ACHIEVING DIGITAL SUSTAINABILITY

Progress report, summary of collaboration platform work and 11 Arcep proposals to combine increasing use of digital technology and reducing its environmental footprint

15 December 2020

INTRODUCTION

The impact that electronic communications networks, devices, data centres and ICT use have on the environment is a **source of growing concern,** and one which an increasing number of stakeholders are gradually starting to address. The Citizens' Convention on Climate[1] also notes that while digital technology is a crucial lever of the green transition, and the battle against climate change, it must not itself be the source of increased emissions.

According to various studies conducted over the past two years[2], **digital technology currently represents 3% to 4% of global greenhouse gas[3 4] (GHG) emissions, and 2% of the carbon footprint in France[5] (including the hardware production and usage stages).** If the exact figures contained in these studies may vary, they all agree on the overall verdict.

If this percentage remains low compared to other sectors, the pace of the annual rise in digital consumption (data volume, number of devices, etc.) is cause for concern. According to the Senate task force on ICT's environmental footprint[6], **digital technology's GHG footprint could increase substantially if nothing is done to curtail it** (+60% by 2040 or 6.7% of the national GHG footprint). If such an increase were to materialise, it would be counter to the commitments made under the Paris Climate Agreement[7] of 2015 which aims to contain the increase in global temperature to well below 2°C, and requires swift and massive efforts from every sector of the economy to reduce their own carbon footprint[8].
On top of which, **there are other contributors to digital technology's environmental footprint** that need to be taken into account, as underscored by a report from GreenIT.fr[9]: in addition to carbon footprint[10], the consumption of abiotic resources (water, minerals...) and primary energy consumption[11] must be factored in.

Digital technology currently accounts for 3% to 4% of global greenhouse gas (GHG) emissions and 2% of the carbon footprint in France

Arcep decided to devote itself fully to this issue, by building on the responsibility it was assigned by law in 2010[12] following the Grenelle Environment Forum, to work in concert with the Government to align its actions with environmental protection imperatives.
Here, it is worth remembering that **digital technology is a powerful engine of change in society**, as much from an economic and social perspective, as in the

1. The Citizens' Convention on Climate (CCC), was formed in October 2019 through a letter of engagement from the Prime Minister of France to the Economic, Social and Environmental Council. The CCC is made up of a group of 150 French citizens who are chosen by lot, and whose aim is to "take a social justice approach to defining structural measures that will reduce greenhouse gas emissions by at least 40% by 2030, compared to 1990". Its report was adopted on 21 June 2020, including proposal 150, to "Support digital development to make it more green" https://www.vie-publique.fr/sites/default/files/rapport/pdf/274855.pdf
2. See in particular The Shift Project, Lean ICT: *Achieving digital sobriety, October 2018; GreenIT.fr, ICT's global environmental footprint*, September 2019; Arcep, Future Networks - Digital Tech's Carbon Footprint, October 2019; CGE, Reducing digital technology's energy consumption December 2019 and Citizing, iCT's carbon footprint in France: are public policies enough to handle increasing usage?, June 2020.
3 At the national, GHG emissions are broken down between direct emissions (i.e. emissions tied directly to the production and use of a product or service) and indirect emissions (i.e. those, on a solely national level, tied to the consumption of energy that is an indirect source of GHG emissions or to other stages in the product or service's life-cycle, such as transport, recycling, etc.). These emissions do not factor in foreign energy sources, but only those located on national soil. The notion of footprint includes both the direct and indirect emissions produced on national soil and abroad. At the global level, then, direct and indirect emissions correspond to the footprint. See Glossary.
4. See Glossary.
5. Senate, Information Report – *Pour une transition numerique écologique*/Achieving a Green Digital Transition, June 2020.

