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Draft BEREC Report on Sustainability: Sustainability Indicators for Electronic Communications Networks and Services

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Body of European Regulators for Electronic Communications

BEREC

During its 54th plenary meeting (9th and 10th March 2023), the BEREC Board of Regulators has approved the Draft BEREC Report on Sustainability: Sustainability Indicators for Electronic Communications Networks and Services for public consultation.

This Draft Report aims to help identify relevant sustainability indicators which are instrumental in measuring and communicating the environmental footprint of the electronic communication sector. It also analyses the potential role of National Regulatory Authorities (NRA) to participate in efforts to harmonise methodologies in order to define sustainability indicators for ECN/ECS.

It provides an outline of the results of BEREC's groundwork on sustainability indicators which includes: an overview of existing regulations and of stakeholders' approaches, a review of current NRAs' activities related to sustainability indicators and an analysis of adoption and support level of a set of sustainability indicators among industry players.

In this Draft Report BEREC also assesses some of the main challenges to increase environmental transparency in the electronic communications sector.

BEREC continues to build up its knowledge on the important topic of sustainability to be able to contribute with its expertise in shaping the twin, green and digital, transition.
Collaboration with relevant stakeholders is of importance in this process, especially for knowledge and

information exchange related to ICT sustainability.

All stakeholders are invited to submit their inputs via EU survey portal no later than 12 April 2023 (17:00 CET).

Contributions should be preferably submitted in English.

In case you are facing any difficulties with the platform, please send your questions and queries to Sustainability_PC@berec.europa.eu. No contributions are accepted on this address.

Please ensure that the overall size of the email (including attachments) is not larger than 2 MB.

We strongly encourage all stakeholders to submit their contributions as early as possible. Contributions received after the above-mentioned deadline will not be taken into account.

All contributions received will be published on the BEREC website, taking into account requests for confidentiality and publication of personal data. Any such requests should clearly indicate which information is considered to be confidential.

* Name

GSMA Europe

Organisation

GSMA

EU member states

- AT - Austria
- BE - Belgium
- BG - Bulgaria
- HR - Croatia
- CY - Cyprus
- CZ - Czechia
- DK - Denmark
- EE - Estonia
- FI - Finland
- FR - France
- DE - Germany
- EL - Greece
- HU - Hungary
- IE - Ireland
- IT - Italy
- LV - Latvia
- LT - Lithuania
- LU - Luxembourg
- MT - Malta

- NL - Netherlands
- PL - Poland
- PT - Portugal
- RO - Romania
- SK - Slovak Republic
- SI - Slovenia
- ES - Spain
- SE - Sweden
- (•) XY - Other

* Email

[redacted]

Feedback on each chapter of the Draft Report

1) Please enter your comments on executive summary and chapter 1 (Introduction and objectives) here:

Reference to the ‘enablement’ effect

- The GSMA would welcome BEREC’s acknowledgement of the key role connectivity plays enabling the ‘green transition’. The mobile industry is committed to reducing its own emissions however, its greatest contribution to combating climate change is reducing the emissions of wider industries through smart connected technologies and promoting consumer behavior change.

- Research conducted by the GSMA with the Carbon Trust found, while the mobile industry is currently responsible for around 0.4% of carbon emissions globally, it enables carbon reductions in other sectors that are 10 times larger, equivalent to approximately 4% of global emissions. Furthermore, research launched by the GSMA at COP26, showed that connectivity can help enable 40% of the required cuts in carbon emissions by 2030 in the manufacturing, transport, energy, and buildings sectors.

- Therefore, the final report should acknowledge the mobile industry has a significant enabling role. While it may be beyond the BEREC capacity and purpose to estimate the precise extent of the enabling factor in other industries (enablement ratio compared to the footprint of the industry), it should be clearly acknowledged that every improvement of environmental impact by telecom industry itself must be estimated in a broader context of its positive environmental impact on other industries.

- Considerations concerning the reduction of the environmental footprint of the electronic communications sector must consider the broader context of impact reduction for other industries. Consistency between different initiatives

- The GSMA welcomes the recent interest on the topic of sustainability shown by National Regulatory Authorities (NRAs). It calls on NRAs to take into due account the work done to date at global level by the mobile industry (measuring what is measurable and not ‘reinventing the wheel’).

- Considering there are various initiatives at EU level, it is critical to grasp the dual role the industry plays: digital technologies enable green solutions (‘ICT4green’), at the same time, digital technologies themselves impact the environment and the mobile industry is working constructively to tackle its climate impact (towards ‘GreenICT’).

- It is equally critical, especially given the announcement by the European Commission of an upcoming proposal for “Code of Conduct” on the environmental sustainability of telecoms (Q4 2025), that there is one consistent set of basic common sustainability indicators of the environmental impact of the industry within the EU.

- Eventual discrepancies between the sustainability indicators by BEREC, by the European Commission (Code of Conduct, EU taxonomy etc.) and by NRAs or other relevant bodies would reduce public trust in the environmental initiatives by all stakeholders, despite our commitment to them. Hence, we fully agree with the suggestion by some BEREC members that “it is necessary to properly define the scope and boundaries of the network (or parts of it) for which the energy consumption is calculated. In addition, the need for the reported figures must be comparable, homogeneous, and based on the same definitions is emphasised.”

2) Please enter your comments on Chapters 2 (European Framework) and 3 (Results from stakeholders’ workshops on environmental transparency and related reports) here:

- The GSMA welcomes the recent interest on the topic of sustainability shown by NRAs. It calls on NRAs to take into due account the work done to date at global level by the mobile industry.

- The GSMA highlights that the mobile industry is tackling climate change, voluntarily developed a decarbonisation pathway aligned with the science-based target initiative (SBTi) and in line with the Paris Agreement target of achieving net-zero emissions by 2050. The mobile sector is taking collaborative action to be fully transparent about the industry's own climate emissions and have developed an industry-wide climate action roadmap, to achieve net-zero greenhouse gas (GHG) emissions by 2050, in line with the Paris Agreement. The mobile industry is making continued progress on disclosing energy and emissions data and setting targets for emissions reductions.

