table 4-1: Overview of actions taken to support sustainability by ECN operators in Greece based on responses to questionnaire (2024) and sustainability reports

	OTE	**Vodafone Greece**	**NOVA**
Fixed network deployment	Not reported	Civil works co-ordination where possible.	Consolidation of racks + consolidation of operations to fewer buildings reducing overall electricity consumption (3.142tCO2e reduction expected)
Migration to more energy efficient fixed technologies	OTE reports removal of unused equipment in the fixed network and replacement of equipment with more efficient equivalents. Specific measures e.g. regarding migration to FTTH / copper switch-off are not reported, but impact of migration noted to be significant reduction in energy consumption.	Upgrading the electromechanical infrastructure in switching centres	Not reported
Recycling and refurbishment of fixed networking equipment	Nationwide waste management network, partnering with certified companies to ensure proper waste handling and material recovery Internal recycling program in 24 office buildings, covering around 9,000 employees, focuses on sorting and recycling materials like paper, packaging, and electronic waste. Overall, in Greece 97% of waste was recycled or reused, while no ICT waste was landfilled	Since 2022 100% of network equipment is reported as reduced, refurbished or recycled	Not reported
Promotion of recycling and re-use of end-user fixed equipment	Non-functional devices are sent to the national WEEE system for recycling, with the entire process managed in-house. In 2023, about 250,000 devices were refurbished and 80,000 recycled, resulting in avoided GHG emissions of 7kt CO2 eq and saving approximately 40 tons of plastic.	Not reported	CPEs refurnished from Jan-June 2024: 14,300 units
Sustainable deployment of mobile network infrastructure	Not reported	Vodafone Greece and Nova have in place a RAN network sharing agreement since 2013, which has been updated to cover 5G technologies.	Nova utilizes active RAN sharing on mobile access network infrastructure. RAN active sharing is in principle a key sustainability driver minimizing to almost

	OTE	Vodafone Greece	NOVA
			a half the needed equipment and substantially reducing the total power consumption. Nova is continuing to identify opportunities to further expanding RAN sharing on its existing network as well as its newly deployed radio stations.
Migration to more energy efficient mobile technologies	OTE reports measures to migrate to more energy efficient mobile technologies, resulting in 9% reduction in consumption (2023 vs 2021) resulting to 2.95GWh saving in 2023.	3G network mostly switched off within 2023. Modernisation of Mobile network (hardware and software)	Not reported
Recycling and refurbishment / reuse of mobile networking equipment	Not reported but may be covered under fixed heading	Since 2022 100% of the network equipment is being reused/refurbished or recycled. Impacts on material consumption high as reported in the National Electronic Waste Registry	Not reported
Promotion of recycling and reuse of customer mobile equipment	By the end of 2023, recycling collection points were established in more than 370 retail shops and 24 office buildings in Greece. The recycling of mobile devices has recovered 95.5 kg of silver, 9.2 kg of gold, 3,548 kg of copper, and 5.4 kg of palladium, while battery recycling prevented the contamination of about 656 million cubic meters of water and conserved energy equivalent to 40,570 liters of diesel.	The Vodafone Recycling program is in place since 2003 in more than 500 places (VF shops and Scouts Greece.) Since the beginning of the program more than 900000 accessories and devices have been recycled. Since the beginning of the program it has been estimated that more 220 tonnes of CO2 eq have been avoided	NOVA answered that during the first quarter of 2024 they proceeded with the installation of recycling bins for mobile equipment in some of their shops. Data is not yet available.
Use of renewable energy	Guarantees of Origin (GOs) to cover 100% of its 2023 electricity consumption in Greece, representing 88% of total energy use across the Group. In 2023, autonomous photovoltaic units and wind turbines generated around 430 MWh of electricity in Greece, with plans to expand RES capacity by installing new photovoltaic units in 100 base stations, expected to generate 1 GWh by 2025. Additionally, a 500 kWp photovoltaic unit	Since 2021 the total electrical consumption of Vodafone Greece has guarantees of Origins (Green certificates from renewables). Reduction of diesel consumption at base stations, through partial substitution from photovoltaic	In 2023, 100% of Nova's purchased electricity consumption was covered through Guarantees of Origin (94.026,8 MWh). Same target for 100% coverage in 2024.

	OTE	Vodafone Greece	NOVA
	is being installed at OTE Headquarters, with more units planned, aiming to generate 900 MWh by 2024.		
Other measures to increase energy efficiency in network operation and data centres	OTE reports deactivation of capacity layers in low traffic periods and and attention to electricity generators in particular for standalone base stations. Consolidation of IT equipment (virtualization, rack orientation, etc.), as well as site infrastructure (UPS systems, HVAC systems, automation and BMS systems) and cabling infrastructure. Testing new solutions such as immersion cooling,	Saving cooling / heating energy in base stations, switching centres and data centres. Reduction of diesel consumption at base stations, installing more efficient generators and activation of energy saving mechanisms in base stations. Optimizing power quality of electrical installations of switching centres and upgrading lighting to LED. • Energy saving in the fixed communication network through exchange of batteries in external cabins	

4.1.2 Deployment of fixed network infrastructure

NOVA listed the following actions and impacts:

Actions	Impact in figures	Impact high/moderate/limited
• OTE physical colocation: consolidation of 346 racks by the end of 2023, resulting in 1.85 GWh electricity consumption reduction for 2023. Further consolidation expansion to 256 more racks in 2024, expected to offer further 6.1 GWh to electricity consumption in 2024. • DCs consolidation by transferring operation to other buildings, evacuating / terminating specific DCs operation. Action will result to 2,3 GWh electricity consumption reduction of Y2024.	• Energy consumption: 8,4 GWh reduction • GHG emissions reduction: 3.142 tCO2e reduction	n/a