Digital technology's GHG footprint could increase significantly if nothing is done to curtail it (+ 60% by 2040 or 6.7% of the national GHG footprint)

daily lives of our fellow citizens and the development of public services. This, then, is the yardstick that Arcep uses to ensure that the users of digital networks and services maintain control over their choices, and are able to reap the benefits of ongoing technological developments. In other words, for the Authority, limiting digital technology's environmental impact is not necessarily synonymous with restricting uses or technologies. The challenge lies in **combining the development of digital technology in keeping with societal and economic needs, and new environmental imperatives.**

This outlook is part of regulation's ongoing evolution. Initially focused on opening markets up to competition, when it was first created in 1997, Arcep then worked to encourage investment to achieve better regional connectivity, and was later given the responsibility of protecting net neutrality[13]. **Now, with these environmental imperatives, Arcep wants to open a new chapter in its regulation.**

Work together to draft tomorrow's regulation

In keeping with how the regulator operates, Arcep decided to begin this new chapter in regulation by a dialogue with all of the stakeholders. **After having published a brief in 2019 on "digital technology's carbon footprint[14]"** in which it calls on industry players to contribute to the work it is doing, **the Authority decided to take things to the next level,** and **so last June launched the "Achieving digital sustainability" collaboration platform**. To bring together the largest number of stakeholders possible, despite social distancing and the Covid-19 crisis, Arcep elected to develop a fully on-line mechanism. It worked in concert with Ouishare, a collective that explores and challenges societal transformations through live encounters, studies and concrete experiments.

Associations, institutions, electronic communications operators, tech companies, civil society stakeholders, government agencies and experts were invited to contribute through a **series of eight meetings** held online between July and November 2020, which provided opportunities for everyone to trade views, practices, tools, skills and knowledge and so contribute to the collective brainstorming

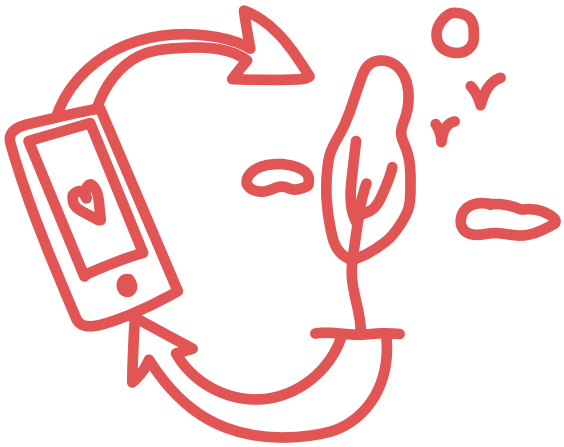
6. See Glossary.
7. The Paris Climate Agreement, adopted on 12 December 2015 in Paris, signed on 22 April 2016 at the United Nations headquarters in New York, and entered into effect on 4 November 2016 https://unfccc.int/files/essential_background/convention/application/pdf/ french_paris_agreement.pdf
8. See Glossary.
9. GreenIT.fr, *Digital technology's global environmental footprint*,, September 2019
10. As a reminder, the carbon component (in carbon dioxide or CO2) is only one of the gaseous components of a GHG footprint.
11. See Glossary.
12. Act No. 2010-788 of 12 July 2010 on the National Commitment to the Environment
13. See Glossary.

Arcep established the work programme for its platform after an inaugural meeting on 9 July 2020. Sixty five participants were invited to share their main areas of focus and concern regarding (fixed and mobile) electronic communications networks as a whole, as well as devices, data centres and applications – which are the chief drivers of digital consumption and its environmental footprint. Five thematic workshops were planned as a result, then hosted by Arcep in autumn 2020:

- ***Adapting business practices to achieve digital sustainability;***
- ***Combating obsolescence to achieve digital sustainability;***
- ***Choosing our networks to achieve digital sustainability;***
- ***Rethinking digital content and services to achieve digital sustainability;***
- ***Designing networks to achieve digital sustainability.***

Two important topics, which pertain more to societal issues, became the focus of two "big discussions":

- ***How to achieve both connectivity for all and digital sustainability?***
- ***How to safeguard both digital sustainability and user freedoms?***



In response to an invitation from Arcep, t**he National Cybersecurity Agency (ANSSI)** embraced the platform's collaborate nature and **hosted its own workshop: "Cyberthreat/environmental threat"** and so further enriching the broad exploration of digital sustainability with matters that fall under its purview.

From the start, these different interactions relied on the collaboration platform to host the discussions and further the work that was done outside the workshops.

The purpose of this report is to relay the positions that the participants expressed during the workshops on the platform, and in written contributions that were transmitted afterwards. It is also meant to **present Arcep's analysis and identify a preliminary action plan** to develop and ensure the ongoing monitoring of the environmental footprint of electronic communications networks and services, and so pave the way for the deployment of more sustainable digital technology.

