BERECBody of European Regulators for Electronic Communications

BoR (24) 186

Draft Report on Infrastructure Sharing as a lever for ECN/ECS Environmental Sustainability

5 December 2024

Contents

Executive Summary

This report by the Body of European Regulators for Electronic Communications (BEREC) explores infrastructure sharing as a lever for environmental sustainability in electronic communications networks (ECNs) and services (ECSs), aligning with broader EU objectives to reduce the ICT sector's environmental impact. As a response to the EU Green Deal and the UN Agenda 2030, BEREC examines how regulatory tools might enhance the environmental performance of telecommunications by minimizing the footprint associated with network deployment and operation. It capitalises on previous publications of BEREC on infrastructure sharing and bases in its analysis on a survey circulated among National Regulatory Authorities (NRAs) within BEREC and on a consultation of stakeholders during a technical workshop.

Infrastructure sharing in the telecommunications sector, which includes passive (e.g., towers, ducts) and active sharing (e.g., transmission equipment, antennas), holds potential to reduce environmental impact through decreased infrastructure duplication, energy conservation, and reduced material consumption. By consolidating physical assets and technology, shared infrastructure can significantly lower carbon emissions, reduce land use and optimize use of resources. These environmental gains also address energy consumption, raw materials usage, and electronic waste generation, creating a positive contribution to the environmental footprint of ECNs and ECSs. These practices can also raise technical, legal and regulatory issues in terms of quality of service, competition, and investments which are not detailed in this report.[1]

The European regulatory framework offers several provisions to support infrastructure sharing – in specific and limited conditions – where environmental, public health, or planning objectives are prioritized. While voluntary infrastructure sharing is common, regulatory interventions varies widely among the EU states. Infrastructure sharing is part of the instruments of access regulation as foreseen by the European Code for Electronic Communications (EECC). Regulation of civil coordination has also foreseen obligations of access to infrastructure aiming for efficiency and cost reduction of deployment (e.g. Broadband Cost Reduction Directive progressively being repealed the new Gigabit Infrastructure Act). Other disposals can be used to promote infrastructure sharing, notably in the frame of the right of way (EECC Article 44) and as part of spectrum allocation (EECC Article 47). The transposition of the current EU provisions on infrastructure sharing is complete, however, the NRAs report that environmental sustainability was mostly not considered or addressed in this frame. For some of these tools (e.g. obligations based on Articles 44, 47 or incentives through guidelines regarding mobile operators agreements), NRAs reported only few cases when these tools were used to promote infrastructure sharing and in most of the cases, environmental considerations were not part of

[1] Some of the effects related to competition are analysed in the BEREC Report on the regulation of physical infrastructure access, BoR (24) 178 and in the BoR (19) 110, BEREC Common position on infrastructure sharing (2019)

the grounds of the assessment and decisions. Most NRAs reported there were no additional incentives for infrastructure sharing in their country. Furthermore, the majority of BEREC members did not have access to comprehensive data on the rate number of shared sites and infrastructure. BEREC members also reported limited inclusion of environmental aspects in their decisions on infrastructure sharing. NRAs identified barriers, such as lack of mandate, limited expertise and data, the difficulty to balance these considerations with other regulatory/political goals (e.g., competition, cost considerations), and the need for standardized methodologies for environmental assessments.

This BEREC report emphasizes in its conclusions that infrastructure sharing can play a vital role in reducing the environmental impact of electronic communications networks by decreasing duplicative infrastructure, conserving energy, and optimizing use of resources. It outlines that NRAs should be enabled to include these environmental benefits in their decision-making related to infrastructure sharing, while weighing these considerations in the context of other possible legal and technical effects of this form of agreement, e.g. on quality of service. To strengthen this approach, BEREC spotlights its previous support to expanding the regulatory mandate of NRAs to explicitly include environmental sustainability objectives. It also suggests assessing the possibility to proportionally expand NRAs capacity to promote infrastructure sharing in the view of the future review of the EECC and developing additional EU-level guidance to provide consistent standards for assessing environmental impacts related to infrastructure sharing, while providing sufficient flexibility to adapt to national specificities. BEREC recommends encouraging data sharing and cooperation among competent authorities and stakeholders to encourage sharing of best practices and to support the production of quantitative studies detailing the avoided environmental impacts due to infrastructure sharing.

In the future, BEREC will continue examining how regulators can support environmental sustainability including through infrastructure sharing.

1. Introduction and context

In its Strategy 2021–2025, BEREC outlines its commitment to incorporate environmental focus into its activities, by supporting objectives related to Information and Communication Technology (ICT) objectives from the European Commission's Green Deal and United Nations (UN) Agenda 2030. The ICT sector accounts for around 3% of global greenhouse gases emissions[2] and is also responsible for other form of impacts such as energy consumption, abiotic resources depletion or water consumption. Networks represent 12-24% of the ICT carbon footprint with emissions related especially to their energy consumption.[3]

[2] Joint Research centre, Identifying common indicators for measuring the environmental footprint of electronic communications networks (ECNs) for the provision of electronic communications services (ECSs) (2024)
[3] BoR (22) 93, BEREC report "Assessing BEREC's contribution to limiting the digital sector's impact on the environment" (2022)

The manufacturing of telecom equipment and infrastructures also relies on raw materials provision, such as mineral, plastic and metal components with an environmental footprint.[4]

The sharing of infrastructures in the electronic communications sector refers to different types of arrangement whereby two or more operators share some network or infrastructure elements to deliver services. Infrastructure sharing can take different forms depending on the elements shared: for example, passive sharing involves sharing physical elements such as towers and ducts, while active sharing includes sharing transmission equipment like local network elements, antennas or base stations, and even spectrum in some cases. By reducing the number of infrastructures required for the provision of electronic communications services, infrastructure sharing can reduce ECN/ECS environmental footprint, especially their carbon footprint, energy consumption and raw material resources use. This report aims to analyse this impact of infrastructure sharing on electronic communications' sustainability. These practices can also raise technical, legal and regulatory issues in terms of quality of service, competition and investment,[5] which are not subject of this report.[6]

Thus, in its 2022 report "Assessing BEREC's potential limiting the impact of the digital sector on the environment",[7] BEREC identified as relevant to investigate how regulators' tools can be drivers for sustainability, including supporting the deployment of more energy efficient technologies (notably fibre rollout) and the promotion of infrastructures sharing. Specifically, it acknowledges that the provisions on infrastructure sharing, as foreseen by EECC and other relevant sectorial regulation, such as the Gigabit Infrastructure Act (GIA)[8] and Gigabit Recommendation,[9] could be used to support environmental targets allowing competent authorities to impose co-location and sharing of fixed and mobile network elements and associated facilities for reducing the environmental footprint of ECN/ECS. BEREC also published several reports and positions focusing on infrastructure sharing which mention the possible environmental benefits of these schemes of deployment:

- In its position on the Broadband Cost Reduction Directive (BCRD),[10] BEREC outlined that the EECC and the BCRD include tools that could support the reduction of the environmental footprint of ECN/ECS. BEREC recalls in this opinion that *"the*

[4] BoR (22) 34, WIK-Consult and Ramboll, External Sustainability Study on Environmental impact of electronic communications (2022)
[5] This report should therefore not be understood as an endorsement of network sharing per se, but as a means for NRAs to better understand the environmental benefits of network sharing in various situations and to properly weigh those issues against other relevant aspects in the decision making.
[6] BEREC published other reports and opinions which covered some of the other aspects to consider while assessing infrastructure sharing agreements especially BoR (19) 110, BEREC Common position on infrastructure sharing (2019) regarding mobile infrastructure sharing.
[7] BoR (22) 93, BEREC report "Assessing BEREC's contribution to limiting the digital sector's impact on the environment" (2022)
[8] Regulation (EU) 2024/1309 on measures to reduce the cost of deploying gigabit electronic communications networks, amending Regulation (EU) 2015/2120 and repealing Directive 2014/61/EU (Gigabit Infrastructure Act)
[9] Commission Recommendation on the regulatory promotion of gigabit connectivity, C(2024) 523 final
[10] Directive 2014/61/EU of the European Parliament and of the Council of 15 May 2014 on measures to reduce the cost of deploying high-speed electronic communications networks, OJ L 155, 23.5.2014.

coordination of civil works, the use of synergies between different network operators and the joint use of existing physical infrastructure might not only help to save investments, but might also reduce the environmental load by reducing the need for additional civil engineering works".

- BEREC outlined in its Common Position on mobile infrastructure sharing[11] published in 2019, that sharing could also decrease energy consumption, thereby lowering the carbon footprint of the electronic communications sector and contributing to the fight against climate change.

- In June 2011, BEREC published, jointly with the RSPG, a report on mobile infrastructure.[12] This report briefly mentioned the environmental and health protection as a potential benefit to infrastructure sharing agreements.

In this context, BEREC included in its 2024 Work Program a workstream to explore on the impact of infrastructure sharing on ECN/ECS sustainability and the role that regulation could play in this perspective. Specifically, the objective of this report is to build a comprehensive view of transposition and implementation of the relevant EU provisions related to network and infrastructure sharing in EU Member States regarding co-location and sharing of infrastructures, with a particular attention to measures that are based on or which include environmental considerations. This report also aims to explore the potential environmental benefits of these practices. Finally, it will explore the possibilities of how to weigh up identified benefits to the environmental impact from network sharing and/or take decisions motivated by the promotion of the environmental sustainability.

This report capitalises on BEREC past work on infrastructure sharing and relevant regulatory disposals (chapter 2). It is also based on replies of NRAs to an internal questionnaire distributed to BEREC members (chapter 3). The views of stakeholders were collected through a technical workshop with sectorial associations, namely Connect Europe, ECTA and the European Wireless Infrastructure Association (EWIA) (chapter 4). Based on these inputs, this report also includes set of strategic conclusions regarding the possible benefits of infrastructure sharing and ways to enable regulators to consider this lever for building more sustainable electronic communications infrastructures and networks.

2. Regulatory framework

The European Union's regulatory framework enables competent authorities to impose or restrict infrastructure sharing in specific situations. Some of these provisions specifically mention the protection of the environment as a possible justification for infrastructure sharing.

[11] BoR (19) 110, BEREC Common position on infrastructure sharing (2019)
[12] BoR (11) 26, BEREC-RSPG report on infrastructure and spectrum sharing in mobile/wireless networks (2011)

The EECC notably foresees the following instruments with respect to infrastructure sharing are the following:

- According to Article 44 of the EECC, competent authorities may impose sharing in order to protect the environment, public health, public security or to meet town- and country- planning objectives, if the establishment of the infrastructure was based on rights of way.

- According to Article 47 of the EECC, when attaching conditions to individual rights of use for radio spectrum, competent authorities may provide for the following possibilities: (a) to share passive or active infrastructure which relies on radio spectrum, or radio spectrum, (b) to enter into commercial roaming access agreements, and (c) to jointly roll-out. Of particular importance here is the effective and efficient use of the spectrum, the promotion of coverage and the rapid deployment of networks (especially in less densely populated areas). In this regard, competent authorities shall not prevent the sharing of radio spectrum in the conditions attached to the rights of use for radio spectrum. Implementation by undertakings of conditions attached pursuant to this paragraph shall remain subject to competition law. This instrument may concern passive as well as active sharing.

- According to Article 61 of the EECC, national regulatory authorities may, upon reasonable request, impose obligations to grant access to cables and associated resources within buildings or up to the first concentration or distribution point, as determined by the national regulatory authority, when this point is located outside the building. This article also foresees that competent authorities will have the power to impose obligations either to share passive infrastructure and or to conclude localised roaming agreements. These obligations would be imposed only under the following conditions: First, passive sharing or localized roaming must be necessary directly for the local provision of services which rely on the use of radio spectrum. Second, no viable and similar alternative means of access to end-users is made available to any undertaking on fair and reasonable terms and conditions. Third, the possibility to impose sharing is clearly provided for when granting the rights of use for radio spectrum. Fourth, market-driven deployment of infrastructure for the provision of networks or services which rely on the use of radio spectrum is subject to insurmountable economic or physical obstacles and therefore, access to networks or services by end-users is severely deficient or absent. In those circumstances, where access and sharing of passive infrastructure does not suffice to address the situation, sharing of active infrastructure may be imposed. Upon failure of commercial negotiations, competent authorities shall resolve the dispute with a binding decision.