Vodafone Greece listed the following actions and impacts:

Actions	Impact in figures	Impact: high/moderate/limited
Civil works-coordination where possible, Reuse/Recycling of infrastructure	• % of equipment recycled / reused: 100	• Energy consumption: limited • GHG emissions: limited • Material consumption: limited • % of equipment recycled / reused: high

4.1.3 Recycling and refurbishment of fixed networking equipment

OTE Group refer to their sustainability report:[75] In the report, there is no distinction between fixed and mobile networks regarding waste. The OTE Group generates solid waste from telecom networks, office operations, vehicle fleet management, and real estate activities, as well as from end-of-life products. They have developed a nationwide waste management network, partnering with certified companies to ensure proper waste handling and material recovery, including metals like copper and iron. The Group also implements a take-back scheme for mobile devices and accessories, collecting 27.3 tons for recycling in 2023, with 22.5 tons in Greece. Additionally, an internal recycling program in 24 office buildings, covering around 9,000 employees, focuses on sorting and recycling materials like paper, packaging, and electronic waste. Overall, in Greece 97% of waste was recycled or reused, while no ICT waste was landfilled. Their assessment regarding "% of equipment recycled / reused" is high.

75 OTE Group (2024), p. 71 ff.

Vodafone Greece listed the following actions and impacts:

Actions	Impact in figures	Impact: high/moderate/limited
Since 2022 100% of the network equipment is being reused/refurbished or recycled	• % of equipment recycled / reused: 100	• Energy consumption: limited • GHG emissions: limited • Material consumption: limited • % of equipment recycled / reused: high

4.1.4 Promotion of recycling and reuse of end-user fixed equipment

OTE Group referred to their sustainability report:[76] Since 2012, the OTE Group has operated a take-back, refurbishment, and recycling program for Customer Premises Equipment (CPEs) such as routers and TV boxes, aiming to extend their lifespan and recycle those beyond repair. Collected equipment from clients and stores is tested, refurbished with new or other refurbished components, and redistributed. Non-functional devices are sent to the national WEEE system for recycling, with the entire process managed in-house. In 2023, about 250,000 devices were refurbished and 80,000 recycled, resulting in avoided GHG emissions of 7kt CO2 eq and saving approximately 40 tons of plastic. Their assessment regarding "% of equipment recycled / reused" is high.

NOVA states that 14.300 units of CPEs were refurbished from January 24 to June 24.

4.1.5 Sustainable deployment of mobile network infrastructure

NOVA says that it utilizes active RAN sharing on mobile access network infrastructure. RAN active sharing is in principle a key sustainability driver limiting to almost a half the required equipment and substantially reducing the total power consumption. NOVA is continuing to identify opportunities to further expand RAN sharing on its existing network as well as its newly deployed radio stations.

Vodafone Greece confirm that they and Nova have in place a RAN network sharing agreement since 2013, which has been updated to cover 5G technologies. The rate of equipment recycled / reused is 100%.

4.1.6 Migration to more energy efficient mobile technologies

OTE Group referred to their sustainability report:[77] They say that improving energy efficiency is a key aspect of OTE Group's strategy to manage energy consumption, costs,

76 OTE Group (2024), p. 58.
77 OTE Group (2024), p. 59.

and exposure to fluctuating fuel and carbon prices. Measures in telecom networks include turning off unused equipment, reducing telecom space to lower cooling needs, optimizing cooling systems, modernizing mobile equipment, and using AI for mobile power saving by predicting network traffic. For electricity generators, especially at standalone base stations, grid connections and hybrid conversions with renewable energy sources are being pursued, alongside regular maintenance. Data centre efficiency efforts focus on upgrading infrastructure, consolidating IT equipment, and monitoring Power Usage Effectiveness (PUE), with the average PUE value improving to 1.86 in 2023. The impacts on energy consumption and GHG emissions are high.

NOVA says it has implemented an activation on the mobile network, resulting in 9% reduction in consumption (2023 vs 2021) and in 2.95GWh saving in 2023 (saved energy consumption: 2.95 GWh, saved GHG emissions: 1.104 tCO2e).

Vodafone Greece reports that 3G networks have mostly been switched off within 2023 and a modernisation of the mobile network (hardware and software) has taken place.

4.1.7 Recycling and refurbishment / reuse of mobile networking equipment

OTE Group refers to their sustainability report. No particular figures for recycling of mobile networking equipment are given (cp. section 4.1.3).

NOVA states that mobile network equipment, that is dismantled for operational or modernization reasons is systematically processed for reselling or recycling. Equipment lists are prepared and, following approval by the responsible technical officers, recycle or sell contracts are assigned to licensed contractors through tender processes. Refurbishment of mobile network equipment is not directly carried out by NOVA.

Vodafone Greece reports that since 2022 100% of its network equipment is being reused/refurbished or recycled. The impact on energy and GHG emissions is low, the impact on material consumption and % of equipment recycled / reused is high.