An additional aim for this report is to further the discussions that have begun at the European level within the Body of European Regulators for Electronic Communications (BEREC), of which Arcep is the co-chair of the *"Sustainability"* Working Group created in April 2020. The objectives set by this group of experts includes studying the environmental impact of electronic communications networks, and cataloguing best practices for behaviour that is consistent with environmental imperatives.

In parallel work, **Arcep also deepened its collaboration with ADEM** (France's Environment and Energy Management Agency). The two entities launched several **shared initiatives** as part of a joint mission entrusted to them by the Ministry for the Ecological Transition, and the Ministry for Economy and Finance, to **quantify the environmental footprint** of fixed and mobile networks' infrastructures, and to assess the different factors that make it possible to quantify every dimension of digital technology's environmental footprint (devices, data centres, usage...). A dedicated joint report on the findings will be published in late 2021.

14. https://www.arcep.fr/actualites/les-communiques-de-presse/detail/n/reseaux-du-futur-2.html

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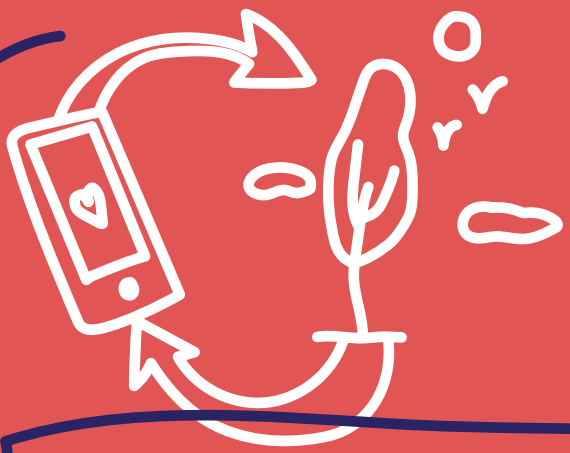
PART 1

[think]

TAKE STOCK OF DIGITAL SUSTAINABILITY ISSUES AND CHALLENGES



In this first part, Arcep wants to highlight the preliminary conclusions reached about digital technology's environmental footprint (1.1). Earlier work on the issues are vital to gauging the scale of this footprint and how important it is to incorporte environmental concerns into any discussion about digital technology. However, to be able to continue and deepen any actions taken to limit the tech sector's environmental footprint, more detailed work is required, for which an analytical method still needs to be devised (1.2).

1.1 Ongoing expansion of usage raising concerns about the sector's environmental footprint

The digitalisation of not only our economy but also our personal lives, and our lives as citizens, has given **digital technology a ubiquitous** presence in France (1.1.1). New products, services and content are propelling our expanding digital behaviours. If this underlying trend can be a source of innovations that help reduce other sector's environmental footprint, it goes without saying that **attentional also needs to be paid to the digtal sector's own environmental footprint** (1.1.2).

1.1.1 The pervasiveness of digital technology in France

The pervasiveness of digital technology in France can be observed in **the increased usage**, both professional and personal, and the resulting ubiquity of digital devices and **growing demands being put on the networks**.

The growth trajectory of devices found inside of French households differs depending on the type of device. For some, their increase appears to have reached a plateau. Such is the case for televisions and computers, for instance: levelling off at around 90% and 85% of equipped households[15]. Tablets peaked at a much lower level of around 50% of equipped households[16]. Smartphones, on the other hand, have continued their steady rise (from 66.9% in Q2 2017 to 77% of households Q2 2020) but have shown signs of reaching maturity in the past several quarters[17]. The more or less lengthy lifespan, and more or less rapid obsolescence, of these devices also means a regular turnover of a very large volume of hardware.

At the same time, other devices are also experiencing significant development, and Cisco estimates[18] that the total number of devices connected to the internet worldwide (including the more "traditional" equipment listed above) will grow from 18.4 billion in 2018 to 29.3 billion in 2023. Western Europe (which includes France) is one of the wold's most heavily equipped regions, with 5.4 devices per person in 2018 and forecast to increase to 9.4 by 2023. France Stratégie sees the Internet of Things (IoT)[19] – for both consumer and business use – as one of the main sources of this increase[20], and Arcep's Digital Market Barometer reveals that only 16% of people in France owned at least one connected object in 2019[21], which points to still tremendous room for growth.