- The GSMA members are working to improve energy efficiency across their operations, transition to renewable energy and make supply chains more sustainable. To date, 62 operators representing 61% of the industry by revenue and 46% by connections have committed to a science-based target of rapidly decreasing their direct and indirect emissions by 2030. A considerable portion of operators have also committed to net zero targets by 2050 or earlier, accounting for 39% of mobile connections and 43% of global revenue.

- The GSMA invites BEREC to read the latest edition of 'Mobile Net Zero' Report: https://www.gsma.com/betterfuture/resources/mobile-net-zero-state-of-the-industry-on-climate-action-2023

3) Please enter your comments on Chapter 4 (National regulatory authorities' approach to environmental transparency and indicators) and ANNEX II (Additional information and graphs on answers to BEREC questionnaire to national regulatory authorities) here:

4) Please enter your comments on Chapter 5 (Analysis of industry players feedbacks on environmental reporting practices and sustainability indicators) and ANNEX I (Additional information on answers to BEREC questionnaire to industry players) here:

- The GSMA welcomes the recent interest on the topic of sustainability shown by NRAs. It calls on NRAs to take into due account the work done to date at global level by the mobile industry (without regulatory constraints).

- Having said that, the GSMA acknowledges the BEREC's efforts to help identify relevant sustainability indicators and assess some of the main challenges to increase environmental transparency in the ICT. Nonetheless, we would like to take this opportunity to request a broader discussion regarding carbon and energy intensity indicators as we find these to provide valuable and comparable information regarding the management and actions being undertaken in the organizations to limit their environmental impact.

- In Section 5.4.3 of the report, there is a mention of KPIs "carbon intensity" (which shows the CO2e emissions in proportion to the transmitted data volumes) and "energy intensity" (regarding energy consumption in proportion to the transmitted data volumes) as being considered as "other indicators considered important by the respondents to estimate environmental performance by industry players".

- However, there is very limited information with regards to these indicators throughout the document. It could be useful to deepen the answers and results that were obtained from all the consultation methods that were carried out regarding intensity indicators.

- It may be helpful to provide further details and discussion on energy efficiency indicators for mobile networks, such as the advantages, limitations, and complementarity of different indicators.

- When analyzing the metrics reported in Annex I related to Carbon emissions we can see that the only relative metric shown is the: tCO2/M€ (intensity using million-euro revenues).

- Energy use per unit data transmitted (e.g. kWh/GB) is a more commonly used indicator to track a mobile operator's progress on energy efficiency over time. It might be preferable to collect data or results on metrics related to tCO2/ energy consumption (MWh), tCO2/Petabyte

- In terms of environmental indicators, "kWh per petabyte" is probably more valuable, as it indicates energy is being used to process and store a given amount of data (energy efficiency), which is directly related to GHG emissions associated with the production of electricity.
"Petabytes per kWh consumed" indicates the amount of data that can be processed with a given amount of electrical power, which is useful for comparing the efficiency of different data centers in terms of data processing, but not so much in terms of environmental impact.

- In section 2.2 of the report, the "Study on Greening Cloud Computing and Electronic Communications Services and Networks Towards Climate Neutrality by 2050" , proposes the use of "the favorable treatment of energy efficient networks (kWh/GByte) in State Aid and with respect to permit granting", indicating this way, the importance that these types of indicators have on measuring impacts and can be thus used as thresholds to compare energy efficiency practices.

- However, used in isolation, a simple ratio of energy use or carbon emissions to data is limited in its ability to compare the efficiency performance of different networks and operators, since mobile network energy consumption is also function of other variables such as the number and distribution of connections, coverage area, peak traffic, climate, and topography, among others.

- Therefore, a more complete understanding of the energy efficiency of a network (and how to improve it) requires consideration of a suite of complementary energy efficiency indicators, such as energy use per unit data, energy use per connection or subscriber, energy use per coverage area, energy per mast site, and others.

- The GSMA's two benchmarking reports on energy efficiency published in 2021 (1) and 2023 (2) have explored the use of different efficiency indicators, along with other resources such as ITU L.1330 and ETSI ES 203 228 (3).

(1) https://data.gsmaintelligence.com/api-web/v2/research-file-download?id=60621137&file=300621-Going-Green-efficiency-mobile.pdf
(2) https://data.gsmaintelligence.com/api-web/v2/research-file-download?id=74384072&file=280223-Going-Green-Second-Edition.pdf
(3) https://www.etsi.org/deliver/etsi_es/203200_203299/203228/01.03.01_60/es_203228v010301p.pdf

5) Please enter your comments on Chapters 6 (BEREC preliminary conclusions on sustainability indicators) and 7 (Next steps and future work for BEREC) here:

6) Please enter any other comments you may have:

Considering industry initiatives and constraints in data collection

- The GSMA welcomes the recent interest on the topic of sustainability shown by NRAs. It calls on NRAs to take into due account the work done to date at global level by the mobile industry (without regulatory constrains).

- The GSMA recalls that the mobile industry showed outstanding leadership and was one of the first sectors to align itself to the goals of the Paris Climate Agreement. The mobile industry has been investing heavily to be exemplary and is working on reducing its own environmental footprint with efforts to reduce its emissions across Scope 1, 2 and 3 and with the objective of being 'Net Zero' by 2050 or before, using a high rate of renewable electricity and shifting towards a circular economy model for its equipment.

- The GSMA agrees with BEREC that measurement of whole value chain emissions is difficult currently. This is partly because of a lack of a standardised approach to measuring Scope 3 emissions across the industry. In response to this challenge, last year the GSMA created a global project group to develop a standardised approach to measuring each of the 15 GHG Protocol Scope 3 categories. This guidance to due to be published in May 2023.