4.1.8 Promotion of recycling and reuse of customer mobile equipment

OTE Group refers to its sustainability report. The report says that circular economy is a key priority for the OTE Group's Sustainability Strategy, which includes operations, suppliers, and customers. Since 2013, OTE Group has promoted recycling at its retail network, collecting over 27 tons of mobile devices, approximately 21.8 tons of home appliance batteries, and 5,490 units of ink cartridges in 2023. By the end of 2023, recycling collection points were established in more than 370 retail shops and 24 office buildings in Greece. The recycling of mobile devices has recovered 95.5 kg of silver, 9.2 kg of gold, 3,548 kg of copper, and 5.4 kg of palladium, while battery recycling prevented the contamination of about 656 million cubic meters of water and conserved energy

equivalent to 40,570 liters of diesel. The impact on material consumption and on % of equipment recycled / reused is assessed to be high.

NOVA answered that during the first quarter of 2024 they proceeded with the installation of recycling bins for mobile equipment in some of their shops. Data is not yet available.

Vodafone Greece says that their recycling program is in place since 2003 in more than 500 places (VF shops and Scouts Greece.) Since the beginning of the program more than 900,000 accessories and devices have been recycled. The implications on energy consumption are assessed to be limited, while they are moderate on GHG emissions (since the beginning of the program it has been estimated that more 220 tonnes of CO2 eq have been avoided). The impact on material consumption is also moderate, on % of equipment recycled / reused it is high.

4.1.9 Use of renewable energy

OTE Group refers to its sustainability report.[78] The OTE Group prioritizes Renewable Energy Sources (RES) for decarbonizing its operations, securing Guarantees of Origin (GOs) to cover 100% of its 2023 electricity consumption in Greece, representing 88% of total energy use across the Group. In 2023, autonomous photovoltaic units and wind turbines generated around 430 MWh of electricity in Greece, with plans to expand RES capacity by installing new photovoltaic units in 100 base stations, expected to generate 1 GWh by 2025. Additionally, a 500 kWp photovoltaic unit is being installed at OTE Headquarters, with more units planned, aiming to generate 900 MWh by 2024. The impact on GHG emissions is expected to be high.

NOVA answered that In 2023, 100% of NOVA's purchased electricity consumption was covered through Guarantees of Origin (94.026,8 MWh). The same target applies for 100% coverage in 2024.

Vodafone Greece states that since 2021 all electrical consumption of Vodafone Greece has guarantees of Origin (Green certificates from renewables). The impacts are limited concerning energy consumption and high (scope 2 net zero value) regarding GHG emissions. Vodafone Greece also reports a reduction of diesel consumption in base stations in part through using photovoltaic panels.

4.1.10 Other measures to boost efficient use of energy

According to OTE, measures taken to reduce CO2 emissions (besides the use of RES) include "the deactivation of capacity layers in low traffic periods"[79] and attention "to the electricity generators, especially those covering the needs of stand-alone base stations

78 OTE Group (2024),p. 58.
79 OTE Group (2023), p. 78.

(24-hour operation)"[80]. OTE also states that it is increasing energy efficiency in data centres by "targeting IT equipment (consolidation, virtualization, rack orientation, etc.), as well as site infrastructure (UPS systems, HVAC systems, automation and BMS systems) and cabling infrastructure."[81] Another strategy is to test new solutions like Immersion Cooling, making air conditioning unnecessary and "resulting in up to 90% energy savings on cooling, an overall increase in productivity and reduction of up to 30% in terms of carbon footprint."[82]

Vodafone Greece's sustainability report lists the following measures to save energy. These are:[83]

- Saving cooling / heating energy in base stations, switching centres and data centres
- Reduction of diesel consumption at base stations, installing more efficient generators and partly substituting by generation from photovoltaic
- Energy saving by using high energy efficiency power supply equipment
- Activation of energy saving mechanism in base stations
- Upgrading the electromechanical infrastructure of the switching centres
- Optimizing power quality of electrical installations of switching centres
- Lighting upgrade in switching centres (installation of LEDs)
- Energy saving in the fixed communication network through exchange of batteries in external cabins

4.2 Investor / Customer environmental profile

In the context the questionnaire, operators were asked whether they consider the environmental profile of their business customers/investors and/or investors.

Vodafone Greece responded that it has a goal is to enable its business customers to reduce their own GHG emissions by 350m tonnes by 2030 (global accumulative target). They note that "To monitor this, we have been estimating the potential global carbon abatement impact of business customer products and services with the support of The Carbon Trust. Carbon abatement, also known as enablement or avoided emissions, is an estimated measurement of carbon savings resulting from the use of products and services. It is specifically the measurement of the avoidance or reduction of greenhouse gas emissions that would otherwise have occurred had these connections and services in these use cases not been in place."

OTE Group responded that it considers the environmental policies and practices of investors and is seeking to comply with them. Meanwhile, for Customers OTE noted that

80 OTE Group (2023), p. 78.
81 OTE Group (2023), p. 78 ff.
82 OTE Group (2023), p. 79.
83 Vodafone Greece (2022), p. 69 ff.

"The OTE Group offers integrated and innovative technology solutions to enhance business and sustainable development. Through products and services, customers make the most of the benefits of using broadband services to improve their operation, environmental performance and prosperity." Examples provided include Smart cities/energy management and fleet management.

5 Future challenges

An analysis of available data regarding GHG emissions (see chapter 3.2) suggests that there is significant scope to level up and ensure consistency in standards in reporting amongst Greek operators, while an analysis of the measures taken by the largest Greek ECN operators (see chapter 4) also reveals areas where improvements could be made, in some cases drawing on best practice already in the market. Further details are provided in the following sections.

5.1 Gaps and lack of consistency in reporting

A key area where improvements could be made concerns reporting.