This equipment gives users the ability to **consume a host of digital services** and content. Each device can either be used for a wide range of services (e.g. tablets and smartphones) or have a very specific purpose (e.g. a smart object dedicated to monitoring the weather or to telemedecine). The advent of new services will no doubt attract new users and **increase the number of devices in circulation**. In additon, as these new services may

15, 16 and 17. Arcep, The Digital Market Barometer, 2019. An annual study conducted since 2000 and managed by Arcep, the Economic Council (CGE) and the French Digital Agency

18. Cisco, Visual Networking Index: forecast and trends, 2018-2023, 2018.

19. From a design standpoint, the Internet of Things characterises connected physical objects that have their own digital identity and are capable of communicating with other objects. This network creates a sort of gateway between the physical and and virtual worlds. From a technical standpoint, this consists of a direct and standardised digital identification (IP address, protocols such as smtp, http...) of a physical object using a wireless communication system, which could be an RFID chip, Bluetooth or Wi-Fi. See Glossary.

20. France Stratégie, *Controlling digital technology's consumption: technological progress will not suffice,* October 2020.

21. This equipment can include household appliances, health, home automation or security devices, and indicates that younger generations are the most attracted by them.

require improvements to the equipment that is already in circulation (new features, greater computing power...) they could acclerate the pace at which users, both businesses and consumers, replace their old equipment.

In terms of digital services, more and more people today are connecting to the internet (increasing from 52% to 88% of people ages 12 and up between 2005 and 2019[22]).This increase is being spurred largely by the rise in **mobile consumption** (from 16% to 57% of the population between 2011 and 2019[23]). Screentime is also rising steadily, and internet users in France spend an average of more than five hours a day online, including close to two hours on their mobile[24]. These **uses are increasingly varied,** including some applications that **consume a great deal of bandwidth**. The Digital Market Barometer underscores the surging popularity of subscription video on demand or SVOD[25] (36% in 2019, + 11 points YoY), the growing percentge of the population that use their mobile phone to surf the web (68% in 2019, or 4 points more than in 2018), and the steady rise in the use of instant messaging[26].

These developments naturally determine how networks and data centres scale their requirements, chiefly in terms of capacity but also for certain uses such as video games or telemedecine, for instance, in terms of quality of service (connection permanence, latency...). The amount of data relayed over the networks, and mobile networks in particular, is climbing steeply, reflecting users' growing consumption of digital content and services.

According to Cisco[27], video accounted for 75% of the global IP traffic transiting over electronic communications networks in 2017, and estimates that this share will reach 82% in 2022[28]. This steady increase in video traffic can be attributed to the proliferation of video content sources (linear and catch-up programme viewing online, SVOD, social media, video chat and messaging apps, spread of video pop-up and banner adverts, etc.). It is also due to the overall increase in video quality, notably with the advent of ultra high definition (UHD).
France's Economic Council (CGE) indicates that distributing content in UHD generates eight times more data than it would in high definition (HD)[29] with an identicl level of encoding[30]. The Shift Project[31] also points out that 10 hours of HD video represents more data than every English language entry on Wikipedia combined.