- According to Article 72, where an undertaking is designated as having significant market power on a specific market as a result of a market analysis carried out, a national regulatory authority may to impose obligations on undertakings to meet reasonable requests for access to, and use of, civil engineering including, but not limited to, buildings or entries to buildings, building cables, including wiring, antennae,

towers and other supporting constructions, poles, masts, ducts, conduits, inspection chambers, manholes, and cabinets, in situations where, having considered the market analysis, the national regulatory authority concludes that denial of access or access given under unreasonable terms and conditions having a similar effect would hinder the emergence of a sustainable competitive market and would not be in the end-user's interest.

Aside from the EECC, other regulatory provisions are relevant to cover infrastructure sharing, especially the BCRD that is gradually repealed by the GIA[13] for access to existing physical infrastructure, and measures related to civil work coordination as well as to infrastructures sharing with non-telco players (for instance with electricity providers).

3. Analysis of existing practices from NRAs

This section depicts the result of a questionnaire distributed to BEREC members in the period of 9 April and 17 May 2024. In total, 26 answers were received, including 24 answers from the following EU Member states: Austria, Belgium, Croatia, Cyprus, Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Poland, Portugal, Romania, Slovenia, Spain, Sweden, The Netherlands) and, as well as two answers from non-EU Member states (namely Norway and Serbia) participated in the consultation.

BEREC members had to provide their feedback on five specific aspects, which are covered in separate subsections: i) implementation of EECC, Article 44; ii) implementation of other regulatory provisions with respect to infrastructure sharing; iii) environmental considerations in network operators agreement; iv) quantitative data, and v) strategic prospective assessment.

3.1. Implementation of Article 44 of the EECC

Article 44 of the EECC provides that "*1. Where an operator has exercised the right under national law to install facilities on, over or under public and private property, or has taken advantage of a procedure for the expropriation or use of property, competent authorities may impose co-location and sharing of the network elements and associated facilities installed on that basis, in order to protect the environment, public health, public security or to meet town- and country planning objectives*."

[13] The BCRD aimed to "facilitate and incentivise the roll-out" with a view on reducing costs of deployment. The GIA now also specifically mentions the aim to "facilitate and stimulate the roll-out of very high capacity networks ('VHCNs') by promoting the joint use of existing physical infrastructure and by enabling a more efficient deployment of new physical infrastructure so that such networks can be rolled out faster and at a lower cost."

The Member States have already implemented Article 44 in their national legislation.[14] Norway is still in the process of proposing to the Parliament a new Electronic Communications Act, of which Article 44 is one component. Most Member States have transposed the article in a general way (as a general obligation), which allows the public authorities, mostly NRAs, to impose obligation on operators to co-locate and share infrastructure.

In majority of the Member States, the designated competent authority is the NRA, but there are also Member States where local authorities[15] or another authority[16] that is not an NRA has the power to issue decisions. In Ireland, the decisions on granting or not of licenses and planning permissions are made by the local authorities.

In most countries, NRAs are also the dispute resolution authorities in cases where operators do not voluntarily agree. NRAs may also have competencies to impose sanctions.[17]

In Spain, public electronic communications network operators may also voluntarily enter into agreements with each other and public administrations shall encourage the implementation of voluntary agreements between operators.

The implementation of environmental aspects in the national legislations is handled differently across competent authorities. In 18 out of 26 countries, environmental aspects are included in the transposed articles.[18] There are also requirements to carry out a public hearing by NRAs in Czechia, Italy, and Luxembourg. No NRA stated that an environmental impact study is required. There are some Member States[19] which do not explicitly mention environmental aspects in their national legislation transposing Article 44, while other Member States have narrower scopes regarding types of infrastructure. Belgium, for example, has implemented the criterion on protecting the environment just on the antenna sites. In Czechia, the environmental aspects are only relevant for infrastructure sharing, when the building of a new site is impossible, e.g. because of restrictions due to a natural reservation or water protection areas.

Respondents from only two countries[20] stated that they have imposed co-location and sharing of network elements and associated facilities based on Article 44, as can be seen in the graph below. In Croatia, co-location and sharing of physical infrastructure is imposed on the operators if appropriate technical access conditions exist (e.g. availability of free space, suitability of the technical solution). The manner and conditions of access, co-location and joint use are prescribed in more detail in an Ordinance. The following aspects of the

[14] These are Austria, Belgium, Croatia, Czechia, Cyprus, Denmark, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Luxembourg, Malta, Poland, Portugal, Romania, Serbia, Slovenia, Spain and The Netherlands.
[15] Ireland, France, Denmark.
[16] Denmark, Malta, Poland, Portugal, Spain, The Netherlands.
[17] For instance, AGCOM.
[18] The NRAs who have included environmental aspects are ACM, AGCOM, AKOS, ANCOM, BIPT, BNetzA, ComReg, CTU, EETT, HAKOM, MCA, NMHH, OCECPR, RATEL, RTR, DADG and UKE.
[19] E.g. France, Latvia, Lithuania.
[20] Croatia, Spain.

environmental protection like public health, public security, meeting town- and country planning objectives are mentioned as general goals. In Spain, the decisions have been adopted by the Minister of Digital Transformation and therefore, the NRA could not provide any further information about the decisions.

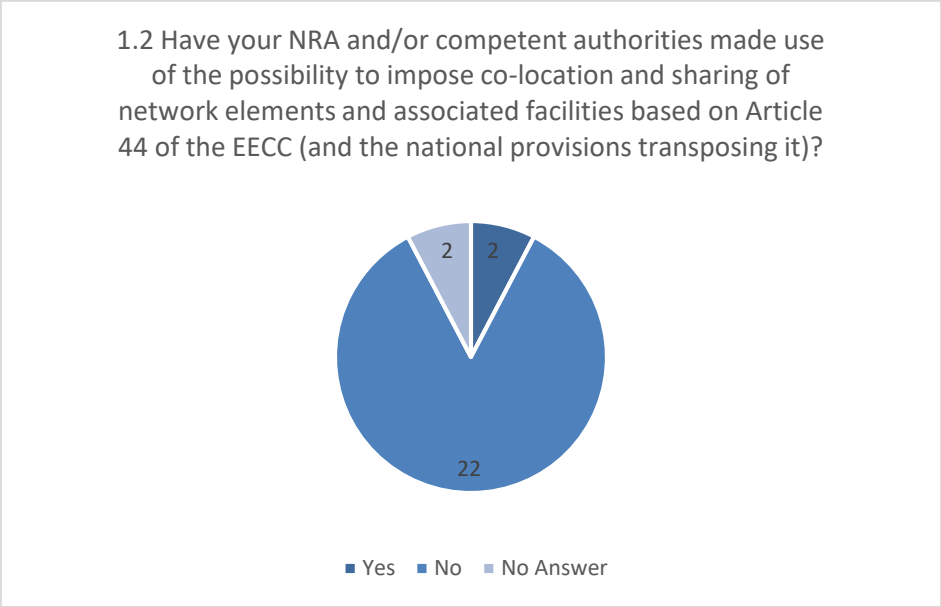


Figure 1

So far, only few decisions have been based on Article 44. Only one NRA[21] provided information on the rationale for imposing co-location and sharing of network elements and associated facilities. It states that the main goal is promoting the use of existing network elements and associated facilities, in order to enable deployment of new networks, to reduce costs and to protect the environment, public health, public security or to meet town- and country planning objectives, although no special evaluations were made regarding the protection of the environment. Chapter 4 contains further information on the potential advantages and difficulties concerning environmental aspects in infrastructure sharing.

3.2. Implementation of other provisions for imposing infrastructure/network sharing (e.g. Article 61)

Having considered the implementation of Article 44 among NRAs with regards to the aspect of environmental sustainability, this report goes on to consider the implementation of other EECC provisions aimed at promoting access to infrastructure and of the provisions of the

[21] HAKOM.

BCRD,[22] which are focused on access to infrastructure and coordination of civil work. It aims also to consider the possibility for NRAs or other competent authorities (OCAs) to impose obligations in relation to passive or active infrastructure sharing in the frame of spectrum licenses awarding. These provisions do not specifically mention the objective of the protection of the environment, but NRAs have been asked to indicate if they have been implemented in such a way to enhance efficiency and environmental sustainability.

Regarding access to infrastructure, it should be noted that complementary information concerning access obligations imposed on SMP operators can be found in the draft BEREC Report on the regulation of physical infrastructure access.[23]

3.2.1 Access to infrastructure

Article 61(3) of the EECC empowers NRAs to mandate the sharing of network elements (wiring and cables) and associated facilities inside buildings or up to the first concentration or distribution point as determined by the national regulatory authority, where that point is located outside the building, such as ducts, conduits, masts, and street cabinets, "*where it is justified on the grounds that replication of such network elements would be economically inefficient or physically impracticable*."

As regards Article 61(4) of the EECC, under specific conditions, when it is directly necessary for local provisioning of services which rely on the use of radio spectrum, competent authorities can impose obligations to share passive infrastructure or to conclude localized roaming agreements "*provided that no viable and similar alternative means of access to end-users is made available to any undertaking on fair and reasonable terms and conditions*".

The BCRD that is gradually repealed by the Gigabit Infrastructure Act sets obligations on access to existing physical infrastructure and on coordination of civil works.

When asked whether NRA/OCA implemented the national provisions corresponding to Article 61 of the EECC and the relevant provisions of the BRCD related to access to infrastructure in such a way that environmental considerations are encompassed, 23 out of 26 NRAs have responded negatively as per the graph below with three positive responses.[24] At the same time, NRAs responding negatively have indicated that there is some inclusion of environmental considerations within the wording of national provisions transposing Article 61 of the EECC and/or the BRCD.[25]

[22] P. 1–14, see especially Article 3 on Access to existing physical infrastructure and Article 5 on Coordination of civil works.
[23] BoR (24) XXX
[24] NKOM, BNetzA, AGCOM.
[25] ANACOM, PTS.

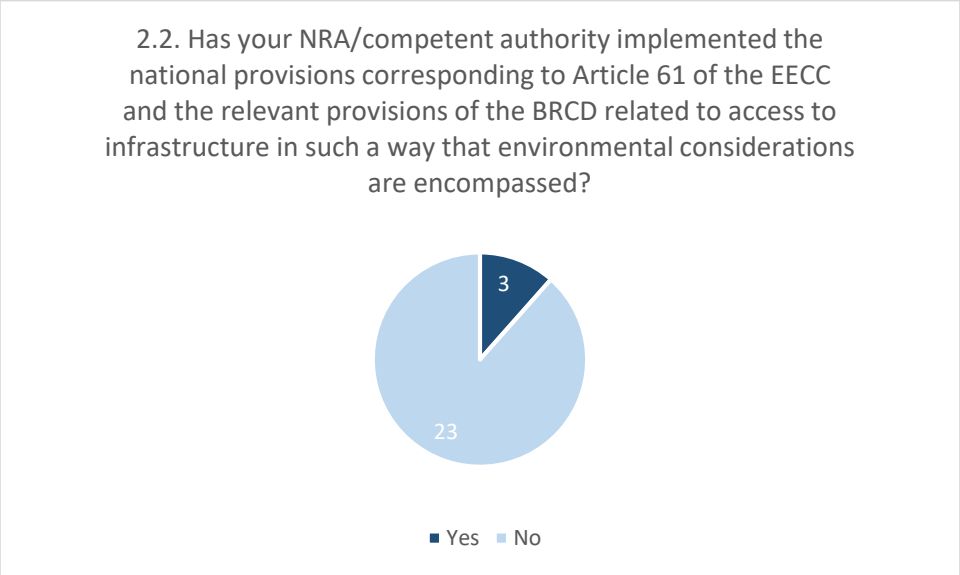


Figure 2

The question referring to whether any decision on access to infrastructure imposing co-location and sharing of network elements and associated facilities under Article 61 of the EECC or under the BCRD has been motivated, at least partially, by the objective to protect the environment, has rendered 23 negative answers, with one NRA not providing a response and only two NRAs[26] responding positively as illustrated below.