- On environmental impacts beyond carbon emissions, in 2021 the GSMA created a project group to begin to understand how to move towards a more circular economy for network equipment. In March 2022 the GSMA published a strategy paper on this topic, with one of the key recommendations being the provision of standardised data sets from network equipment manufacturers. The GSMA members support agreement on standardised measurement for life cycle carbon emissions and other environmental impacts.

Balancing regulatory intervention

- The optimal and efficient way towards common EU indicators for network-specific sustainability requires the dialogue between policymakers and the industry players. Considering the telecom industry in Europe has a proven record of the ability to agree on effective common standards, processes and approaches and support of harmonization of indicators (including engagement in Green Digital Coalition shows) we do not see the need for a binding harmonisation via European regulation.

- Furthermore, the introduction and/or extension of reported sustainability indicators should maximise alignment with existing data collection and reporting initiatives to limit any increase in the reporting burden upon operators to allow operators to prioritise their resources and efforts on advancing climate action.

- Any reporting obligations concerning sustainability indicators should be reasonable, feasible and apply to all operators (independently of size) to dully capture the environmental impact of the sector.

- In our view, BEREC as the body of EU telecom sector regulators could explore ways how "greening" of networks should be linked to the sectoral regulation, for example by incentivising investment in more sustainable network technologies by lessening the regulatory burden. For example, network elements deployed via more sustainable methods (such as microtrenching etc.) should be subject to lighter SMP regulation, if at all.

Broad support for conclusions

- We are in line with the conclusions obtained from BEREC's report, we agree that the most relevant

environmental sustainability indicators for the ICT sector are those related to measuring energy consumption and GHG emissions.

• However, we do make the request for BEREC to elaborate further on the results obtained from the different stakeholders regarding carbon and energy intensity metrics, as these could potentially serve as a threshold and criteria used for many emerging regulations aiming at measuring and quantifying the impacts from the ICT sector, e.g. EU Taxonomy. For these reasons we find it a priority issue for these types of indicators to be further shared, discussed and implemented through all stakeholders in the sector.

Supporting documents:
https://www.gsma.com/betterfuture/resources/mobile-net-zero-state-of-the-industry-on-climate-action-2023
https://www.gsma.com/betterfuture/esg-metrics-for-mobile
https://www.gsma.com/betterfuture/resources/strategy-paper-for-circular-economy-mobile-devices

Please upload here any supporting document that you deem relevant:

Only files of the type pdf,doc,docx,odt,txt,rtf are allowed

c6203b73-f688-4c25-96e1-bbd399c6b679/2023.04.06_GSMA_response_to_RSPG_Questionnaire_Climate.pdf

In accordance with the BEREC policy on public consultations, BEREC will publish all contributions and a summary of the contributions, respecting confidentiality requests. Any such requests should clearly indicate which information is considered confidential.

* Do you request some information to be considered as confidential?

- ○ Yes
- ◉ No

Background Documents
Draft BEREC Report on Sustainability

Contact
Sustainability_PC@berec.europa.eu

Contact

Contact Form

GSMA response to the RPSG Questionnaire on the Role of Radio Spectrum Policy to help combat Climate Change

6 April 2023

About the GSMA

The GSMA is a global organisation unifying the mobile ecosystem to discover, develop and deliver innovation foundational to positive business environments and societal change. Our vision is to unlock the full power of connectivity so that people, industry, and society thrive. Representing mobile operators and organisations across the mobile ecosystem and adjacent industries, the GSMA delivers for its members across three broad pillars: Connectivity for Good,Industry Services and Solutions, and Outreach. This activity includes advancing policy, tackling today's biggest societal challenges, underpinning the technology and interoperability that makemobile work, and providing the world's largest platform to convene the mobile ecosystem at the MWC and M360 series of events.

We invite you to find out more at gsma.com. Follow the GSMA on Twitter: @GSMA and @GSMAEurope

Questions directed to ECN stakeholders
GSMA response

7. What information on energy consumption of the wireless ECNs does your company / the Members of your stakeholders' association collect? Which methodology/ methodologies are being used? Please name any standards that are being used.

- Sustained cost pressures and commitments to net zero in support of the 2015 Paris Agreement have made energy efficiency a strategic priority for many telecoms operators around the world. This will be compounded by data traffic rises associated with LTE and 5G migration. To help provide an evidence base for measuring progress, GSMA partnered with a group of operators to develop an Energy Efficiency Benchmarking tool[1].

- This benchmarking tool is based on real-world data inputs from operators on a fully anonymised basis to quantify network energy consumption and efficiency levels, allowing for comparisons at the network and regional levels. In 2021, seven operators participated in the project: BT, Deutsche Telekom, Etisalat, Globe, KPN, Smart and Vodafone. Data provided from these groups spans 31 networks in 28 countries. In 2022, ten operators participated: Airtel Africa, Airtel India, Axiata, Chunghwa Telecom, Deutsche Telekom, Etisalat, CK Hutchison Group Telecom, Reliance Jio, Zain and Tigo. Data provided from these groups spans 58 networks in 56 countries.

- The unique analytical approach of the benchmarking tool, which controls for variables outside the operators' control such as population distribution and climate, allows operators to compare the relative efficiency of their networks using multiple energy efficiency indicators. The direct energy consumption of the operators can be categorised into four groups:

    1. RAN energy consumption – energy consumed by the radio access network (RAN). This includes BTS, Node B, eNodeB and gNodeB energy usage and all associated infrastructure energy usage such as from air-conditioning, inverters and rectifiers. It includes energy usage from repeaters and all energy consumption associated with backhaul transport.

    2. Core energy consumption – energy consumed by the core network related to the mobile network. This includes the RNC, BSCs, MSC, SGSN, GGSN, HLR, SMS-C, MMS-C, MME, Serving Gateway, and all associated infrastructure energy usage as from air-conditioning, inverters, and rectifiers.