The three largest telecommunication companies in Greece all publish data on sustainability but these differ not only with respect to granularity and focus, but also with regard to the reporting standards used. This creates significant challenges when it comes to comparing outcomes and assessing progress made.

Firstly, regarding scope in sustainability reporting, while, for example, NOVA and OTE report on their Scope 1, 2 and 3 emissions, Vodafone Greece only gives general information on their aims and measures in the latest sustainability report. There is also patchy or incomplete reporting in the sustainability reports of other indicators identified as important in a recent JRC study[84] (see Table 5-1).

84 EU Commission (2024).

Table 5-1: JRC indicators reported by Greek telecommunication companies in latest sustainability report

	Reported by		
Indicator	**NOVA**	**OTE Group**	**Vodafone Greece**
Energy consumption	Yes	Yes	Partly
Energy efficiency	No	Partly	Partly
Use of renewable energy (rate)	No	Yes	Partly
GHG scope 1 emissions	Yes	Yes	No
GHG scope 2 emissions	Yes	Yes	No
GHG scope 3 emissions	Yes	Yes	No
E-waste production	Partly	Yes	No
Distribution or utilisation of recycled/ refurbished/ reused products	Partly	Partly	Yes

As shown in Table 5-2, Greek telecom operators also vary regarding the extent to which they have set measurable (and where possible quantitative) targets in relation to the JRC indicators.

Table 5-2: Targets regarding JRC indicators

	NOVA	**OTE Group**	**Vodafone Greece**
Energy consumption	As per Scope 1 & 2 targets		
Energy Efficiency	PUE metering in AC Data Centers Buildings consolidation, Software features activation in radio equipment Power and AC modernization with high efficiency equipment. Evaluate PV panels installation in our eligible premises.		
Use of renewable energy (rate)	Setting 2022 as base line, we proceed with 100% of purchased electricity through renewable sources.	100	
GHG scope 1 emissions	UG target for 90% reduction by 2030 from 2020 base year	The targets are established for total scope 1, 2, 3 emissions	At least 90% reduction (Baseline year 2020) and maximum 10% Carbon offsetting
GHG scope 2 emissions	UG target for 90% reduction by 2030 from 2020 base year	The targets are established for total scope 1, 2, 3 emissions	Zero emissions. (Achieved with green certificates with GO and own photovoltaics on sites)
GHG scope 3 emissions	Reduce scope 3 by 40% from a 2022 base year	The targets are established for total scope 1, 2, 3 emissions	At least 90% reduction (Baseline year 2020) and maximum 10% Carbon offsetting
E-waste production	Aiming at prolonging smartphones lifecycle, Nova offers through its shops hassle-free service at no additional cost when within 2y warrantee. On the front of plastic footprint reduction, Nova has introduced half sized SIMs reducing the plastic waste by half; target is to move entire SIMs production to half size by Q4 24 Moreover, Esim has been introduced for new/existing subscribers whose smartphones is eSIM capable; this way Nova encourages subscribers to get a physical voucher with a QR code on top and provision their smartphoner over the air contributing to our lowering environmental impact strategy Last but not least, Nova has run intensive marketing activities aiming at moving subscribers from paper to e-bill		
Distribution or utilisation of recycled/ refurbished/ reused products	Introduce refurbished CPEs/STBs		Planned within 2024

UG: United Group

It should be noted that the indicators listed in the JRC study go beyond those for which reporting is mandatory under the Greek Climate Law, which focuses on GHG emissions and is limited to scopes 1 and 2, and also cover indicators that are relevant to assessing progress regarding the implementation of Regulations regarding electrical and electronic waste.

However, setting measurable targets and assessing progress against this wider set of indicators is likely to be important, not only to reflect best practice (as may be set out in a future Code of Conduct at EU level), but also to help companies benchmark effectively, reduce cost and comply with regulations (e.g. CSRD) and identify risks related to climate change, resource use, and governance issues.

Responses to the questionnaire sent in June 2024 suggest that improvements in reporting regarding coverage of the indicators identified in the JRC study can be expected. For example, Vodafone Greece noted that in the forthcoming 2024 report, all the KPIs listed (from the JRC study) will be duly disclosed. Meanwhile, OTE noted that it will report on waste generated by its own activities while NOVA will report on electricity produced through renewable sources. Further efforts could however be made to encourage Greek ECN operators to establish as a minimum (amongst other possible targets) targets and indicators which are associated with the JRC indicators, as this could support comparability.

Another concern beyond the scope of indicators and targets is that while the same reporting standards have been used (see Table 5-3) they have been applied in different manners.

Table 5-3: Standards used in latest sustainability reports

NOVA / Wind

Standard	2017	2018	2019	2020	2021	2022
GRI Standards	Greek language	Greek language				
The Telecommunications Sustainability Accounting Standard issued by SASB						

OTE Group

Standard	2017	2018	2019	2020	2021	2022
GRI Standards	na					
The AccountAbility AA1000AP Principles on Inclusivity, Materiality,	na					
The United Nation's Global Compact Principles	na					
The Athens Stock Exchange (ATHEX) ESG Reporting Guide	na					
The criteria of the Greek Sustainability Code	na					
The Telecommunications Sustainability Accounting Standard issued by SASB	na					
Guidelines of the Task Force on Climate-related Financial Disclosures (TCFD)	na					

Vodafone Greece

Standard	2017	2018	2019	2020	2021
GRI Standards	na				

used
not used
na: not available / not published

Adherence to common standards in reporting will be very important in ensuring comparability in targets and measurements going forwards. In this context, it is positive to note that all operators have reported that they will comply with the ESRS reporting standards in future, once the standard is in force. [85] This will however need to be verified.