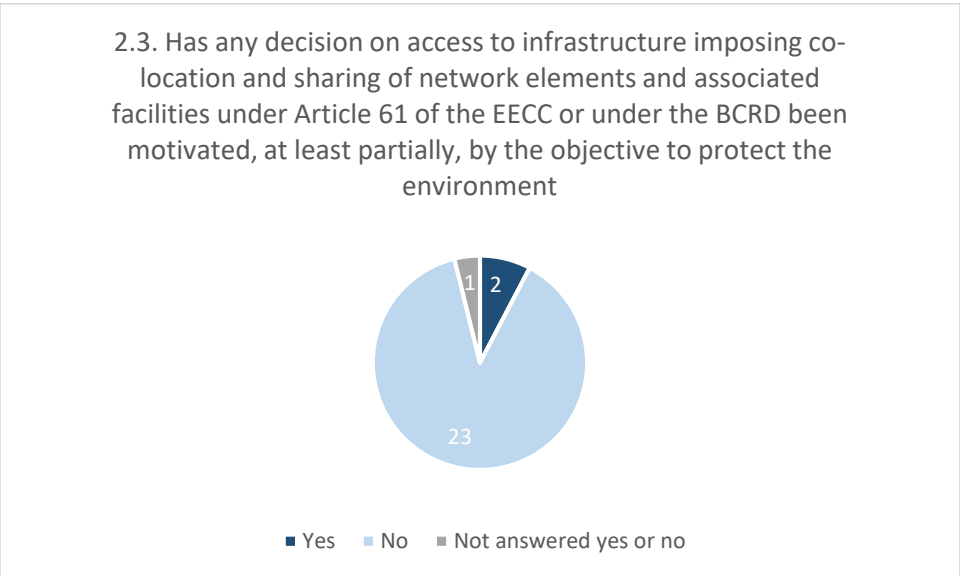


Figure 3

[26] BNetzA, AGCOM.

In most of the Member States, no reference related to the protection of the environment is included in the national provisions transposing Article 61 of the EECC and the provisions of the BCRD.

Nonetheless, Latvian NRA SPRK stated that environmental aspects, as they do not directly apply to the electronic communications industry, may be defined in other specific environmental regulations. ANCOM has also noted that in Romania, environmental protection issues are regulated by other national authorities. Furthermore, two NRAs specified that although there was no reference to the environment in the provisions transposing Article 61 of the EECC and the BCRD, infrastructure sharing could lower the environmental cost of deploying electronic communication networks,[27] or stated that any use of the BCRD provisions for infrastructure sharing has a positive impact on environment since it avoids duplication of infrastructure.[28] Furthermore, in France, all FttH networks are shared and although the set of decisions and recommendations taken by the NRA[29] do not mention the protection of the environment directly, they mention network deployment efficiency. The provisions transposing Article 61(3) of the EECC refer also to general Arcep's regulatory objectives which include among other objectives "a high level of protection of the environment", when stating that Arcep can specify the terms and conditions for access by internet service providers to FttH networks. As regards the implementation of the national provisions in such a way that environmental considerations are encompassed, Arcep considers it beneficial to pursue environmental objectives in the implementation of the GIA regulation and in the review of the EECC.

In several Member States, environmental considerations are considered in some ways. In Portugal, the NRA is allowed to impose co-location and sharing of infrastructure for environmental reasons on the basis of a national Decree-Law 123/2009 derived from the earlier Article 12(2) of Directive 2002/21/CE (Framework Directive), dated back to before the BCRD. In Greece, the provisions transposing the BCRD mention that the Dispute Resolution Body takes into account, among other criteria, the protection of the environment when resolving a dispute regarding access to existing physical infrastructure. However, as no dispute resolution requests have been submitted, the environmental protection provision remains unspecified. In Germany, sustainability is not directly mentioned in the transposition of Article 61(3) and (4). Nevertheless, reduction of emissions is mentioned in the explanatory memorandum and in its decisions based on the provisions transposing the BCRD, the ruling chamber included the explanatory memorandum and additional arguments on emissions. BNetzA underlines that the aims of cost reduction and economic sustainability lead in the same direction and that environmental sustainability is used as an additional argument.

More specifically, as regards the implementation of the BCRD provisions on coordination of civil work, several NRAs outline that coordination of civil work is mainly done to lower the costs

[27] HAKOM.
[28] Arcep
[29] Arcep

and to minimize the disturbance of local residents[30] or that the measures for the expansion of broadband networks make it cheaper.[31] In Cyprus, coordination of civil work can include environmental requirements, as the NRA[32] may impose one or more environmental, spatial and urban planning requirements. In Poland, a number of provisions regulating civil work coordination focus on sustainability-related effects.[33] In Finland, explicit references to sustainability-related effects or objectives are not mentioned in the national provisions, however, environmental considerations are mentioned as one example in the recitals of the proposal for legislation. Other NRAs outline that coordination of civil works helps the environment[34] and that it has a positive impact on environment since it avoids duplication of works.[35] MCA,[36] in line with Articles 61(4) and 44(1) of the EECC and local law, may impose co-location or a use of network sharing elements to protect the environment and public health, amongst other reasons, or to meet town and country planning objectives. Spectrum licences awards shall allow for the possibility of infrastructure and network sharing.

The EECC allows NRAs/OCAs to impose infrastructure and network sharing obligations when setting out conditions to individual rights for use of the radio spectrum (Article 47(2) of the EECC) or when Member States grant, amend or renew rights of use for radio spectrum (Article 52(2)(a)).

Enquiring about whether NRAs or other competent authority in each Member state have imposed obligations in relation to passive or active infrastructure sharing in the frame of spectrum licenses awarding (notably based on provisions of Article 47 of the EECC), seven NRAs[37] responded positively, three have not provided a yes or no response and 16 have responded negatively as per the following graph.

[30] BIPT
[31] PTS
[32] OCECPR
[33] The Act on supporting the development of telecommunications services and networks comprises a number of provisions regulating civil work coordination focused on sustainability-related effects, e.g. that (i) network operator is obliged to make accessible for telecommunication entrepreneur the information on scheduled or conducting civil works, (ii) network operator is obliged to consider the request of telecommunication entrepreneur in terms of coordination of construction works, (iii) local public administration bodies are authorised to settle dispute between network operator and telecommunication entrepreneur in terms of coordination of construction works by issuing administrative decision.
[34] HAKOM
[35] Arcep
[36] MCA
[37] BIPT, HAKOM, Arcep, EETT, MCA, AKOS, CNMC.

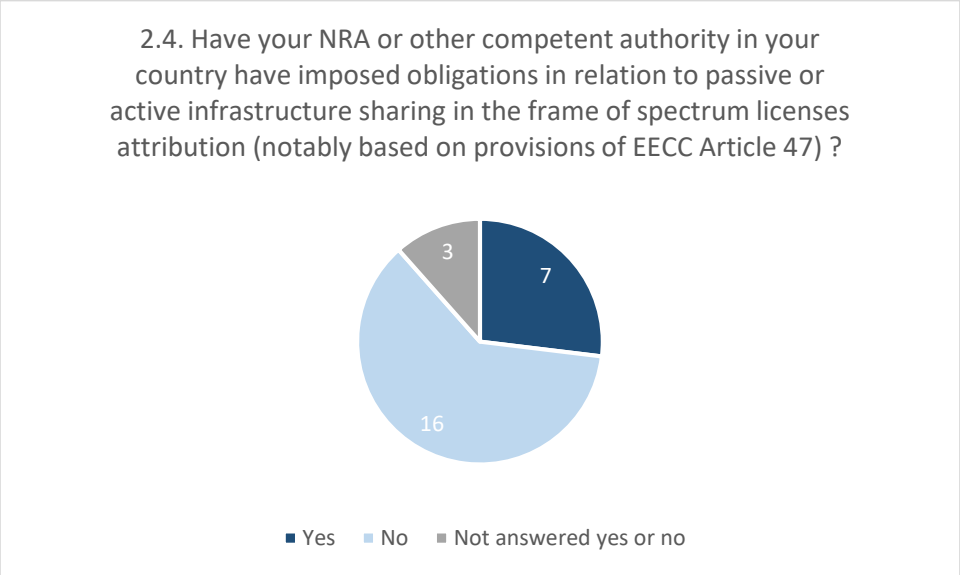


Figure 4

Nevertheless, in the Member States where infrastructure sharing obligations have been imposed in the frame of spectrum licenses, no decision was motived by the objective to protect the environment. In Croatia, infrastructure sharing obligations are aimed at providing a better coverage. In France, network sharing obligations have been imposed in the frame of spectrum licenses awarding in order to ensure:

- The development of investment, innovation and competitiveness in the electronic communications sector;
- The exercise of effective and fair competition between network operators and providers of electronic communications services for the benefit of users;
- The land-use planning.

The current provisions of the EECC limit the possibility for Member States to impose infrastructure obligations as they have to be either announced in the spectrum licenses or to be specifically localised, which leads to a small number of Member states having made use of it. A broader empowerment of NRAs to decide on imposing passive and active infrastructure sharing, out of the scope of spectrum licenses, could enhance infrastructure sharing and environmental sustainability.

Deducing also a conclusion from the questionnaire results, the transposition of EECC articles related to access to infrastructure and network sharing and of the BCRD often do not include any reference to environmental protection according to NRA responses, except in few cases where general provisions have been integrated and specific requirements for environmental impact assessments or sustainability guidelines are not mandated. This indicates a diverse approach to integrating environmental sustainability into electronic communications infrastructure planning and regulation across the EU. Nevertheless, the positive effects of access to physical infrastructure and network sharing related provisions are considered to

have a positive impact on environmental sustainability. Pursuing the inclusion of environmental considerations in the provisions on infrastructure sharing in the implementation of the new GIA regulation which replaces the BCRD and in the revision of the EECC would thus be a positive development, promoting considerations on environmental sustainability.

3.3. Environmental considerations in the assessment of network sharing agreements between operators

Infrastructure sharing may derive from commercial agreements between mobile network operators which, on a voluntary basis, decide to share passive and, in some cases, active infrastructure. Most NRAs gather information on infrastructure sharing agreements only under specific circumstances (in cases of disputes) and in most countries, there is no formal legal/regulatory requirement for operators to notify NRAs about infrastructure sharing.

Where specific guidance/rules with respect to infrastructure sharing are provided,[38] five NRAs[39] have indicated that the protection of the environment is a criterion on the basis of which the operators' network sharing agreements are analysed. Hence, in France, Arcep adopted in 2016 network sharing guidelines[40] to provide predictability to MNOs regarding Arcep's assessment of mobile network sharing agreements. In Greece, the national law provides that co-location may be imposed "with a view to protecting the environment", with specific provisions established for the co-location of antenna systems. Generally, the guidelines recognise that mobile network sharing agreement can contribute to the protection of the environment and in particular of natural and landscape heritage, by allowing the common use of infrastructures between several operators, which limits the need for the installation of new infrastructures, such as towers. It can also be noted that guidelines for infrastructure sharing,[41] adopted by BIPT in 2012, list the environmental benefits among the main arguments in favour of RAN sharing. It is also considered that infrastructure sharing can contribute towards broader environmental goals and mitigate citizens' concerns over electromagnetic field (EMF) radiation from base stations. Passive and active sharing can mitigate the visual impact of mobile networks on the landscape by reducing the total number of masts and towers. Sharing power supplies reduces energy consumption, which helps supporting government and corporate policies on reducing carbon emissions.