    3. Data centre energy consumption – energy consumed by data centres, which are the physical sites that host operators' IT, including OSS and BSS and intranet infrastructure.

    4. Other operations – energy consumed by the mobile operator for its own operations. This includes offices, shops, retail activity and logistics.

[1] GSMA 'Benchmarking of energy efficiency of mobile':
First edition - https://data.gsmaintelligence.com/api-web/v2/research-file-download?id=60621137&file=300621-Going-Green-efficiency-mobile.pdf
Second edition - https://data.gsmaintelligence.com/research/research/research-2023/going-green-benchmarking-the-energy-efficiency-of-mobile-networks-second-edition-

- Data from 2022 show that most of the energy (87%) is consumed in the RAN. The remaining distribution of consumption comprises data centres and the core (12%) and other operations (1%). The average energy efficiency was 0.17 kWh/GB representing operators serving 1.3 billion connections globally. Energy efficiency improvements have been achieved by a operators through equipment upgrades featuring AI-driven RAN shutdowns, liquid cooling (sites and data centres), swapping out lead acid for lithium-ion batteries and smarter site selection to better position cells to users.

Other considerations:

- While energy costs are a significant proportion of operator's Operational Expenditure (OpEx), it is also an area with many opportunities for OpEx savings with targeted Capital Expenditure (CapEx) on energy efficiency measures.

- Some mobile network operators monitor and collect data (to different extents) on energy consumption by type of energy (electricity, gas, diesel etc.) and area of usage (mobile access, fixed access, core and data centres, offices, and retail).

- Dedicated energy meters are useful for measuring power consumption. For example, some operators gather information on the consumption of the base stations (radio access network) using use the data obtained from the electricity utility's meter. In cases where the operator is not the owner of the the power supply point (tower companies, landlords etc.), they can make consumption estimates, assuming an average power demand based on the installed equipment.

- Operators must of course comply with national and local regulations some of which requiring 'energy efficiency certificates' (not necessarily based on specific standards but built on a baseline benchmark that allows to track traffic/ energy consumption of a given site).

8. Does your company / the Members of your stakeholders' association measure or calculate energy efficiency of wireless ECNs? Which methodology/ methodologies are being used? Please name any standards that are being used.

- The goal of the Energy Efficiency Benchmarking tool (see response to Q7) is to help operators measure and compare the relative efficiency of their networks. Based on the L.1330 standard of ITU-T and the European Telecommunications Standards Institute (ETSI), mobile network data energy efficiency is the ratio between the data volume and the energy consumption during the same period. A mix of complementary KPIs can help operators measure the relative efficiency of their networks in the era of multi-generational networks, including 2G, 3G, 4G and 5G. The Energy Efficiency Benchmarking Tool evaluates four KPIs, providing a more holistic and comprehensive evaluation of network-level energy efficiency (compared with using a single indicator):
    - Data traffic per unit of energy consumption (GB / kWh)
    - Number of connections per unit of energy consumption (connections / kWh)
    - Number of cell sites per unit of energy consumption (cell sites / MWh)
    - Revenue per unit of energy consumption (€ million / MWh).

- Each measure has its advantages and limitations, so the exercise of selection becomes a question of balance.

- It is also worth mentioning that comparing multiple networks in different countries with different characteristics – such as climate, population density and data consumption levels – is a complex task. For the purposes of the benchmarking study, to normalise the results and allow like-for-like comparisons, GSMA divided the explanatory variables into two groups: (i) non-network-related variables – those outside the operator's control (e.g. population distribution and climate); (ii) network-related factors – those within the sphere of control of the operator.

9. For the items described in Questions 7) and 8) above, which data breakdowns are available to your company / association2: e.g., by operator (if applicable), by service, by frequency band, by technology (e.g., 2G/3G/4G/5G), by region, by site, by network element, etc.? Please mention also the cases for which incomplete breakdowns are available.

- GSMA invites the RSPG to read the GSMA Intelligence report 'Going green: benchmarking the energy efficiency of mobile'[2]. To help provide an evidence base for measuring progress, GSMA partnered with a group of operators to develop an Energy Efficiency Benchmarking tool. The tool is based on real-world data inputs from operators on a fully anonymised basis to quantify network energy consumption and efficiency levels, and fuel sources.

- Most European mobile network operators may be able to break down data by site, region, and/or country. Note however that sites are often mixed use e.g. for fixed and mobile network, data centres, hosting of third parties.

- While it remains challenging to measure the energy efficiency of different technologies, there is evidence of the relative energy efficiency gains between different technology generations. Past transitions to new wireless standards have entailed a significant improvement in the energy efficiency of data transmission. 5G already offers significant energy-efficiency improvements per gigabyte over previous technologies, and significant further gains are anticipated over the next decade. Improved sleep modes of 5G are also expected to contribute to energy savings.[3]

10. Are you considering collecting any additional information that you could collect with reasonable effort?

- Some mobile network operators are working with their vendors to obtain more granular reporting from radio so that they can break down by technology or frequency band. However, this is not available for older HW and non-radio consumption. Likewise, some operators are installing submetering on a sample of access sites to separate consumption between different operators or to better understand breakdown of usage. They are also installing submetering in their data centres to allow more accurate and timely tracking of PUE (Power Usage Effectiveness).

[2] GSMA 'Benchmarking of energy efficiency of mobile':
First edition - https://data.gsmaintelligence.com/api-web/v2/research-file-download?id=60621137&file=300621-Going-Green-efficiency-mobile.pdf
Second edition - https://data.gsmaintelligence.com/research/research/research-2023/going-green-benchmarking-the-energy-efficiency-of-mobile-networks-second-edition-

[3] https://hellofuture.orange.com/en/5g-energy-efficiency-by-design/

11. Which actions is your company / the Members of your association taking to improve the energy efficient use of radio spectrum (e.g. switching to new technologies, advertisements to make energy efficient technologies more attractive, sleep mode for base stations, or other actions)?