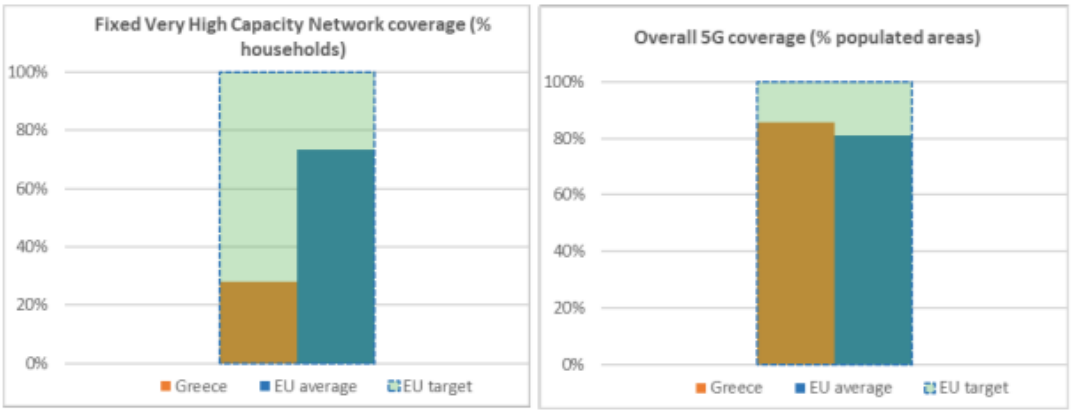
85 Vodafone Greece states that in addition their Group annual disclosures are developed with reference to the GRI framework and the UNGC principles, and their Group annual disclosures include a TCFD aligned disclosure on climate-related risk

5.2 Limited prioritisation of fixed network upgrades

Feedback to the questionnaire from the largest operators present in the Greek market shows that while attention has been given to sourcing renewable energy and improving energy efficiency, there has been limited impetus towards fibre migration and the switch-off of legacy fixed networks. No specific targets have been set. However, as noted in section 2.1, literature suggests that maintaining copper networks, particularly as bandwidth consumption grows, is a key source of inefficiency in energy consumption in telecoms networks. FTTH coverage levels that lie well below the EU average (see Figure 5-1) is likely to be a core reason behind the limited progress towards copper switch-off.

Figure 5-1: Development of Greek communication infrastructure

	Greece			EU	EU
	DESI 2021	DESI 2022	DESI 2023	DESI 2023	2030 target
2a1 At least 100 Mbps broadband take-up	**3%**	**9%**	**20%**	**55%**	
% households	2020	2021	2022	2022	
2a2 At least 1 Gbps broadband take-up	**<0.1%**	**<0.1%**	**<0.1%**	**13.8%**	
% households	2020	2021	2022	2022	
2a3 Fixed Very High Capacity Network (VHCN) coverage	**10%**	**20%**	**28%**	**73%**	**100%**
% households	2020	2021	2022	2022	
2a4 Fibre to the Premises (FTTP) coverage	**10%**	**20%**	**28%**	**56%**	
% households	2020	2021	2022	2022	
2b1 Mobile broadband take-up	**67%**	**76%**	**76%**	**87%**	
% individuals	2018	2021	2021	2021	
2b2 Overall 5G coverage	**0%**	**66%**	**86%**	**81%**	**100%**
% populated areas	2020	2021	2022	2022	
2b3 5G spectrum	**99%**	**99%**	**99%**	**68%**	
Assigned spectrum as a % of total harmonised 5G spectrum	2021	2022	2023	2023	



Source: EU Commission(2023), p. 5.

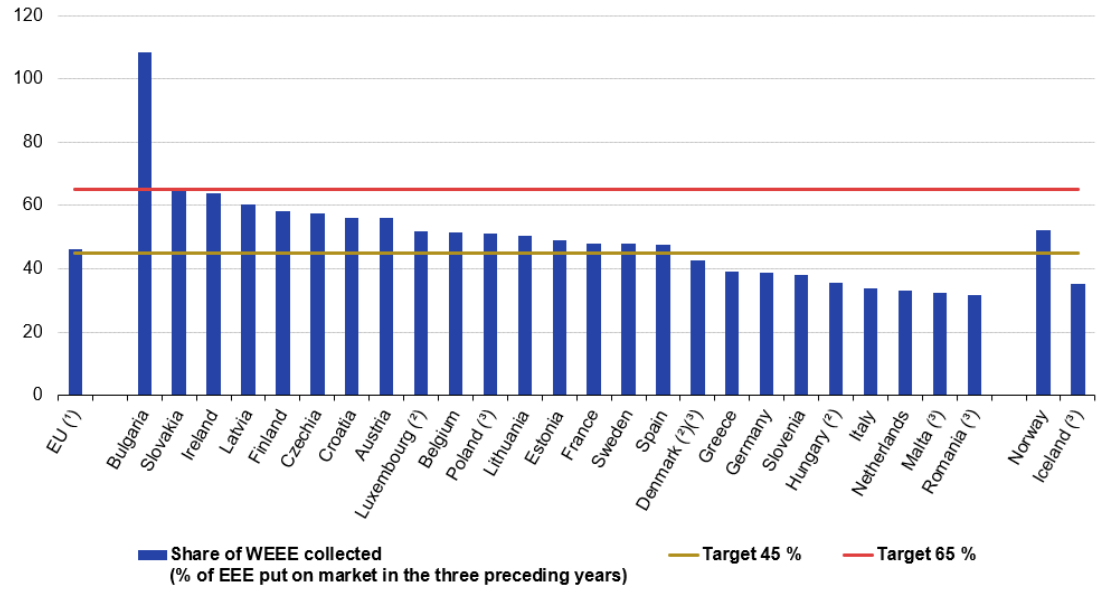
Switch-off of legacy mobile technologies such as 3G and efficient deployment of 5G, including network sharing where appropriate in the context of network densification / use of higher frequencies, will also be important in containing energy consumption associated with the upgrade of mobile networks. Available data suggests that Greece's coverage of 5G lies above the EU average. Attention will nonetheless be needed to ensure that further densification in the mobile network is carried out in a way that seeks to limit energy emissions.