As regards the definition of an analytical framework related to environmental considerations, the OCECPR, the NRA of Cyprus, indicates that according to the secondary legislation concerning colocation, operators have an obligation to negotiate colocation agreements

[38] According to BEREC Report on infrastructure sharing, BoR (18) 116, half of the countries provide guidance with respect to infrastructure sharing, guidelines being provided either by NRAs, competition authorities or government ministries.
[39] RTR, OCECPR, Arcep, EETT and AGCOM.
[40] https://www.arcep.fr/uploads/tx_gspublication/2016-05-25-partage-reseaux-mobiles-lignes-directrices.pdf
[41] https://www.bipt.be/file/cc73d96153bbd5448a56f19d925d05b1379c7f21/e46162a74b310463820f3cfcde4fc5e79a251887/3666_en_02_tech_infra_sharing_eng_final.pdf

including inter alia, reasons related to the need to protect the environment. RTR considers that competition law is relevant within the analytical framework and refers to chapter 9 of the European Commission Horizontal Guidelines.[42] This chapter covers horizontal agreements that pursue a sustainability objective. Nevertheless, although it is generally admitted that network sharing agreements and more generally infrastructure and network sharing can benefit to environmental sustainability, the primary objective of network sharing agreement is not environmental sustainability but rather to reduce deployment costs while improving service offering.

On the question if the impact on the protection of the environment has already been considered in the assessment of infrastructure/network sharing agreements between operators, four NRAs note that the protection of the environment is not the main concern in the assessment of infrastructure/network sharing agreements between operators but rather the competition.[43] RTR states that in principle, the impact on the protection of the environment has been considered but was not explicitly mentioned and not decisive in one of its decision.[44] SPRK indicates that as a primary objective, the impact on competition is assessed, but the impact on the environment is discussed as well. In Denmark, where sharing agreements of private companies are analysed in case of a complaint about the failure to conclude a sharing agreement or about the conclusion of agreement on terms that are not fair and reasonable, the environment is not the main consideration when issuing a decision. Irish NRA ComReg notes it cannot have a firm view on spectrum rights sharing (pooling) and network sharing other than it would look more favourably on agreements that wouldn't unduly restrict competition and would deliver demonstrable benefits shared with end-users. MCA from Malta notes that although there are existing sharing agreements for duct access, they were primarily established on the principles of income and reciprocity amongst the operators.

3.4. Quantitative data shared by BEREC members

Quantitative data on infrastructure sharing can be an important element to evaluate the scale of environmental benefits of different types of network deployments (e.g. passive infrastructure sharing, active sharing of network elements). Hence, for the purpose of this report, BEREC's survey asked NRAs the existing quantitative data at national level on passive and active sharing of infrastructure or network elements, as of 31st December 2023, for both mobile and fixed networks. The data requested in the BEREC's survey was further split into the following three categories of locations: '*Densely populated areas*', '*Medium density areas*', and '*Thinly populated areas*'.

[42] European Commission, Communication, Guidelines on the applicability of Article 101 of the Treaty on the Functioning of the European Union to horizontal co-operation agreements (2023/C 259/01)
[43] RTR, DADG, ComReg, SPRK.
[44] https://www.rtr.at/TKP/aktuelles/entscheidungen/entscheidungen/c_1_23.de.html (non-confidential version, only in German).

For mobile networks, ten NRAs[45] provided data regarding site sharing. A subgroup of these ten NRAs provided the 'total' numbers, without providing this data on a more granular level (e.g. classify areas as densely, medium density and thinly populated or differentiating for the total number of masts, poles and towers).

BEREC notes only few NRAs provided data with this subcategorization (*'Densely populated areas', 'Medium density areas', 'thinly populated areas'*). BEREC underlines that due to the geographic size of the region, certain NRAs may not differentiate between so-called 'medium' versus 'thinly populated' areas in the data where telecommunication infrastructure are located.

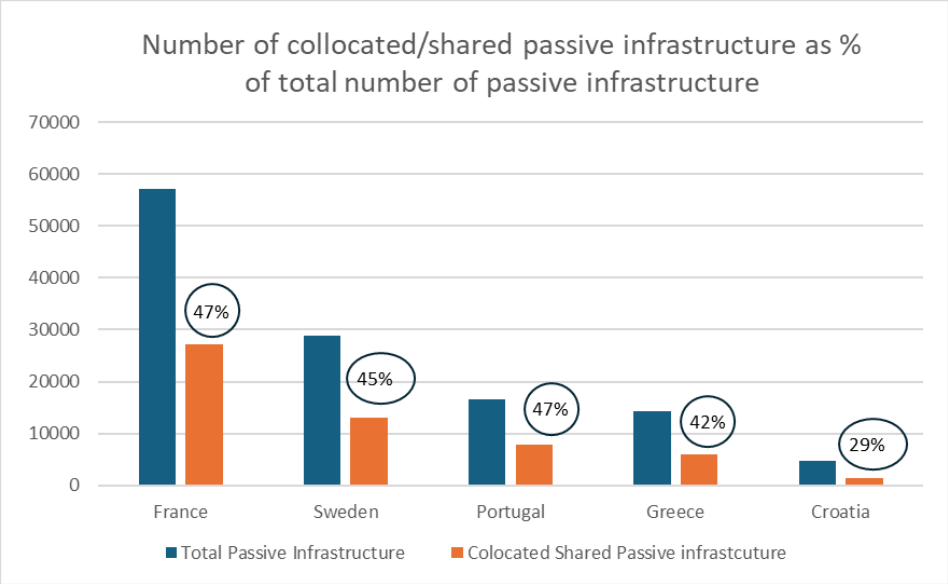
BEREC acknowledges that not every NRA collects this data, therefore the information in the graphs provided reflects the data regarding shared infrastructure sites provided by the aforementioned ten NRAs.

NRAs have also been asked to provide data with a distinction between collocated/shared passive infrastructure[46] and passive and active shared sites[47] on a collocated/shared passive infrastructure.[48] From the data provided and displayed in figures 5 and 6, it can be observed that collocated/shared passive infrastructure represent 47.3% of the total number of sites with passive infrastructures in France, 43.6% in Sweden, 42% in Greece, 39% in Austria, 29.1% in Croatia. Active site sharing represents 65% in Portugal, 60.7% in France (mostly in thinly populated areas) and 98% in Greece. Two NRAs[49] also mentioned respectively active infrastructure sharing agreements between operators, which will have an impact on the rates of active infrastructure sharing.

It should be noted that following two figures depict data provided by NRAs to the BEREC survey for this report and may not include all operator data in that country.

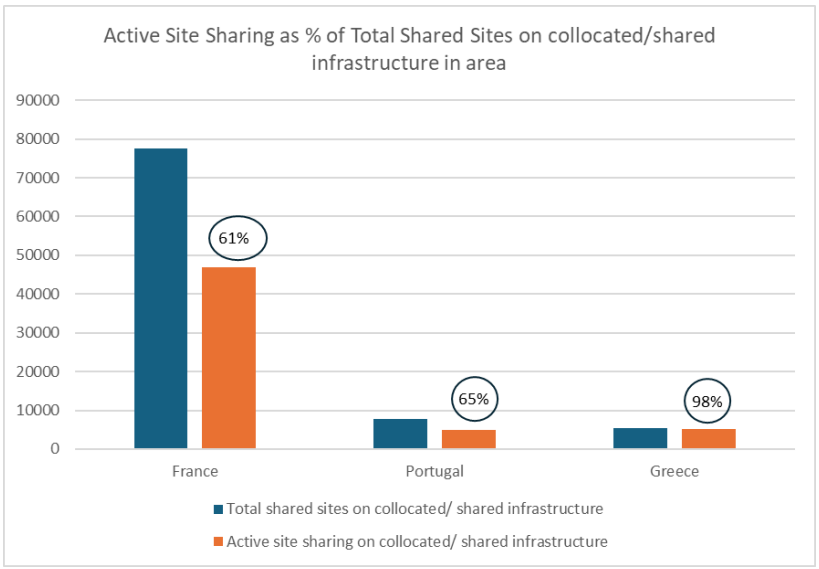
Figure 5: Number of collocated/shared passive infrastructure for mobile network (on which several MNOs sites are hosted) as % of total number of passive infrastructure (tower, rooftop, mast, etc.) hosting MNOs' sites*

[45] Arcep, ANACOM, BIPT, CNMC, EETT, HAKOM, MCA, OCECPR, PTS, RTR.
[46] Infrastructure on which mobile equipment is installed (tower, mast, rooftop, etc.).
[47] MNOs radio transmission points.
[48] The methodology used to collect the data may have differed between NRAs.
[49] BIPT and CNMC.



*Note: For data in France, Arcep considers in this calculation the number of "supports," which refers to a physical location — an infrastructure that accommodates mobile equipment (such as a pylon, rooftop, high point, etc.).

Figure 6: Number of active shared sites (MNOs radio transmission points) on a collocated/ shared active infrastructure as percentage of total shared sites in area for mobile networks**



**Note: For Greece, EETT data does not include antenna structures/installations with low electromagnetic outputs.

For fixed networks, it is not possible to provide a breakdown of percentages of infrastructure sharing in a similar manner as provided for mobile networks in the section above. From the survey results, BEREC notes that NRAs collect data using various units of measurements; for

example, for fibre sharing, some NRAs use the metrics of either number or percentages of total premises passed, whereas other NRAs use kilometres. BEREC notes that NRAs did not provide any data on the number of co-location sites. Six NRAs (NMHH, MCA, OCECPR, ARCEP, PTS and HAKOM) provided data on passive and active infrastructure sharing (physical infrastructure sharing (ducts, poles), fibre access and active sharing). Certain NRAs disclosed in the survey that they do not collect any data regarding infrastructure sharing for fixed networks.

Table 1 below illustrates the heterogeneity of data collected and shared by NRAs. For example, one NRA (NMHH) provided information regarding total lengths of ducts and poles in kilometres, whereas other NRAs (e.g., HAKOM) provides the total kilometres for ducts, and then the total numbers for poles. Another NRA (MCA) did not provide any number of kilometres or units, but rather provided the of 'Passive infrastructure sharing' as a percentage of the total number of shared/collocated sites or lines in the country.

Table 1: Number of shared/collocated sites or lines by types of sharing for fixed networks

		Number of shared/collocated sites or lines		
		Total	**Passive infrastructure sharing**	**Active infrastructure sharing**
TOTAL	**NMHH**	29,919 km	29,919 km (ducts, poles, dark fibre)	-
	MCA		Between 5% to 7%	-
PIA Sharing	**NMHH**	23,583 km	23,583 km (ducts and poles)	-
	ARCEP	Only for SMP – 600k kilometres of ducts and 13 million of poles (supporting copper)	Almost all these physical infrastructures are or will be reused by operators during fibre rollouts	-
	HAKOM	-	19861km (ducts), 3334 poles	49606 copper
Fibre Sharing	**NMHH**	6,336 km	6,336 km (dark fibre)	-
	ARCEP	38 million premises passed	95% already passively shared (with a potential of 100%).	-
	PTS	Approximately 35000 leased dark fibre	-	-
	HAKOM		31928 dark fibre	17173 fibre

Despite the lack of homogeneity in the available data for both fixed and mobile networks regarding infrastructure sharing, BEREC was able to draw some key findings:

- The majority of NRAs did not provide quantitative data regarding infrastructure sharing for fixed or mobile networks. Additionally, the lack of comparable data across BEREC member NRAs made it difficult to compare the relative environmental benefits derived from infrastructure sharing/co-location. However, it can be concluded from the data collected, that the physical infrastructure (ducts, poles, towers etc.) is being shared among operators across Europe, which infers that environmental benefits are being observed in these regions from this sharing.
- Six NRAs (Arcep, ANACOM, BIPT, EETT, HAKOM, OCECPR) could provide data regarding sharing of active infrastructure for both fixed (Arcep, HAKOM) and mobile (Arcep, ANACOM, BIPT, EETT, OCECPR). This included data on antennas, entire base stations or even elements of the core network, despite increasing trends in sharing this type of infrastructure. Some countries expressed difficulties in assessing shared sites. Despite data on shared masts not being widely collected by NRAs, in general masts have the potential for sharing.
- For the countries that provided data on fixed networks, it can be concluded that many existing ducts and poles used for the deployment of fixed networks are currently or will be reused by operators through sharing agreements. Active wholesale products can also benefit the environment as other operators can use this access to provide high-speed services to customers, using existing lines (fibre or copper), without the need to rollout their own networks. However, it should be highlighted that the share of active parts of the networks have significative implications on infrastructure-based competition. Infrastructure sharing, or even sharing elements of the network, can provide environmental benefits; however, other regulatory objectives, for example implications on competition dynamics or the deployment of fibre networks, need to be taken into account.
- The standardised collection of data on network sharing is important for comparability and for any future study to evaluate the impact of network sharing on sustainability. NRAs could consider benefits of cooperation for environmental sustainability in their regulatory decision making when weighing all relevant aspects.