- For many mobile network operators, energy consumption has historically been a significant consideration as it is one of the highest operating costs. Energy is becoming even more important due to climate change and sustainability considerations.

- GSMA members have taken various measures to improve the energy efficient use of radio spectrum. While initiatives might differ between mobile network operators, some prevalent examples include:
  - Modernizing 4G radio networks at the same time as deploying 5G to benefit from the latest energy efficient vendor hardware;
  - Shutting down 3G and re-farming spectrum to 4G/5G, which are more energy efficient technologies;
  - Identifying and modernizing very old/legacy radios in the network which are very energy inefficient;
  - Implementing energy saving features such as (i) Introducing sleep mode so that during low or moderate traffic, less carriers remain active; (ii) during midnight up to early morning hours, when traffic is negligible on 5G MaMIMO sites, placing radios in sleep mode; (iii) continuing to work with network vendors to extract greater energy efficiency in the network;
  - Sites selection;
  - Radio transmission parameters configuration;
  - Advocating for technology neutrality to facilitate modernization and refarming processes among countries;

- GSMA also opened debate spaces with government representatives during mobile industry events to share actions and regulatory activity on the matter.[4] Recent exchanges highlighted that: (i) late 5G assignments result in reliance on older mobile generations with higher energy consumption and carbon emissions; (ii) restricted spectrum availability means mobile operators must rely on more base stations to keep up with demand. That, in turn, leads to higher carbon emissions; (iii) lack of technology neutrality decreases energy efficiency and spectral efficiency improvements, leading to higher carbon emissions.

- Furthermore, the deployment of 5G technology will strongly improve energy efficiency of mobile networks. While traffic volumes continuously increase, 5G provides the required capacities while consuming the least energy in terms of “watt per bit”(Evolving from 0,47-0,61 W/bit (for 4G 1800 MHz RBS powered with 4 x 20 W or 4 x 40 W, 20 MHz BW, 256 QAM, 4 x 4 MIMO) to 0,12-0,13 W/bit (for 5G 3700 MHz RBS powered with 100-200W, 80 MHz BW, 64 TX, MU-MIMO16, 8 users).

- GSMA is working to further understand how efficient spectrum policies can affect energy consumption and carbon emissions. GSMA is currently analysing different spectrum policy scenarios through an emissions impact model as to provide informative resources and public policy recommendations for regulators to reduce carbon emissions throughout efficient spectrum management policies.

[4] https://www.gsma.com/spectrum/the-future-of-mobile-spectrum-debated-at-the-gsma-ministerial-programme/

12. What were the triggers for these actions (e.g. legal requirement, economic interests, consumer expectations, competitiveness, etc.)?

- Sustained cost pressures and commitments to net zero in support of the 2015 Paris Agreement have made energy consumption/ efficiency a strategic priority for many telecoms operators around the world.

1) Industry commitment to climate action

- The mobile sector has worked collaboratively to create an industry-wide climate action roadmap to achieve net-zero greenhouse gas (GHG) emissions by 2050, in line with the Paris Agreement. The mobile industry was recognised as one of the first breakthrough industries and the GSMA as an Accelerator for the UN Race to Zero.

- GSMA members are working to improve energy efficiency across their footprint, transition to renewable energy and make supply chains more sustainable. To date, 62 operators representing 61% of the industry by revenue and 46% by connections have committed to a science-based target of rapidly decreasing their direct and indirect emissions by 2030. A considerable portion of operators have also committed to net zero targets by 2050 or earlier, accounting for 39% of mobile connections and 43% of global revenue[5].

2) Energy costs

- Irrespective of climate change, impetus for energy saving measures from telecoms operators has grown because of sustained increases in network costs in a low revenue-growth environment.

- The mix effect of LTE and 5G upgrades in emerging and advanced economies will result in these technologies accounting for 60% and 20% of the global mobile connections base respectively by 2025. The proximate impact of this shift will be a continued rise in mobile data traffic. Combined with the rising costs of spectrum, capital investment and ongoing RAN maintenance/upgrades, this means energy-saving measures in network operations are necessary rather than nice to have.

- With more data being transferred across mobile networks, demand for energy is increasing each year. This threatens operator energy efficiency and carbon reduction targets. While energy costs are a significant proportion of operator's Operational Expenditure (OpEx), it is also an area with many opportunities for OpEx savings with targeted Capital Expenditure (CapEx) on energy efficiency measures.

3) EU operators response to energy crisis

- The energy crisis has had a significant impact on the telco sector, which consequently presents several risks to not only the network operators themselves, but also to the citizens and industries that rely on their critical services.

[5] https://www.gsma.com/betterfuture/resources/mobile-net-zero-state-of-the-industry-on-climate-action-2023

- By further reducing its own energy use, helping other customers and sectors do the same, and also helping make renewable sources more efficient and available, the sector can play a role as a key partner in mitigating the challenges posed by both higher prices and supply shortages. But for these gains to be made, it is imperative that the sector receives support to allow it the regulatory freedoms to act quickly and efficiently, and to provide it with the financial health to continue to make further investments in these energy efficient technologies.

4) Technological evolution

- Optimized network planning and deployment evolving towards network softwarization are key to maximize the capacity and quality of service for the benefit of residential and business users and make it possible to increase energy efficiency of both mobile terminals and network.

13. Were there any difficulties when you attempted to introduce or perform these actions? Please specify.

- Operators' initiatives to improve the efficient use of radio spectrum are at times constrained by unnecessary limitations and requirements for network deployment as well as the availability of sufficient spectrum resources. Examples of barriers to swift network deployment including excessive bureaucracy; overly restrictive strict EMF exposure limits; regulatory obligations preventing data optimization; unjustified restrictions to co-investment etc.