5.3 Variable practices regarding recycling / reuse

Information provided by the operators in the context of sustainability reports and the Q2 2024 questionnaire suggests that progress regarding recycling and reuse of networking and end-user equipment is not uniform, and could be improved in certain cases especially by NOVA, along with more consistent reporting of outcomes. This could for example include the number of devices, their weight and the amount of precious materials recovered, as well as the GHG emissions avoided and re-use of plastic, as reported by OTE.

Although not specific to telecom networking equipment and CPE, figures from Eurostat suggest that there is scope to improve the recycling and re-use of electronic equipment in Greece. Figure 5-2 shows how countries perform according to the WEEE Directive (Waste Electrical and Electronic Equipment Directive).

Figure 5-2: Total collection rate for waste electrical and electronic equipment (EEE), 2021 (% of average weight of EEE put on the market in the three preceding years)



(1) Eurostat estimate.
(2) 65 % target not applicable. Country applies calculation methodology based on WEEE generated: see Figure 2b.
(3) 2020.
Source: Eurostat (online data code: env_waseleeos)

(1) Eurostat estimate.
(2) 65 % target not applicable. Country applies calculation methodology based on WEEE generated: see Figure 2b.
(3) 2020.
Source: Eurostat (online data codes: env_waseleeos)

The WEEE Directive initially set a collection target of 45% or 4 kilograms of e-waste per inhabitant per year, which EU member states were required to meet by 2016. From 2019, the targets were increased, requiring member states to collect either 65% of the average weight of EEE placed on the market in the previous three years or 85% of the e-waste generated. As can be seen from the figure, Greece's performance currently falls beneath these targets.

5.4 Untapped potential to support end-users in adopting sustainable practices

Improvements in recycling and support for sustainable choices can be supported by informing and engaging both residential and business customers in this process. Wider sustainability gains can also be achieved by supporting end-users in using technology to reduce energy consumption in other sectors such as in buildings and transport. Vodafone Greece and OTE both report that they are active in supporting their customers in achieving reductions in their environmental footprint. Vodafone further reports that it has set targets in this regard and is monitoring progress with the support of The Carbon Trust. Greater attention could be given by ECN operators more generally to inform customers

about the environmental implications relating to their use of connectivity and associated devices and to make use of technology to achieve energy efficiency more widely.

6 Competencies of regulatory authorities regarding sustainability

6.1 Regulatory strategies to support sustainability targets

There are various ways in which regulators can contribute to reducing the carbon footprint in the telecom sector, where this is compatible with their remit.

Actions which relate to regulation include:

- Facilitating efficient deployment e.g. through enabling or promoting infrastructure sharing or where appropriate sharing of active elements
- Facilitating the deployment of more energy-efficient technologies and the switch-off of less efficient fixed and mobile legacy technologies
- Attaching incentives, conditions or requirements regarding sustainability in the context of Rights of Way, spectrum licence awards or State Aid

Actions which could be taken to measure environmental impact and support sustainable practices include inter alia:

- Supporting in data gathering, respecting European standards and recommended indicators
- Organising working groups involving the industry (ECN operators only or the wider ICT value chain) and/or consumer organisations regarding sustainability initiatives
- Facilitating the preparation of and/or adherence to Codes of Conduct
- Supporting in the development of eco-design
- Conducting representative consumer surveys regarding awareness and concern around environmental issues
- Supporting in the development of awareness-raising initiatives amongst consumers
- Providing advice and support in applying digital solutions that increase sustainability in other sectors
- Conducting studies to better understand dynamics around environmental impacts and sustainable initiatives relevant to the national situation

It is important to ensure that any initiatives taken are effectively co-ordinated with relevant bodies including the national Government, environmental agencies, European regulators, the European Commission and international organisations in order to maximise their effectiveness and limit fragmentation and administrative burdens on industry.

6.2 Competencies of European telecom regulators

The EETT currently does not have any overarching objectives related to sustainability and is not specifically tasked with any actions under Greek environmental legislation. Responsibility for implementing the related provisions set by the National Climate Law regarding ECNs data gathering lie within the remit of The Natural Environment and Climate Change Agency and (for electronic waste) the Hellenic Recycling Agency.

As regards its remit to take into account environmental impacts in the context of specific regulatory measures, EETT can impose co-location and sharing of network elements (including masts, towers and similar antenna supporting structures) in order, among other reasons, to protect the environment. The relevant legal basis is article 152 of Law 4727 of 2020 (transposition of article 44 of EU Directive 2018/1972). Legislation in place beforehand[86] also required operators to collocate antennae on request on reasonable terms, for environmental reasons and to provide collocation where technically feasible. EETT has published a Regulation concerning collocation.[87] Sustainable deployment can also be promoted through passive network sharing. In the context of the award of 5G spectrum bands, ECN operators were granted the right to enter into commercial infrastructure sharing agreements with a simple notification to EETT.