3.5. Strategic and prospective inputs

3.5.1. Incentives put in place in order to promote infrastructure sharing

In general, infrastructure sharing brings cost savings for telecom operators, as they could capitalize on shared resources by reducing CAPEX costs. Most NRAs consider that there are no or only limited additional regulatory incentives put in place in their country to promote

infrastructure sharing.[50] Nevertheless, infrastructure sharing is promoted in some countries by the regulatory framework like in Spain or in France, where passive mobile infrastructure sharing is encouraged throughout the country, with some provisions targeting specific areas (e.g. mountain areas or rural areas with low housing and population density). Similar provisions on passive infrastructure sharing are in place in Austria.[51] Arcep noted that significant network sharing rates derive from obligations to share active installations or only passive mobile infrastructures depending on the case that have been imposed on operators within the framework of rights for the use of radio frequencies. Otherwise, on a commercial basis, network sharing agreements are generally concluded between two MNOs. In Czechia, as part of the Recovery plan for Europe, the Ministry of Trade and Industry has opened a tender for enhancing 5G coverage in railway corridors. The conditions of the tender specifically request that all MNOs must have access to passive or active sharing of the infrastructure built with the support of this scheme. But the reasoning for this sharing was rather economic and logistical. Some NRAs[52] quoted measures which derive from the implementation of the provisions of the BCRD on access to infrastructure and transparency concerning planned civil works. They have been implemented in some cases in a wider sense, like in Denmark, where the definition of "network operator" has been broadened to encompass undertakings such as municipalities constructing and offering access to ducts. These access obligations have been in force since 1999, prior to the BCRD, and also applies to owners of private buildings, structures and infrastructure exceeding a specified height. Two NRAs[53] mentioned regulatory obligation to grant co-location in cost-oriented prices.

3.5.2. Specific work or assessment on environmental sustainability and infrastructure / network sharing or deployment

Environmental benefits of infrastructure / network sharing are commonly recognized in various papers from BEREC, think tanks, industry organizations or NRAs.[54] In Greece, as regards environmental sustainability, according to Article 20 of Climate law, telecom operators (fixed/mobile) should report calculate and report their GHG emissions using specific

[50] Question submitted to the NRAs: "Are there incentives put in place in order to promote infrastructure sharing?". 14 NRAs replied "no" (ACM, ANCOM, ANACOM, BIPT, BNetzA ComReg, EETT, IRL, MCA, NMHH, PTS, RATEL, RRT, RTR) , 8 NRAs "yes" (OCECPR, CTU, DADG, Arcep, SPKR, NKOM, AKOS, CNMC), 3 NRAs didn't answer.

[51] According to Art. 64 Austrian Telecommunications Act 2021, passive sharing for mobile networks is mandatory.

[52] DADG, SPRK.

[53] OCECPR, NKOM.

[54] BEREC 2018 Report on Infrastructure sharing (BoR (18) 116), BEREC 2019 Common position on mobile infrastructure sharing (BoR (19) 110), CERRE 2020 Report "Implementing co-investment and network sharing", May 2020, GSMA 2023 5G Co-construction and sharing Guide and MCA's discussion paper The contribution of the Communications Sector and the MCA's potential role towards achieving Malta's sustainability goals, published in October 2023, which makes multiple references to infrastructure sharing and co-location of network elements as potential contributors to limit the GHG emissions of the ICT sector and where NRAs are considered to have typical remit.

standards, starting by year 2022, to a competent authority and GHG emissions are calculated using specific standards.[55]

On the basis of the NRAs answers, it may be concluded that there is a lack of specific work or assessment (quantitative studies, regulatory evaluations, etc.) on environmental sustainability, and the existing infrastructure/network sharing or deployment can be used to quantify the impact of network sharing on sustainability in terms of reduction of the carbon footprint or reduction of electric consumption.

Nevertheless, in some countries, mobile operators, which have created a joint venture for active infrastructure sharing of the mobile sites (without spectrum), claim that this has a positive impact on environmental sustainability as it will enable a reduction of energy consumption of more than 20% and lower the number of sites by 40%.[56]

3.5.3. Environmental sustainability benefits stemming from infrastructure sharing

As compared to a non-shared deployment, the responding NRAs mentioned a number of benefits of infrastructure sharing. Besides economic advantages, the NRAs named, e.g. reduction of costs,[57] enabling deployment[58] and operational synergies.[59] Also, infrastructure sharing and avoiding duplicated deployment reduce the social and environmental costs in the rollout of mobile and fixed networks.[60]

The NRAs identified a whole list of positive environmental impacts of infrastructure sharing:

- Reduction of the number of equipment used;[61]
- Resource efficiency, reduction of (natural) resources and material consumption;[62]
- Reduction of the need for civil works[63] and reduction of the volumes of generated waste;[64]
- Reduction of energy consumption[65] as it improves efficiency[66] and helps coping with rising energy costs and consumption;

[55] More specifically, the ISO14064-1:2018 standard (scope 1 and 2) or a combination of the 2006 IPCC Guidelines and GHG protocol/
[56] Active mobile infrastructure sharing (without spectrum) between Proximus and Orange through the joint venture MWingz in Belgium: https://www.proximus.com/green/net-zero-and-true-circularity.html
[57] BNetzA, CNMC, HAKOM, MCA, PTS.
[58] HAKOM
[59] BNetzA
[60] DADG
[61] ANACOM, Arcep, BIPT.
[62] AKOS (citing excavation as an example), CTU, MCA, NMHH, OCECPR, DADG, SPRK.
[63] OCECPR
[64] BIPT, MCA.
[65] Arcep, BIPT, ILR, NMHH, OCECPR.
[66] Mentioned by BIPT.

- Reduction of emissions and the carbon footprint,[67] avoiding the resource intensive process of constructing new facilities;[68]
- Protection of the environment[69] – especially reduction of visual pollution[70] and other environmental impacts (on local natural habitat and biodiversity,[71] water and resource depletion[72]);
- Saving space in rural areas that need to be cleared in order to establish a safe protected area for a transmission tower;[73]
- Reduction of the impact on the urban environment in terms of reduction in road works,[74] pollution, noise and traffic congestion (for fixed infrastructure sharing);[75]
- Potential circularity of the infrastructure without any additional soil artificialization.[76]

In regard to the contribution of different infrastructure and/or network elements to the environment, infrastructure sharing benefits vary according to the sharing types (passive, active, roaming).

Some NRAs state that no measurements and standardized indicators are available to either assess the level of impact or rank it according to contribution to the environment.[77] Hence, it would not be possible to quantify potential environmental benefits of infrastructure sharing based on the available data.[78] Nevertheless, Arcep considers that mobile passive sharing will have mainly positive impacts on the reduction of the use of support goods[79] and BIPT specified that passive infrastructure only focusses on non-electric infrastructure. Thus, active mobile infrastructure sharing will have additional impacts on reduction of equipment and energy consumption and most NRAs consider that sharing of the mobile RAN network would be of the utmost benefit to the environment since they are the most energy demanding.[80] Indeed, reducing the number of base stations and radio signal transmitters can lead to a reduction in energy consumption and radio emissions. Consequently, optimizing the energy-efficient operation of active network elements can be a significant contribution to environmental sustainability. Also, the longer time of its active utilisation, the better due to material and

[67] ANACOM, ANCOM, OCECPR.
[68] ANCOM.
[69] HAKOM
[70] BIPT
[71] ANACOM, CTU
[72] ANACOM
[73] CTU
[74] NMHH, MCA
[75] MCA, DADG
[76] ILR
[77] ANACOM, OCECPR.
[78] BNetzA
[79] According to ITU-T L.1450 Recommendation:
"*Support goods encompass equipment installed on site or at facilities for the grid and non-grid power supply of networks, as well as equipment installed on site or at facilities for cooling purposes*".
[80] Arcep, BIPT, EETT, PTS, RATEL SPRK.

energy saving.[81] According to PTS, sharing of fixed links for backhauling would be on second place of interest.

As regards to fixed networks specifically, construction works are considered to have the biggest impact on the environment, with sharing of towers, ducts and poles contributing the most to the environment.[82] Therefore, better coordination of those activities and sharing of infrastructure would be beneficial for the environment. Divergent opinions have been expressed about access network and core network.[83] One NRA[84] noted that in general, energy consumption is greater in wireless networks and have the potential for increased sustainability through sharing, but aspects such as competition, security, etc. are important to be included in the assessments.

3.5.4. Plans to enhance the integration of environmental considerations

According to the survey, some NRAs are currently focusing on active infrastructure sharing. In France, in addition to the measures already in force, extending network active sharing obligations between all or some of the MNOs in specific areas are under study. This is because active network sharing in rural areas particularly could contribute, under certain conditions, to reducing the environmental footprint, while improving coverage and quality of services.

More generally, in Malta, MCA intends to enhance the integration of environmental considerations when determining the potential imposition of network or infrastructure sharing obligations during the allocation of the right for the use of radio spectrum.

Certain NRAs are conducting studies on sustainability. In Austria, RTR commissioned a study on the environmental impacts of fibre networks in comparison to “legacy networks” (results expected in November December 2024). In Greece, EETT is currently conducting a study with a consulting company regarding sustainability issues related to ECN/ECS, assessing the current activities of Greek operators in terms of environmental sustainability. Depending on the results, further steps could be defined. In Spain, CNMC is currently analysing the possibility of including specific environmental aspects in its decisions. In Hungary, NMHH has plans to assess environmental effects for granting the rights for the use of radio spectrum, to introduce financial incentives (e.g. lower supervisory fees when environmental requirements are met), to broaden mandatory elements of reference for access to infrastructure (e.g. expected environmental effects), to add environmental aspects to spectrum granting procedure and to make detailed environmental assessment of network sharing.

In some Member states, environmental considerations have already led to specific measures when awarding rights for the use of radio spectrum, but not specifically related to infrastructure sharing. In Austria, in the latest spectrum award and for the first time, the regulatory authority

[81] Mentioned by CTU.
[82] According to HAKOM.
[83] CNMC and NMHH.
[84] NKOM.

is allowing these awarded frequencies to be switched off between 00:00 and 05:00 in connection with supply requirements, provided there is no reduction in performance compared to daytime operation. In Norway, the new Electronic Communications Act will contain provisions that give the authority the legal basis to set climate relevant conditions related to the right for the use of radio spectrum.