- The GSMA is working on a report on spectrum policy and carbon emissions. The new analysis shows the impact of inefficient spectrum policy choices:
  - Late 5G assignments result in reliance on older mobile generations with higher energy consumption and carbon emissions.
  - Restricted spectrum availability means mobile operators must rely on more base stations to keep up with demand. That, in turn, leads to higher carbon emissions.
  - Lack of technology neutrality decreases energy efficiency and spectral efficiency improvements, leading to higher carbon emissions.

- (Please see answer to Q14).

14. What further actions would enable you to foster (a more) energy efficient spectrum use, if any? Should such an activity be done by national spectrum regulators / ministries / European entities? Please specify and explain.

GENERAL CONSIDERATIONS

A. Spectrum availability and assignment

- In general, efficient spectrum policy supports climate goals. By ensuring availability of sufficient spectrum resources regulators can help reduce climate impacts.
  - Availability of sufficient spectrum decreases the number of mobile sites needed, leading to lower energy consumption, less densification and network duplication and lower amounts of network equipment. Less network equipment leads to lower emissions throughout the supply chain (manufacturing, transport, construction).

- Availability of sub-1GHz spectrum decreases the number of macro sites needed to achieve coverage in certain areas, leading to lower energy consumption, and less network equipment.
- Availability of spectrum for 5G enables operators to develop and offer network solutions needed for IoT and big data. These solutions enable new energy efficient and environmental solutions across several sectors, transport, manufacturing, agriculture, building and energy.
- Large contiguous spectrum blocks, potentially in fewer bands, are more efficient to deploy, leading to lower energy consumption, and less network equipment. This should be taken into account when studying new spectrum bands for IMT and when preparing for assignment. Fragmenting spectrum bands (e.g. through set-asides) may not be climate friendly.

- The GSMA cautions against spectrum policy initiatives that can affect the enablement effect (potential for mobile connectivity to positively affect energy savings in other industries). Spectrum scarcity and high spectrum prices negatively impact coverage and end user prices, jeopardising the digitalisation of customers and the potential for them to benefit from technologies that enable emission reductions.

- Regarding energy efficiency in mobile networks themselves, spectrum regulators have a key role to play and need to consider the impacts of restricting spectrum supply, inducing licensees to maintain legacy technologies running, and restricting network sharing.

- In general, it is more energy efficient to expand capacity by adding spectrum, because densification increases the number of sites and overhead use of electricity. Artificially restricting spectrum supply for mobile services, or imposing unnecessary constraints to protect other spectrum users, can therefore result in higher energy use than necessary.

- Mobile networks are at their most efficient when they have sufficient spectrum to deploy at mobile sites to carry customer traffic demand – this means NRAs must expedite the availability and assignment of mobile spectrum, and avoid situations of spectrum scarcity, arbitrary spectrum reservation of national spectrum for non-national use.

- Predictable and timely spectrum licensing encourages long-term network investment. Also, voluntary spectrum sharing, leasing and trading promote efficient spectrum use.

B. Facilitate network deployment and operation/ consolidation

- Any measures supporting effective network deployment and operation will leverage the networks efforts to save energy as well as to enable other sectors. For instances, the recent European Commission proposal for a 'Gigabit Infrastructure Act' is set to serve as an effective pan-European instrument to accelerate network roll-out by reducing administrative barriers and costs.

- Incentivizing and facilitating the deployment of future networks is paramount. This requires cutting red tape, improving network roll-out conditions and avoiding unnecessary deployment limitations (e.g., unnecessary restrictions to transmission power, stricter EMF limits than recommended by ICNIRP).

- Allowing operators to efficiently deploy networks – including shared networks - entails less network equipment. Therefore, the increased possibilities for sharing of active equipment should be

supported as this may contribute to energy savings. When drafting rules on sharing of active equipment, spectrum administrations should take this into account. When evaluating the benefits and drawbacks of sharing, environmental considerations should be given proper attention.

- Mobile networks obey the rules of economies of scale – the larger the networks, the more efficient they are, in terms of traffic throughput, asset utilisation, and unit energy consumption. Excessive fragmentation likely leads to energy inefficiencies therefore, when considering a consolidation proposal, NRAs could also take into account the resulting effect on energy consumption.

C. Support Network Sharing

- Some regulators are encouraging infrastructure sharing of mobile operators because they believe that there are regulatory/social benefits that society can reap. Major social benefits come directly from the economic benefit, where mobile operators can direct saved cost to the customer in pricing. In addition, infrastructure sharing can help reduce energy consumption and radio emissions of networks.

- Further incentives are necessary to motivate commercially agreed network and infrastructure sharing. For instance, RAN sharing agreements allow GSMA members to meet the high expectations on investments in terms of timing, quality and coverage and improve mobile coverage with minimum environmental impact. RAN sharing agreements contribute to the EU's environmental goals since they allow for a reduction in the number of mobile sites (without any impact on service quality or coverage) and thus their environmental impact. They also contribute to reducing energy consumption. The competition law guidelines on horizontal cooperations should include the positive effect on energy consumption giving companies more certainty as regards competition law assessments of envisaged infrastructure sharing initiatives.

- In rural areas, asset utilization could be improved through active sharing, avoiding duplicate separate radio equipment, thereby reducing energy consumption.

D. Support mobile network switch-off

- Facilitating the switch-off of mobile legacy networks and migration to new technologies is key to support the green transition. Allowing operators to switch-off 2G/3G erases the footprint of less-efficient legacy equipment, enables more efficient spectrum use with newer technology, and thus contributes to lowering overall energy consumption.

- It is not desirable nor efficient for mobile network operators to run older network technologies in parallel while deploying 5G. Constraints on maintaining older networks means a high, and increasing, energy consumption; it is therefore important to foster the adoption of new technologies in order to support the green transition. EU regulations should not hold back network switch-off.