In contrast, a number of other national administrations have provided for a collaboration between environmental protection agencies and telecom regulatory authorities in the enforcement of sustainability rules applying to electronic communication network operators and – in some cases - other actors in the ICT value chain. This is for example the case in France, where **ARCEP's** responsibility for taking into account environmental concerns was included in legislation in 2010 in Article L32-1 of the Code for Post and Electronic Communications as follows.

> *"II.-Within the framework of their respective attributions, the Minister in charge of electronic communications and the Regulatory Authority for Electronic and Postal Communications, under objective and transparent conditions, reasonable measures proportionate to the objectives pursued and ensure: (...) 12. addendum - A high level of protection of the environment and the health of the population, jointly with the ministers responsible for health and the environment*;".[88]

ARCEP's responsibilities as regards the environment have been further elaborated in the French Government's 2021 Roadmap for "Digital and Environment".[89] A key task is to develop an environmental barometer / index for the digital ecosystem. ARCEP's work in

86 Par 7 of article 29 of Law 4070
87 (750/5/2015) with a latter modification on 2018 (859/3).
88 Article L32-1 du code des postes et des communications électroniques Modifié par LOI n° 2010-788 du 12 juillet 2010 - art. 183 (V). Available at: https://www.arcep.fr/fileadmin/reprise/textes/lois/article-L32-1-cpce-loi-2010-788.pdf (Accessed: 13.07.2021).
89 https://www.ecologie.gouv.fr/feuille-route-numerique-et-environnement

this area has been supported by legislation introduced in December 2021[90] which extended the obligation to provide environmental data to all market players within the ecosystem.

ARCEP has also collaborated with the French environment agency ADEME by providing expertise on networks in relation to the implementation of the French Circular Economy Law[91] adopted in 2020 which provides that Internet providers must inform their subscribers of the quantity of data consumed and the corresponding GHG emissions starting 2022 and entrusts ADEME to manage the associated databases. In this context, ARCEP has also studied how mobile distribution models impact terminal renewal rates.[92]

ARCEP has also been tasked with taking into account environmental considerations in the context of spectrum allocation – in particular for the 26 GHz band, and has conducted a technical study to compare the energy efficiency of 4G vs 5G deployment.

Since 2022, ARCEP has been involved in projects to assess the environmental footprint of the audio-visual sector, providing recommendations to content service providers and TV broadcasters, and working on an eco-design recommendation together with Arcom (the audio-visual regulator) and ADEME.[93] The 2022 edition of the ARCEP digital barometer includes data regarding the lifetime and recycling of TV sets.[94]

Another NRA which has been active in supporting the environmental agenda is **Traficom** in Finland. In 2019 Traficom established a working group involving different stakeholders including telecom operators, universities, research organisations, consumer associations, media providers, environmental organisations and public sector bodies. The output was a strategy published in 2021, which contained recommendations for telecom operators, data centres and Government organisations. In addition to providing a voluntary questionnaire aimed at data gathering from telecom providers, Traficom also commissioned external studies. One focused on the environmental impact of emerging technologies such as AI and blockchain, while the other was a consumer survey which sought to gather insights regarding the knowledge, attitudes and behaviour of consumers in relation to the environmental impact of ICT devices and services.

Certain other regulators such as **ComReg** have pursued initiatives which seek to increase understanding of the potential for electronic communications to limit emissions in other sectors. For example, in December 2019, Comreg launched a Call for Inputs to understand how electronic communications could contribute to improvements in sustainability in transport (e,g, through traffic optimisation), agriculture (e.g. through precision farming), electricity (e.g. through smart grids) and industry including M2M.

90 https://www.legifrance.gouv.fr/jorf/id/JORFTEXT000044553569
91 https://www.legifrance.gouv.fr/jorf/id/JORFTEXT000041553759/
92 https://www.arcep.fr/uploads/tx_gspublication/rapport-renouvellement-terminaux-mobiles-pratiques-commerciales-distributionjuillet2021.pdf
93 BEREC BoR (22) 93
94 https://www.arcep.fr/cartes-et-donnees/nos-publications-chiffrees/barometre-du-numerique/le-barometre-du-numerique.html

ComReg cites the assignment of specific frequencies for Smart Grids (400 MHz) as one initiative through which they as a telecom regulatory authority have been able to contribute towards sustainability in other sectors. ComReg has also included questions regarding awareness and attitudes towards sustainability in its representative consumer survey.

7 Preliminary proposals to reduce carbon footprint

Drawing on the key challenges identified in chapter 5 and regulatory approaches taken in other markets (see chapter 6), there may be scope for the Greek authorities to consider initiatives in the following areas.

Reporting: A key finding from the information gathering process carried out for this study is that there are gaps in reporting on key sustainability indicators and information that is available is reported in different ways, even when the same standards are used. ECN operators should set targets for and report on key indicators that will be elaborated through relevant EU-level Codes of Conduct. The **indicators identified in the JRC study**[95] could serve as a useful starting point in the meantime. Companies should also aim to harmonize their reporting standards by adopting internationally recognized frameworks (in future: the **ESRS standard**) for calculating and reporting emissions, ensuring consistency across disclosures. Transparency in Scope 3 emissions reporting should be a priority, given the substantial impact of these emissions, with more comprehensive data required. References to sustainability reporting on ECN in Greek legislation should ultimately be aligned with EU standards, but during the period while harmonisation is still in progress, companies should avoid discrepancies between different reports, ensuring alignment between data submitted to authorities like N.E.C.C.A. and published sustainability reports, and explain differences that may result from the standard used or the subject of reporting (e.g. networks only, networks and buildings etc.). Regular updates on emissions and energy consumption, using clear and comparable metrics, would ensure stakeholders can track progress toward sustainability goals. Additionally, operators should explicitly disclose the sources of electricity used, especially regarding renewable versus non-renewable energy, to provide clarity on energy consumption. Finally, greater transparency in the methodologies used to calculate emissions, particularly in approaches for Scope 3 categories, would strengthen the credibility of the reports. The Greek authorities could usefully monitor progress by ECN operators in establishing targets and publishing data for common priority indicators such as those outlined in the JRC study and complying with relevant standards and Codes of Conduct established at EU level, once these are in force.