3.5.5. Challenges to integrate environmental considerations in the decision-making process

NRAs identified many challenges to integrate environmental considerations in the decision-making process. In their responses, the NRAs mentioned several types of challenges.

a) Issues of mandate

Several NRAs mentioned they observe a **lack of explicit mandate** to integrate environmental considerations in the decision-making process for infrastructure sharing[85] and **lack of legal basis** for imposing concrete obligations.[86]

Only in Cyprus,[87] France,[88] Serbia and Spain,[89] the NRAs have specific mandate to ensure the compliance with environmental objectives in the electronic communications sector. The Danish Agency for Digital Government Supply and Infrastructure (DADG) is not explicitly entrusted with ensuring compliance with environmental objectives in the electronic communications sector. However, environmental considerations are valid in the administration of the area. In most of the Member States (Austria, Croatia, Czechia, Greece, Italy, Romania, Slovenia), it is the Ministry who is responsible for ensuring the protection of the environment and achieving environmental sustainability.[90] In other Member States (Belgium,[91] Finland,

[85] ACM, ComReg, CTU, RATEL.
[86] HAKOM, EETT, RTR.
[87] OCECPR's strategic planning includes matters of environmental sustainability and its legislation which has transposed the EECC includes relevant general provisions for environmental protection, it is currently under review to be modified.
[88] Arcep operates mainly through data collection. Since 2020, Arcep has implemented an annual publication to describe the environmental impact of digital: the annual survey “Achieving digital sustainability”. Initially collecting environmental data from the four main telecommunications operators, Arcep’s data collection powers were extended by law in December 2021 to include data from other digital players such as data centre operators and terminal manufacturers.
[89] The General Telecommunications Act 11/2022, of June 28th do not set up the protection of the environment as a specific objective of the law, but, in a few cases, not in general, environmental aspects must be taken into account in order to comply with this law. The General Telecommunications Act entrusts different authorities, mainly the Minister of Digital Transformation, the CNMC and others.
[90] In three cases, the Ministry is supported by an agency or separate organisations the Czech Nature Conservation Agency of the Czech Republic Agency for Protection of the Environment (CNC AOPK), the Portuguese Agency for the Environment (APA) and the Slovenian Inspectorate for Natural Resources and Spatial Planning.
[91] The responsibility for environmental aspects rests with the regional governments, meaning that each region has its own environmental Agency.

Germany, Malta, Norway, Sweden, Luxembourg[92]), one dedicated agency/authority or multiple regional and local authorities are responsible for ensuring the protection of the environment and achieving environmental sustainability**.** In some countries, the responsibility can be shared between the ministry in charge of environmental matters and the national environmental agency (e.g. Portugal).

Hence, the two aspects, environmental and infrastructure access, are in many cases managed by different national authorities, the agenda being in some cases mostly assigned to the ministry and agency protecting the environment with no means established how to share the agenda at national level, or to entail the involvement of other public or private undertakings which may be more competent in regards of environmental considerations.[93] In Ireland, Article 44 of the EECC has been transposed in such a way that the opinion of the relevant authority (in most cases, it is the local authorities, whose remit includes granting licenses and planning permission which should include environmental considerations) must be sought.

Due to the lack of explicit mandate to integrate environmental considerations in the decision-making process for infrastructure sharing and the lack of legal basis for imposing concrete obligations, certain NRAs reported consequently **missing resources, knowledge, skills and expertise** about environmental sustainability to effectively integrate environmental aspects into decision-making processes.[94]

b) Issues of practical application

The NRAs acknowledged that there is a strong need for **flexibility and focus on overarching sustainability principles** to create future-proof decision-making. Measuring, examining and assessing the direct and especially indirect environmental impact is a very complex task for regulators especially due to the lack of data and the need for a clearer and more harmonised mandate at EU level to collect environmental data. BEREC and its member NRAs have been working to develop expertise on sustainability indicators resulting in a dedicated report and set of first data collection on the environmental footprint of ECN/ECS in several Member States. Advancing in measuring the environmental footprint of ECN/ECS more precisely could enable to assess the avoided environmental impact from infrastructure sharing to **weigh up environmental issues alongside with other effects related to regulatory objectives** such as quality of service, network deployment and rollout according to the technology advancements.[95]

---

[92] In Luxembourg, the "*Administration de l'Environnement*" is responsible for ensuring the protection of the environment and achieving environment sustainability. Antennas' installations are subject to authorisation delivered by that Administration.
[93] ANCOM, CTU, DADG.
[94] AKOS, CTU, HAKOM.
[95] ANACOM, OCECPR.

Also, depending on the extent and quality of any analyses and assessments in that regard, the integration of environmental considerations in the decision-making may result in **potential delays in the decisions**.[96]

It is **difficult to quantify environmental sustainability.** Environmental factors are very complex and it is necessary to have unbiased, comprehensive, reliable, standardized and up-to-date data on the environmental benefits and a methodology defining an analytical framework to consider environmental benefits when imposing infrastructure/network sharing obligations or assessing network sharing agreements between operators. Imposing infrastructure/network sharing obligations or assessing network sharing agreements between operators requires making a balance between different regulatory objectives. In order to integrate environmental considerations in the balance, a thorough impact assessments should be done.[97]

One NRA also mentioned that application of further measures, more reporting and collecting the environmental data from telecom operators, in order to measure the negative impact of the environment in their countries and to publish statistical information are facing negative perceptions from the sector.[98]

c) Interaction with other regulatory objectives

The conflicting objectives are not only related to connectivity. Trade-offs between environmental sustainability and other goals have to be assessed. The partially counteracting regulatory goals must be balanced in an objective way.[99]

To mention some of them, **cost considerations** and balancing eco-friendly requirements with higher costs is among the most discussed.[100] MCA mentioned that the benefits of infrastructure sharing in Malta are less significant compared to larger countries, where economies of scale make sharing more economically viable. Integrating environmental considerations in decision-making is thus hindered by cost and competition concerns. Initiatives with long-term cost recovery and those posing non-competitiveness are less likely to be adopted.

The infrastructure sharing could also have a **potentially negative impact on competition**, especially as regards sharing of spectrum and/or mobile RAN networks.[101] Hence, as mentioned by SPRK, the competition assessment (including assessment of impact on environment) needs to be carried out in case of active infrastructure sharing only (MORAN/MOCN). It can also be outlined that considering environmental aspects when

[96] DADG
[97] AKOS, Arcep. BIPT, BNetzA, NKOM, OCECPR, RRT, TYT.
[98] CNMC.
[99] AKOS, BNetzA, Arcep.
[100] NMHH, OCECPR.
[101] EETT, PTS

assessing decisions that affect competition should rely on commonly shared standards and a level playing field to avoid distortions among market players.[102]

3.5.6. Complementary actions to amplify positive effects of infrastructure and network sharing on environmental sustainability of ECN/ECSs

Majority of the respondents agree that complementary actions are needed. Some of them acknowledged[103] that all the complementary actions mentioned in the questionnaire, such as assessment, share of practices among NRAs, guidelines or definition of standards, could increase the positive impact of infrastructure sharing and network in terms of environmental sustainability and such development would lead to harmonisation of practices and making the overall situation clearer and more transparent.

Sharing of experiences and best practices among NRAs on infrastructure and network sharing related to environmental sustainability is important for most NRAs,[104] especially since the legal mandate is unclear and/or the situation is different in various member states.[105] If some NRAs have implemented a specific methodology to assess the impact of infrastructure and network sharing on environmental sustainability, Arcep is of the opinion that it would be helpful to the other NRAs to have a consistent approach in the impact assessment in order to objectify positive effects of infrastructure and network sharing on environmental sustainability. According to MCA, in general, successful infrastructure sharing cases can inspire others to follow.

To facilitate implementation and comparison across countries and to have a reference framework for NRAs and the industry, many NRAs are in strong support of **developing guidelines,** applicable at the EU level and adopted by BEREC along with the Commission, and **defining standards** for sustainable infrastructure and network sharing, providing sufficient flexibility to take into account national specificities.[106] According to ANACOM, these are essential not only for assessing environmental impacts but also for determining the net impacts, considering the positive effects of infrastructure sharing. According to some NRAs,[107] further guidelines and best practices would be helpful in order to ensure a harmonized and common approach in Europe, especially if sustainability is added as a regulatory goal. Guidelines on voluntary environmental impact assessment could provide quantitative figures of environmental impact of the deployment and operation of the popular ECN/ECSs, e.g., fixed (fibre), wireless (5G, Wi-Fi), satellite.[108]

[102] BIPT
[103] CTU, EETT.
[104] ACM, AGCOM, ANACOM, ANCOM, HAKOM, ILR, MCA, NKOM, NMHH, RATEL, DADG, Arcep.
[105] As reminded by Traficom.
[106] AGCOM, AKOS, ANACOM, ANCOM, BIPT, CNMC, ILR, MCA, NKOM, DADG, SPRK.
[107] BNetzA, OCECPR, DADG
[108] RTR

RTR refers on the on hand to its **specific national procedure on ex-ante assessment of active sharing agreements** (Article 85 Austrian Telecommunications Act) that includes an assessment based on competition law and the applicable European and national guidelines on **competition law and sustainability**. It also refers to the existing Common position of BEREC on mobile infrastructure sharing and on the other hand the existing rules on sharing in the EECC transposed into national law.

Certain NRAs also support **further studies** on the impact of network sharing on environmental sustainability, which are anyway needed to integrate environmental considerations in the decision-making process.[109] All stakeholders should be involved in the process in order to provide relevant data, including MNOs and TowerCos which are also important actors in network sharing. Three NRAs[110] proposed new aspects of thematic work for BEREC: i) Collaboration among stakeholders, including regulatory bodies, industry, academic and research institutions, and non-governmental organizations, is very much needed, to develop comprehensive solutions and strategies for sustainable sharing and ii) in BEREC directly, the work could have the form of a specific workflow on this topic to enhance the collective knowledge and experience.

3.5.7. Levers for supporting the promotion of more sustainable deployment of ECN/ECS – including through further infrastructure sharing

The survey asked NRAs about the levers they consider suitable to support the environmental sustainability of the ECN/ECS further deployment. Several NRAs[111] mentioned proposals, which could be included within the frame of the revision procedure of the EECC.[112]

As infrastructure / network sharing is largely considered among NRAs as a positive contributor to the environmental sustainability, they would suggest that NRAs and Member States would be allowed, in compliance with EU law, to **impose mobile network sharing obligations in specific areas** (e.g. rural, historical, cultural, environmentally sensitive areas) outside of spectrum rights licenses. As regards fixed networks, it has been suggested to give attention in terms of sustainable development to the copper switch-off and building of optical networks in rural areas (co-funded by EU), which could be included in existing acts or new measures for better coverage in remote rural areas with energy-efficient mobile networks, possibly extending optical networks to base stations.[113]

NRAs could be better empowered to take decisions on infrastructure sharing if the **environmental protection was included as an objective** in the mechanisms already

[109] AGCOM, Arcep, ILR, NKOM
[110] AKOS, Arcep, OCECPR.
[111] ACM, AKOS, Arcep, BIPT, CNMC, ComReg, EETT, MCA, OCECPR, RATEL, RRT.
[112] OCECPR, ComReg, RRT, RATEL.
[113] AKOS.

existing in the regulation on infrastructure sharing (either for provisions such as Article 44 of the EECC, or the GIA).[114]

Another lever proposed in the survey is to **assess environmental impact** when taking decisions granted that it does not constitute an overburden for decision-makers and stakeholders[115] and/or **take into account environmental issues in the dispute proceedings about infrastructure sharing.**[116] In that respect, specific and clear mandate relating to regulatory and other provisions regarding environmental sustainability would ensure a harmonized and universal application of such measures in the deployment of ECN/ECS[117] and would support NRAs in the promotion of more sustainable deployment.[118] Furthermore, it must be clear how to approach environmental protection/environmental sustainability issues under the review of the EECC to ensure harmonised approach across Member States.[119]

The review of the EECC, and potentially the expected "Digital Network Act" proposal could be a possibility to include **additional competences for NRAs towards e.g. NetCos and TowerCos,** including environmental sustainability as an objective.[120] In addition, non-regulatory levers that could be supported were mentioned, such as industry workshops/consultations on sustainability issues, studies on carbon footprint and environmental impact of ECNs and ECSs, or end-user awareness programmes.[121]

3.5.8. Influence of current trends on network/infrastructure sharing practices and impact on environmental sustainability

The current trends in network architecture are likely to impact the practices in terms of network and infrastructure sharing. These trends could have various implications for sustainability considerations: efficient resource utilization, enhanced infrastructure sharing opportunities and promotion of innovation and collaboration.[122]

From environmental sustainability perspective, as operators share the same physical infrastructure (data centres), they can achieve reduced impact with significant carbon footprint reduction and impact on water consumption.[123] They will allow for more flexible and efficient resource allocation, reducing the need for physical infrastructure, lower energy consumption and overall reduced environmental impact.[124] New technologies and network architectures are

[114] Arcep, OCECPR
[115] BIPT which suggests that in that respect, the NRA could be assigned as the authority that defines the proper indicators and controls the statements of the providers.
[116] CNMC.
[117] OCECPR
[118] EETT.
[119] ComReg, RATEL, RRT, OCECPR.
[120] OCECPR.
[121] ANCOM.
[122] SPRK.
[123] Arcep.
[124] BIPT.

expected to be designed with sustainability improvements on mind.[125] But pairing technological advancement with sustainability focus and appropriate actions will be important.[126] Establishing a standardized definition for measuring sustainability across its various aspects remains crucial.[127] For instance, Open-RAN architecture raises concerns about the potential energy inefficiency of commercial-off-the-shelf (COTS) hardware, despite its versatility.[128] Further studies could be considered on the impact of these new technologies on infrastructure sharing and environmental sustainability.