- Overlapping technologies are a large source of energy consumption and result in large parts of the radio access network being duplicated. The main barriers to shutting down energy-intensive legacy technologies are the installed base of end user devices and regulatory incentives or obligations to keep legacy technologies in use. Similarly, the social benefits of imposing obligations on mobile

operators to provide connectivity for legacy 2G/3G services should be weighed against the environmental costs of keeping an energy inefficient technology running.

E. Incentivise data optimization

- Avoiding excess coverage and minimum data speed obligations, enables the optimisation of network operations, energy consumption, and the number of network equipment based on actual and timely demands.

- Also, it is important to incentivizing economical data consumption. Not all data is equally valuable for consumers and the industry should have the ability to provide economic signals to encourage more efficient consumption.

- As video traffic accounts for 60% of global internet traffic and its share continues to grow[6], mobile networks require more capacity. We must find a way to incentivise data optimisation. This could be done via streamsaver solutions, which would help adapting the video resolution to the screen size (e.g. 480 pixels for smaller screens). For the uptake of such solutions, one could consider encouraging consumers to change behaviour and/or give a financial incentive to the main content providers using the networks.

- The RSPG should cooperate with BEREC and other regulatory authorities to take a "joined up" approach to this issue. MNO energy consumption is a direct function of the volume of traffic to be carried on the networks. In most cases, this is beyond the control of mobile operators themselves.

F. Incentivise take-up

- As operators are requested to respect strict obligations regarding coverage that include providing connection to allow for high performance services even in non-urban environments or in suburban areas, the spectrum would be more efficiently exploited if a public policy were put in place to foster remote activities (like remote working, interacting with the Public Administration via digital platforms, remote health services, online training etc.). In more general terms, the coverage obligations would be justified if the availability of mobile and wireless services were made necessary by widespread advanced digital applications like smart cities, smart industry, smart mobility, smart agriculture and so on.

STUDY ON THE IMPACT OF SPECTRUM POLICY ON CARBON EMISSIONS (UPCOMING)

- The GSMA is working on a study to research and quantitatively model the potential carbon emissions impacts of various spectrum policy aspects. This study, due to be published in May, examines the impacts of spectrum policy on the emissions of the mobile sector. The study identified evidence on how delays to 5G assignment, restricted spectrum, spectrum fragmentation, and non-neutral assignments can lead to increased emissions of the mobile sector (Table 1).

[6] Ericsson (n.d.) "Streaming video – from megabits to gigabytes" https://www.ericsson.com/en/reports-and-papers/mobility-report/articles/streaming-video

- Spectrum policy can impact emissions across the economy because the mobile sector plays a role as an enabler of emission-saving use cases for households and other sectors.[7] Examples include video calling, which reduces emissions from physical travel, or connected electrical grids which improve their efficiency. Estimates of the mobile enablement effect suggest that mobile can lead to reduction in emissions that is over ten times greater than the sector's own emissions.[8]

- Inefficient spectrum policy can raise the cost of building and operating mobile networks and lower the adoption of emission-saving technologies. This could result in a missed opportunity to reduce emissions by households and other sectors that rely on mobile connectivity.

- According to the scenarios modelled in the study, inefficient spectrum policy can lead to millions of tonnes of additional CO2 emissions in a representative medium-size country (population: 80 million) over the main phase of 5G rollout (2022-2031).

- This evidence leads to a recommendation that the regulators should incorporate the assessment of climate change impacts as a pillar to their spectrum assignment decisions on aspects described in Table 1.

Table 1 Detailed description of impact mechanisms from spectrum policy to emissions of the mobile sector

Late 5G assignments delay adoption of more energy efficient technologies	• Each successive mobile technology generation (2G, 3G, 4G, 5G) has been more efficient in terms of the energy use per unit of data. Estimates show that 3G networks brought ten-fold improvement in network energy efficiency over 2G, while 4G networks improved the efficiency nearly 30 times over 3G.[9] Similar order of magnitude in improvement is also expected for 5G.[10] • Energy efficiency of RAN is paramount because RAN is the largest component of energy consumption by the operators. Estimates show that emissions linked to RAN account for between 57% and 73% of the total operators' footprint.[11] [12] • Therefore, delays to 5G spectrum assignment will slow its adoption and a larger share of data will continue to be transmitted over less efficient older mobile generations, generating greater emissions.[13]
Restricted mobile spectrum means more base stations and higher emissions in their manufacturing	• Only a certain amount of data can be transmitted per unit of Hertz in a given time. Therefore, the maximum data throughput per base station increases with the available radio frequencies. • With limited spectrum, operators require more base stations to serve the same amount of traffic. This means increased footprint embodied in equipment, construction, and transportation.

[7] GSMA (2019), The Enablement Effect, Available at: https://www.gsma.com/betterfuture/wp-content/uploads/2019/12/GSMA_Enablement_Effect.pdf
[8] GSMA (2019), The Enablement Effect, Available at: https://www.gsma.com/betterfuture/wp-content/uploads/2019/12/GSMA_Enablement_Effect.pdf
[9] Comparaisons based on: Pihkola et al. (2018) "Evaluating the Energy Consumption of Mobile Data Transfer—From Technology Development to Consumer Behaviour and Life Cycle Thinking". https://www.mdpi.com/2071-1050/10/7/2494 ; Malmodin et al (2018) " Life Cycle Assessment of ICT". https://onlinelibrary.wiley.com/doi/abs/10.1111/jiec.12145 ; Orange (2020). "5G : energy efficiency "by design"" https://hellofuture.orange.com/en/5g-energy-efficiency-by-design/
[10] Orange (2020). "5G : energy efficiency "by design"". https://hellofuture.orange.com/en/5g-energy-efficiency-by-design/
[11] Elisa (2014). "Elisa 2014 Annual Report". https://corporate.elisa.com/attachment/content/Elisa_Annual_Report_2014.pdf
[12] GSMA Intelligence (2021) "Going green: benchmarking the energy efficiency of mobile". https://data.gsmaintelligence.com/api-web/v2/research-file-download?id=60621137&file=300621-Going-Green-efficiency-mobile.pdf
[13] GSMA Intelligence (2019) "The impact of spectrum prices on consumers". https://www.gsma.com/spectrum/wp-content/uploads/2019/09/Impact-of-spectrum-prices-on-consumers.pdf