- **Migration to energy-efficient fixed and mobile technologies:** Further attention could be given by policy-makers and ECN operators to achieving full fixed Gigabit coverage and establishing goals for the associated switch-off of copper networks,

95 EU Commission (2024).

including in areas which may not be served by the incumbent. In order to foster accelerated deployment of 5G, consideration could be given to addressing barriers which relate to licensing conditions and EMF limits.[96] Encouragement could also be given for the switch-off of legacy mobile technologies where other more efficient solutions are available.

- **Sustainable wireless and fixed deployment policies:** The Greek authorities and EETT could usefully consider whether there is scope to foster sustainable wireless deployment through conditions associated with spectrum Rights of Use once existing Rights expire.[97] Expedited processes to review proposals for infrastructure and RAN sharing could also be considered. The application of the recently approved Gigabit Infrastructure Act could also provide opportunities to support better co-ordination of deployment and infrastructure re-use.
- **Workshops for industry:** The EETT / Greek authorities could consider establishing workshops for industry to facilitate the sharing of best practice in limiting environmental impacts e.g. with regards to recycling / re-use and associated reporting.
- **Transparency for consumers:** The EETT / Greek authorities could consider how best to inform consumers and small businesses about the environmental impacts of their communications purchasing and use, as well as the potential to achieve energy efficiencies in other areas through the use of technology.[98]
- **Further research:** ECN operators in Greece are broadly agreed that EETT could play a valuable role by conducting further studies to better understand dynamics around environmental impacts and sustainable initiatives relevant to the national situation. These could inter alia involve analysis of how strategies such as those described above could best be implemented to support sustainable outcomes in the Greek market.

96 In this context, Vodafone Greece advocates harmonization of public exposure limits to electromagnetic fields with the Recommendations of the International Commission on Non-Ionizing Radiation Protection (ICNIRP) for a seamless and full development of 5G networks. In Greece, the upper limits are significantly lower (by 30%-40%) than ICNIRP guidelines, which poses obstacles to the smooth development of 5G. Harmonization will remove current obstacles in network deployment, such as constraints on full use of allocated frequencies and need for densification of current network topology, therefore it will subsequently result in decreased energy consumption.

97 Rights of Use will expire in 2027 for 900 MHz and 1800 MHz bands and in 2030 for 800 MHz and 2600 MHz bands

98 In this context, Vodafone Greece notes that “Empowering consumers with knowledge about environmental impact is crucial for fostering a sustainable and eco-conscious ICT sector. Initiatives like EcoRating play a pivotal role in reaching the public. The National authority’s support is particularly important, as it establishes trust among consumers, ensures accurate and unbiased information dissemination, and can ultimately drive positive behavioural change.”

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Glossary

Climate Change Adoption refers to activities that help reduce or prevent the adverse effects of climate change or increase resilience to its impacts. This can involve measures such as improving infrastructure to withstand extreme weather events, enhancing water management systems, or adopting new agricultural practices to cope with changing climate conditions. To qualify under the taxonomy, these activities must support the adaptation to current and future climate risks while ensuring they do not cause significant harm to other environmental objectives.

Climate Change Mitigation refers to activities that contribute to the reduction or prevention of greenhouse gas emissions, thereby helping to limit global warming. This includes actions such as improving energy efficiency, transitioning to renewable energy sources, developing low-carbon technologies, and enhancing carbon capture and storage. For an activity to qualify as climate change mitigation under the taxonomy, it must substantially contribute to the EU's goal of achieving climate neutrality by 2050 without causing significant harm to other environmental objectives.

EU Taxonomy: The EU Taxonomy is a classification system designed by the European Union to define environmentally sustainable economic activities, helping to guide investments toward green projects. It sets clear criteria for businesses and investors to assess whether an activity significantly contributes to environmental objectives such as climate change mitigation, while avoiding harm to other sustainability goals. The taxonomy aims to support the EU's broader sustainability and climate neutrality goals, making it a key tool in the European Green Deal.

Pollution Prevention and Control refers to activities aimed at minimizing or eliminating the release of pollutants into air, water, and soil, thereby reducing environmental and human health risks. This includes initiatives such as improving waste management, reducing emissions of harmful substances, and enhancing technologies for pollution control. To qualify under the taxonomy, these activities must contribute significantly to preventing or controlling pollution while ensuring they do not cause harm to other environmental objectives.

Protection and Restoration of Biodiversity and Ecosystems refers to activities that conserve, enhance, or restore natural habitats and ecosystems to promote biodiversity. This includes efforts such as reforestation, habitat restoration, sustainable land use practices, and conservation of species. To qualify under the taxonomy, these activities must significantly contribute to the preservation or improvement of biodiversity and ecosystems while ensuring they do not harm other environmental objectives.