More specifically, as regards the infrastructure sharing opportunities, **virtualization** enables to host several software-enabled equipment (called "virtualized network functions (VNFs)") into the same hardware (this is an example of consolidation and sharing of network elements within the same network operator). Similarly, virtualization supports network sharing among operators by enabling VNFs from different operators to run onto the same hardware. Virtualization of the RAN would be a possible way of network sharing provided that supporting interfaces and underlying infrastructure are open or standardized so that operators can use and manage independently their own RAN software on a common cloud infrastructure. It will depend on how all the equipment is orchestrated. Under existing sharing agreements, one operator is typically responsible for all the component parts of a shared site, with both operators using the same RAN vendor or software release, and life cycle management.[129]

Selecting from the other technologies available, the **C-RAN** enables the aggregation of BBUs of different radio sites and collocate them within a single pool.[130] **Edge computing** implies the co-location of computer servers which will be installed as close as possible to the users and traffic sinks/sources.[131] With the advent of **MEC and Stand-Alone transitions**, this flexibility will extend deeper into the access network, reaching closer to end users.[132] Certain NRAs noted possible effects of satellite developments on infrastructures scheme (e.g. terrestrial equipment, cloudification), with eventual consequences on sharing practices and on sustainability.[133]

4. Views of stakeholders (e.g. industry associations)

A technical workshop has been held with several companies, Connect Europe, ECTA and EWIA[134] which responded to a call by BEREC to collect and reflect the views of stakeholders on infrastructure sharing and environmental sustainability. BEREC asked the stakeholders a

[125] ANACOM.
[126] AKOS.
[127] ANACOM.
[128] ANACOM.
[129] Arcep.
[130] Arcep.
[131] Arcep, see also BEREC Report on Cloud and Edge Computing Services,
[132] MCA.
[133] BIPT, MCA, NKOM.
[134] MVNO Europe and the Shift project were also consulted but were not able to provide inputs before the date of publication of the draft version of this report.

set of questions related to i) the current regulatory framework; ii) commercially driven incentives in terms of infrastructure sharing; iii) existing study/assessment on infrastructure sharing possible environmental impact and iv) prospective inputs on the future of infrastructure sharing. This part reflects solely the views of stakeholders who responded positively to participate to the technical workshop: BEREC does not endorse the views summarised in this Chapter 4, nor the different studies mentioned by respective organisations.

4.1. Infrastructure sharing impact on environmental sustainability

The stakeholders agree on the general benefits of network sharing for environmental sustainability, which go beyond reducing costs for operators:

- Reduction of carbon emissions, land use, waste production and energy consumption by avoiding overbuilding and duplication of infrastructure;
- Energy efficiency, with network sharing optimising the energy consumption of networks.

These benefits are documented by EWIA in a study conducted on its behalf by EY Parthenon[135] on how the TowerCos business model, based on passive infrastructure sharing, can help reduce the sector's carbon footprint. It leads to the conclusion that, based on the expected growth rate of sites in the next ten years and on the fact that independent TowerCos enable greater levels of infrastructure sharing, a reduction of the number sites, compared to a scenario led by MNO deployments, will result in concrete and steel materials not being used, leading to a net carbon emission saving. In addition, shared cooling facilities and an innovative energy savings feature, coupled with the use of renewable sources would help annual energy savings up to 15%. According to this study, thanks to a reduced number of towers, a reduction in maintenance visits is expected, reducing both the number of kilometres travelled by maintenance teams, as well as the size of the fleet needed. This will be translated in an overall reduction of pollution deriving from CO_2 emissions of maintenance vehicles.

Other stakeholders indicated that they had no in-depth study on the subject.[136] Nevertheless, Connect Europe outlined there are environmental benefits to network sharing with lower emissions, land usage and less waste. Infrastructure sharing prevents overlaps in infrastructure and potential 'overbuilding', which duplicates energy consumption and results in a relatively larger carbon footprint.

For ECTA, in a general sense, infrastructure sharing has the potential for positive environmental impact both in terms of reducing embodied emissions of hardware and

[135] EY, The sustainability contribution of the European independent TowerCos sector, a report for the European Wireless Infrastructure Association, March 2023.

[136] ECTA cited the study by Pantelis Koutroumpis (University of Oxford), Pau Castells (GSMA), Kalvin Bahia (GSMA), "*To share or not to share? The impact of mobile network sharing (or consumers and operators)*", 2023. This study does not focus on the impact of network sharing on environmental sustainability but rather on the impact on markets and consumers.

operational impacts from energy and cooling. There exist different challenges for fixed and mobile networks and there are also concerns that apply specifically to consumer and wholesale or enterprise business deployments. Similar to Connect Europe, ECTA acknowledged the higher network densification required by 5G technology which is likely to increase the energy consumption unless coupled with environmentally sustainable solution. When it comes to the technical implementation of the sustainability objectives by the NRAs, and in order for NRA's or other bodies to better integrate environmental concerns, ECTA suggested to conduct net impact analyses on use cases for infrastructure sharing and refers to general methodologies developed by the ITU[137] and the European Green Deal Coalition.[138]

4.2. Existing practices and commercially driven infrastructure sharing

According to Connect Europe, voluntary network sharing agreements have become widespread in Europe and Connect Europe claims to have seen the benefits of infrastructure sharing extending beyond just cost reduction and quality improvements, but also to enable wider and faster roll-outs, where operators join efforts to deploy new technologies in both fixed and mobile. Both fixed and mobile network roll-out can be facilitated by allowing flexibility for market players that decide to enter into voluntary commercial wholesale agreements, network sharing and co-investment agreements.

ECTA expects that mobile network sharing agreements and deals with tower companies which entail mast sharing may become even more attractive options for operators, with respect to 5G networks and common environmental goals. The competitive environment in European telecoms over the past 20 years must also be preserved. ECTA believes that the paper “To share or not to share? The impact of mobile network sharing for consumers and operators”[139] is a good description of the different trade-offs, synergies and sensitivities that could derive from mobile network sharing.

EWIA highlighted the major role of TowerCos for passive wireless infrastructure sharing and underlined that the independent TowerCo model leads to an efficient sharing with positive impact on competition and economics (economics savings, better coverage and accelerated time to market including for new innovative service providers).

[137] Recommendation L.1480: Enabling the Net Zero transition: Assessing how the use of information and communication technology solutions impact greenhouse gas emissions of other sectors

[138] https://www.greendigitalcoalition.eu/overview-of-egdc-methodologies/

[139] Koutroumpis, P. et al, 2023, “To share or not to share? The impact of mobile network sharing for consumers and operators”, https://www.sciencedirect.com/science/article/pii/S016762452300046X#br0010

4.3. The role of policies and regulation to support infrastructure sharing and environmental impact of networks according to stakeholders

Connect Europe members have found that infrastructure sharing agreements can be very difficult and bureaucratic and depends on a number of factors, including the size of the networks concerned. Connect Europe believes that voluntary and commercially viable network sharing agreements should be supported by removing hurdles that currently exist in practice for operators and a more flexible framework, for example one which includes the presumption of legality for active RAN sharing. They cited their response to the Commission's draft Horizontal Guidelines, where the organisation stressed in the absence of consistent rules for legitimate sharing, it can be difficult for parties to identify the boundaries of such agreements.

ECTA noted that the majority of current mobile infrastructure sharing agreements in Europe are the result of commercial negotiation rather than regulatory intervention and deduced that this is a clear indication of how those sharing agreements are driven by the operators' own initiative rather than an external push by the authorities. ECTA believes the current legislation[140] and guidance[141] are appropriate to avoid the risk of restriction of competition and that its effective implementation and preservation remains key for the correct balance of the market dynamics in terms of achieving multiple objectives of competition, network infrastructure investments, innovation, environmental sustainability and consumer welfare. Nevertheless, ECTA highlighted the regulatory approach adopted by France under the Mobile New Deal as a successful example of network sharing imposed by regulation ensuring a balance between the objectives of competition and territorial coverage. This position was shared by EWIA.

To attract and retain investment, including from outside Europe, EWIA believes it is important that EU policy makers and NRAs are able to ensure long-term stability of rules that will foster additional investment in the future. In this regard, it welcomes the recently adopted GIA regulation and supports any tool that can foster infrastructure sharing and its positive role on environmental sustainability of networks.

[140] In particular, the provisions of the EECC were mentioned (Articles 44, 47, 61, 73).

[141] The European Commission's guidelines on horizontal restrictions, revised in 2023, which include a section dedicated to telecommunications infrastructure sharing agreements. ECTA argued that the EC considers that active sharing agreements do not restrict competition by their object and sets criteria to be considered. It argues that certain factors are important to take into account in the analysis of the restrictive effects of competition of the agreements, such as the opening of the agreement to a third operator and the existence of local regulations that restrict competition (e.g. low levels of electromagnetic field emissions in certain countries that reduce deployment spaces, permits).

4.4. Stakeholders' prospective work relevant for the future of infrastructure sharing in the context of network cloudification and virtualisation

In 2023, Connect Europe commissioned a report by Deloitte[142] which emphasised the future importance and impact on the telecom sector of open networks (OpenRAN, APIs) and virtualisation of network functions, including edge cloud. In particular, and in light of future 5G SA and 6G network technologies, Connect Europe highlighted that the virtualisation of mobile networks makes the differentiation between passive and active sharing, including spectrum sharing to some extent, less relevant, with the main differentiators in terms of quality and performance being software-based. Connect Europe considers that spectrum sharing would be better approach to address the needs of verticals rather than reserving spectrum in auctions which can create scarcity and fragmentation of spectrum. This is important in terms of environmental sustainability, as increasing spectrum per site is more energy efficient than increasing the number of sites, especially considering the dense deployment of base stations needed for 5G. According Connect Europe, overly strict limitations on mobile active sharing could prevent spectrum management to play a positive role in the fight against climate change. When considering infrastructure sharing decisions, environmental concerns need to be given proper attention.

Unlike Connect Europe, ECTA sees no role for the virtualized access solutions (i.e. APIs) to the network and thus no affiliated issues in terms of infrastructure sharing. ECTA emphasizes that effective wholesale (passive and active) access to electronic communications infrastructures is and will remain a fundamental pillar also in a world characterized by the advent of cloudification and virtualization. It believes that any option that would restrict wholesale access to infrastructure for operators with significant market power by replacing it with access to application programming interfaces would constitute a brake on the development of innovative technologies. For ECTA, an example of innovative technology for infrastructure sharing contributing to environmental sustainability could be the IPCEI (Important Projects of Common Economic Interest) CIS (Cloud Infrastructure and Services) projects. One ECTA member, Eurofiber, is part of the consortium working on Modular & Integrated Sustainable Datacentre, which aims to deploy a decentralized network of data centres, resulting in multiple smaller data centres which would be used for computing (i.e. energy intensive activities) that could be placed either close to where green energy is produced or where heat generation could be utilized.