	• The amount of emissions embodied in base station equipment is a significant part of the overall footprint. For example, countries such as the UK or Germany have each over 50,000 mobile base stations. Each base station can have up to 128 tonnes of CO2 embodied in it, depending on the type.[14]
Fragmented spectrum reduces its usage, resulting in network inefficiencies and higher emissions	• Spectrum fragmentation refers to the assignment of frequency bands that are narrow and scattered. For example, a single mobile operator may have two 50 MHz-wide channels with each channel separated by assignments to other operators, instead of a single contiguous 100 MHz-wide band. • Such fragmentation can reduce network performance as more spectrum needs to be used in guard bands to prevent radio interference. Fragmentation into non-contiguous 50 MHz channels can reduce spectrum utilisation by 2.5%, compared to a contiguous 100 MHz channel.[15] • Fragmentation forces network operators to rely on carrier aggregation. Carrier aggregation uses some of the bandwidth to transmit data necessary to co-ordinate network activity (signalling overhead). This reduces the useful bandwidth for the user data, as the overhead can double from 6% for a single 100MHz channel to 12% when two separate 50MHz channels are used.[16] • Combined, these two effects reduce network throughput, increase the number of base stations required and the emissions embodied in them. • Separately, the use of carrier aggregation can also impact the power consumption of user equipment.[17] Increased power consumption of smartphones generates additional emissions in the energy sector as the demand for grid electricity increases.
Spectrum assignments that are not technology neutral prevent spectrum re-farming to more efficient technologies	• Non-neutral assignments restrict spectrum use for a specific technology. • Such restrictions could slow down spectrum re-farming and migration to the latest technologies, preventing gains in energy efficiency and increasing emissions.
Other mechanisms which were not modelled may include use of different frequency bands and spectrum pricing	• The energy efficiency of a network can also be affected by the band in which it operates. Empirical data on the performance of the network equipment shows that the energy efficiency of power amplifiers boosting the mobile signal can decrease when amplifying higher band signal. [18] However, low and high band spectrum are not direct substitutes. Rather, they are complementary resources that will need to be used to enable fast and reliable mobile connectivity in various conditions. • Another crucial policy aspect is spectrum pricing. High spectrum prices are associated with lower investment in mobile infrastructure.[19] Underinvestment in networks can slow down the rollout of the fastest, most reliable and most energy-efficient technologies. This indirectly could lead to lower network energy efficiency and higher emissions.

[14] GSMA calculations based on Ding et al. (2022). "Carbon emissions and mitigation potentials of 5G base station in China". https://www.sciencedirect.com/science/article/abs/pii/S092134492200177X?via%3Dihub

[15] ECC (2018) "Guidance on defragmentation of the frequency band 3400- 3800 MHz". https://docdb.cept.org/download/3a143dbe-7cbc/ECCRep287.pdf

[16] Idem.

[17] Santos et al. (2020) "LTE-A UE Power Consumption for Carrier Aggregation Scenario". https://www.sbrt.org.br/sbrt2020/papers/1570661121.pdf

[18] Georgia Tech Electronics and Micro-System Lab (GEMS) (n.d.) "Power Amplifiers Performance Survey". https://gems.ece.gatech.edu/PA_survey.html

[19] GSMA (2019) "The impact of spectrum prices on consumers". https://www.gsma.com/spectrum/wp-content/uploads/2019/09/Impact-of-spectrum-prices-on-consumers.pdf

15. Would some kind of spectrum regulation facilitate your motivation to use radio spectrum in a (more) energy efficient way?

- Upgrading mobile networks to the latest and most efficient radio technologies is key to reducing energy consumption. To facilitate this, NRA's need to create: 1) a supportive investment environment, which means cultivating an industry with improved financial health that has sufficient free cash to make upgrade investments, as well as 2) licences that can be automatically extended to better match the investment timeframe needed to provide the possibility of a return on investment. The Economic Ministry in Spain has led the way on this by extending all mobile licences to 30 or 40 years in total duration.

- Incentives could be offered (reduction of spectrum fees, price of renewals of licences, partial redemption of price obligations) in favour of any new effort towards efficiency and climate neutrality or beneficial on the end user perspective.

- MNOs will also be better able to invest in both radio and energy sourcing improvements if less money is extracted from the sector in the form of inefficient spectrum auctions and excessive annual fees.

- Deploying the most efficient technologies also means switching off older technologies such as 2G and 3G. Efficiency improvements can also be facilitated by removing spectrum fragmentation and encouraging repurposing and trading.

- Using MIMO antennas in urban areas can further improve energy efficiency and would benefit from a more accommodating permit regime.

16. Taking into account the scope of the work of the RSPG above, do you wish to share other thoughts or ideas which could be helpful to the RSPG to identify the role radio spectrum policy can play to help combat climate change and mitigate other adverse environmental impacts?

- From the perspective of environmental objectives, spectrum policy needs to support deployment and operations of efficient networks. This not only minimises the emissions impact of the mobile sector, but also reduces the network costs, leading to more affordable connectivity. This translates into wider adoption and further abatement of carbon emissions in other sectors and across households as a result of the mobile enablement effect. Maximisation of the economic benefits of mobile connectivity and reduction of carbon impact are simultaneously supported by spectrum policy that leads to efficient radio networks. This is a win-win situation for the regulators as effective spectrum policy principles also ensure long term affordability for communications services, maximising their economic benefits.