From EWIA's perspective, innovations can be ways for TowerCos to extend their sharing model to new areas: Distributed Antenna Systems (DAS) and Small Cells are opportunities for TowerCos to offer active networks of neutral hosts, Edge Infrastructure and Cloud RAN

[142] 'Future connectivity: new study finds radical change is coming and highlights investment challenge', Deloitte for ETNO (now Connect Europe), 2023

are emerging concepts in mobile network architecture that offer potential for pooling, and Artificial Intelligence, enhanced imaging and computing technologies are already enabling the rise of “Digital TowerCos” by exploiting the powerful use cases of digital twins.

5. Conclusions and future work

BEREC emphasizes the importance of ensuring network deployment and promoting connectivity for all European citizens. It is also crucial to ensure that the environmental impact of this deployments and of the electronic communications sector is minimized. In this regard, infrastructure sharing, whether passive or active, can be an instrument to reduce the environmental footprint of deployments and encourage increase network efficiency.

It should be noted that infrastructure sharing, especially where active components of the networks are concerned, can raise significant issues in terms of competition, investment incentives, and service quality, which depend on the context and (e.g. the population density and the derived demand for data services in of the area in question). Coherently with the EU regulatory framework, these aspects are already considered by regulators and BEREC reminds readers that this document focuses on the links between environmental sustainability and infrastructure sharing, and refers to other work on this subject concerning the additional impacts and issues related to sharing practices.

Infrastructure sharing can bring various benefits such as cost reduction, improved efficiency, consumer choice, greater public acceptance of infrastructures, as well as minimisation of environmental impact of telecom infrastructures, etc. Concerning the latter, although there is little quantitative data and studies on the avoided environmental impacts through infrastructure sharing, regulators and stakeholders agree on the various environmental gains that it brings. It should be underlined that the benefits of infrastructure sharing have to be weighed against potential technical, legal and regulatory issues in terms of quality of service, competition and investment.

Table 2: Summary potential environmental benefits associated with infrastructure sharing

Environmental Benefit	Lifecycle phase	Description	Expected Impact
Reduction in Duplicative Infrastructure	Manufacturing and deployment	By sharing infrastructure, fewer physical structures like towers and ducts need to be built, reducing the overall environmental impact.	Reduction in the number of new towers, ducts, and other physical structures.

Energy Efficiency Improvements	Operation	Shared infrastructure (especially when active components equipment is shared) allows for more efficient energy use by reducing redundant equipment and optimizing resource allocation.	Lower energy consumption per network, particularly in data centres and cellular networks.
Resource Conservation	Manufacturing	Fewer materials such as metals, plastics, and other resources are needed for new infrastructure, conserving natural resources.	Reduced extraction and processing of raw materials, contributing to less environ-mental degradation.
Reduction of CO2 Emissions	Operation and deployment	Fewer new deployments and optimised energy usage lead to lower emissions of CO2 and other greenhouse gases.	Potential reduction of thousands of tons of CO_2 annually, especially in densely networked areas.
Decreased Land and Resource Use	Deployment	Less land is needed for new installations, minimizing environmental disturbance and reducing the exploitation of natural resources.	Lowered environmental footprint in sensitive ecosystems, less deforestation or land clearing.
Reduction of E-waste	Decommissioning	Infrastructure sharing reduces the need for replacement and disposal of electronic devices and components, helping to lower electronic waste.	Minimized accumulation of outdated and discarded electronic components.

It is worth noting that infrastructure sharing is an established feature in electronic communications market included through commercially driven agreements that are established without regulatory intervention. As covered in BEREC Common position on

infrastructure sharing,[143] the current regulatory framework enables competent authorities – in limited and respectively specific situations to restrict or to impose infrastructure sharing. Various provisions allow for the restriction and imposition of passive or active infrastructure sharing obligations at the European level with the aim to contribute to achieving the objectives of the European regulatory framework on electronic communications. For fixed networks, infrastructure sharing is part of access regulation implemented by the European regulatory framework. The coordination of civil work is also a public policy and regulatory principle established in European law by the BCRD, which will be gradually repealed by the GIA. In mobile networks, in addition to the general provisions allowing the imposition of infrastructure sharing obligations in the exercise of rights of way, spectrum allocation procedures can include network-sharing obligations. It appears that the current European framework does not foresee the ability to formulate infrastructure sharing obligation for mobile networks, outside spectrum allocation.

Implementation of infrastructure sharing regulatory disposals dispositions are quite disparate in Europe and relatively scarce: for instance, between two to seven NRAs impose infrastructure sharing obligations, depending on the regulatory basis considered (e.g. Articles 44 and 61 of the EECC or spectrum licenses). According to this report, the majority of BEREC members claim that no additional incentives are put in place in their Member State to promote infrastructure sharing. Furthermore, a very small number of NRAs currently integrate environmental considerations into their decisions regarding infrastructure sharing. It seems that the lack of a clear mandate is one of the main obstacles to such integration, as well as the lack of expertise and specific standards/guidelines on the assessment of environmental aspects.

Hence, to facilitate the inclusion of environmental considerations in regulation, including regarding infrastructure sharing, adding an environmental sustainability objective to the regulatory mandate of NRAs, as mentioned by the European Commission in its White Paper and already supported by BEREC,[144] would be a favourable development. While regulatory tools already exist to encourage infrastructure sharing, the possibility to expand the capacity of NRAs to impose or incentivise infrastructure sharing to the benefit of the minimisation of ECN/ECS's environmental footprint could be examined during the next review of the EECC. Furthermore, additional guidance at EU level could support NRAs and competent authorities willing to include sustainability aspects while assessing decisions related to electronic communications and infrastructure sharing. Such guidance could complement existing guidelines on horizontal sustainability agreements[145] and would have to be elaborated in close cooperation with NRAs, competent authorities and stakeholders.

[143] BoR (19) 110, BEREC Common position on infrastructure sharing (2019)
[144] BoR (24) 100, BEREC's input to the EC public consultation on the White Paper "How to master Europe's digital infrastructure needs? (2024)
[145] European Commission's Horizontal Guidelines (2023) - Chapter 9 on Sustainability Agreements: https://competition-policy.ec.europa.eu/document/fd641c1e-7415-4e60-ac21-7ab3e72045d2_en

It is also noted that only ten NRAs collect or did have access data on infrastructure sharing, and none have conducted environmental impact assessments of sharing practices so far. In this regard, BEREC deems it relevant to foster the share of data in this regard by the operators and encourage relevant stakeholders (market players, researchers, public bodies, etc.) to conduct quantitative studies to improve understanding of the links between infrastructure sharing and the environment. Collecting environmental data from telecom players by NRAs, supported by a clearer and harmonised mandate at EU level, could also contribute to developing their expertise on the subject and facilitate the inclusion of this information in their decisions.

To foster the sharing of best practices on the topic, it would be relevant for BEREC to include in its next work on infrastructure sharing an environmental component, in coherence with the objectives set in its 2021-2025 Strategy. Besides, in the context of the work conducted by the European Commission to establish a sustainability Code of Conduct for ECN/ECS, infrastructure sharing, particularly passive sharing, could be considered among the best practices integrated into the document. Finally, more prospectively, network cloudification and virtualisation trends could also present an opportunity to promote resource optimization through sharing when it is relevant and compatible with applicable legal obligations. These trends could deserve close look from BEREC and its members in the future.

Finally, BEREC will continue to explore how regulators and the current framework can support the twinning of digital and environmental transitions.

Glossary

CO_2 e: CO_2 equivalent of a GHG emission is the amount of carbon dioxide that would cause the same cumulative radiative forcing over a given period of time, i.e., would have the same ability to trap the solar radiation.

Passive sharing: a common use by two or more operators of passive elements of their respective networks. Passive elements are those which are not able to process or convert telecommunication signals in any way and which are not integrated parts of the system dedicated specifically to the conveyance of signals. Passive elements are sometimes referred to as 'unpowered components' as these elements usually do not require a power supply. This is however not always the case. For instance, air conditioning for cooling equipment might be considered a passive element, but usually requires an external power supply. Passive sharing can encompass the sharing of passive backhaul elements. Co-location is a form of passive sharing where the operators share the same location (such as compound, base station sites, rooftops, etc.) for the construction of the base stations. It could be limited to a common access to the location. It could also include the use of common masts and other mounting/supporting constructions or cabinets including related installations (such as air conditioning, power supply etc.).

Site sharing: a form of co-location where two or more operators agree to deploy their masts or other supporting constructions in the same location. Typically, each operator provides own mast, backhaul, cabinets and active equipment. Mast sharing is a form of co-location where two or more operators agree to use the same mast or other supporting construction. Generally, each operator provides own backhaul, cabinets and active equipment.

Active sharing: a common use by two or more operators of active elements of their respective networks. Active elements are those which are able to generate, process, amplify and control signals. Examples of active elements are very diverse and include many different types of electronic equipment (hardware and software) capable of various functions (transmitters, receivers, amplifiers, decoders etc.). While antennas have been traditionally classified as passive elements, technology advance has led to a paradigm shift to active antenna systems (AAS), which are considered a key enabler for 5G networks. Such antennas (or antenna arrays) can also be considered as active when equipped with radio frequency units such as amplifiers and signal processing elements. Furthermore, 5G, including virtualization technology, may enable new forms of network sharing, in particular for building common network slices tailored to specific services.

RAN sharing: a form of active sharing where two or more operators agree to use the same access network equipment, including base station active equipment and possibly the antenna. Each operator uses its own core network. This type of active sharing itself can typically be split into two types, depending on whether operators share the same spectrum or not:

- Multi-Operator Radio Access Network (MORAN) sharing is a form of RAN sharing where only equipment is shared (i.e. not spectrum). The end-users of each operator

access the services of their respective MNO with the frequencies of their respective MNO.

- Multi Operator Core Network (MOCN) sharing is a form of RAN sharing where all elements of the radio access network, including spectrum, are shared. The end-users of each operator can access the services of their respective MNO through all the frequencies that are shared in the access network. The frequencies can be provided by one or several operators that are part of the sharing. When the frequencies of several operators are used, it is called MOCN with frequency (or spectrum) pooling.

National/local roaming: a form of active sharing where one operator uses the mobile service of another operator within the same country for the purpose of providing services to its end users.

Core Network sharing: a form of sharing where operators agree to share elements of their core network, either on a standalone basis or in addition to sharing elements of their access network(s). Core network sharing can be limited to data transmission ring which connects the core network components and can extend to components themselves (such as switching centre with HLR, billing platforms and value-added services (VAS))

Backhaul sharing: a form of sharing where one or more operators share backhaul elements. It is a form of passive sharing when the shared elements are passive, for example ducts and poles. It is a form of active sharing when it is the common use of network components for data transmission.

Environmental footprint: a multi-criteria measure of the environmental performance of a product or goods/services providing organisation based on a life cycle approach. The term derives from the academic notion ‘ecological footprint’ that refers to the land (and water) area of the planet or particular area required for the support either of humankind’s current lifestyle or the consumption pattern of a particular population. It is the inverse of the carrying capacity of a territory.

Environmental impact: refers to the direct effect (also called first order effect) of socio-economic activities and natural events on the elements of the environment

Environmental Sustainability: The United Nations Brundtland Commission defined in 1987 sustainability as ‘meeting the needs of the present without compromising the ability of future generations to meet their own needs.’ It encompasses three dimensions: environmental, economic and social. An attempt definition of environmental sustainability would be the conditions of balance, resilience, and interconnectedness that allows human society to satisfy its needs while neither exceeding the capacity of its supporting ecosystems to continue to regenerate the services necessary to meet those needs nor by our actions diminishing biological diversity.

Life cycle: a life cycle begins with extracting raw materials from the ground and generating energy. Materials and energy are then part of manufacturing, transportation, use (e.g.,

operation of networks), and eventually recycling, reuse, or disposal. A life cycle approach (LCA) identifies both opportunities and risks of a product or technology, all the way from raw materials to disposal. There is a considerable number of life cycle approaches, ranging from qualitative (life cycle thinking) to quantitative approaches.

Life cycle approach/assessment: a compilation and evaluation of the inputs, outputs and the potential environmental impacts of a product or service throughout its life cycle.