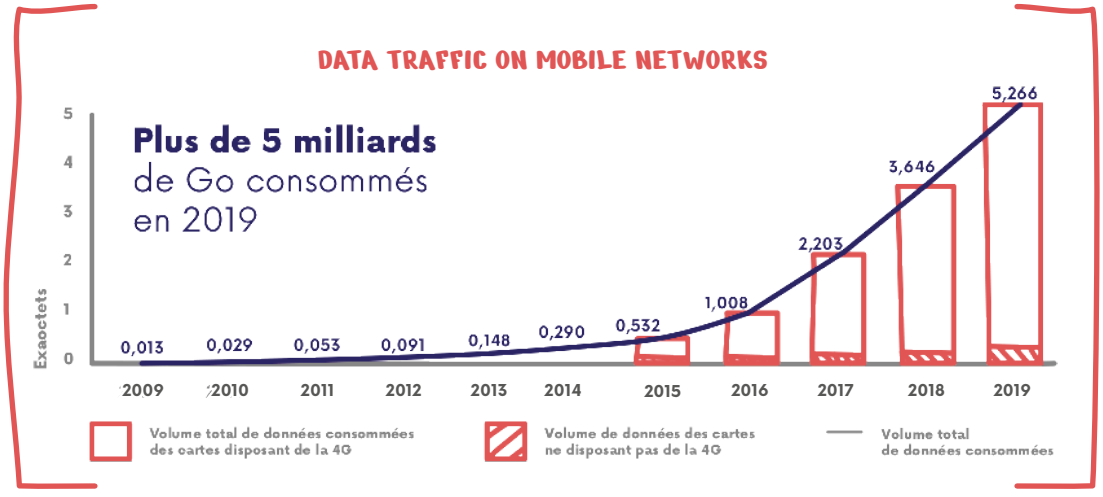


Figure 1: Data traffic on mobile networks

22 and 23. Arcep, *The Digital Market Barometer*, 2019.
24. Hootsuite & We Are Social, *Digital 2020 Global digital overview*, 2020
25. SVOD includes subscription video on demand as provided by services like Netflix, Amazon Prime, and the more recent Salto.
26. "62% of people in France send messages and 51% make phone calls using applications, which marks a 9-point and 11-point increase year on year, respectively." Arcep, *The Digital Market Barometer*, 2019.
27. Cisco, *VNI Global IP Traffic Forecast*, 2017-2022, p.17.
28. Another more marginal, albeit growing, segment is gaming, whose share of traffic has risen from 1% to 4%.

While video plays a prominent role here, it is not the only bandwidth-hungry application. The firm Sandvine[32] has drawn up a list of the 10 uses and applciations that generate the most traffic. A ranking that includes video games and file sharing, alongside video.
This naturally affects the amount of data stored in data centres. According to France Stratégie[33], the quantity of data stored in data centres quadrupled between 2011 and 2016, and is expected to triple from 2017 to 2022.

TOP 10 USES AND APPLICATIONS IN TERMS OF TRAFFIC SHARE

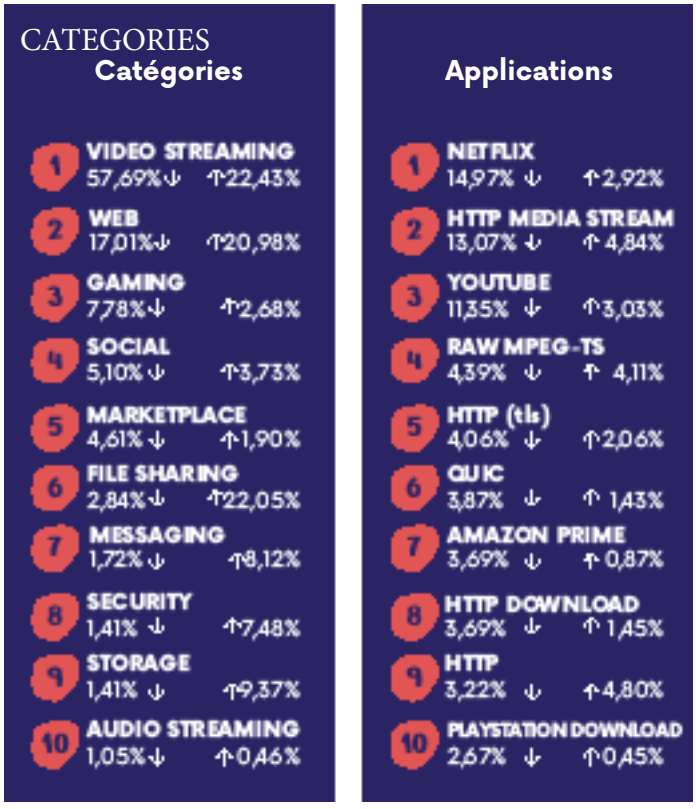


Figure 2: Top 10 uses and applications in terms of traffic share (source: Sandvine)

1.1.2 A situation that raises questions about the sector's footprint

These changing usage patterns are resulting in a growing environmental footprint for the sector, which has become an **increasingly documented source of concern**. The Shift Project[34] report estimates that digital technology currently accounts for 3% to 4% of global GHG emissions, and growing by around 8% a year. GreenIT.fr provides similar figures on global GHG emissions, and warns of other aspects of the environmental footprint that need to be factored in, including water consumption (in cooling systems), the artificialisation of soil (from mining rare earth metals) and the consumption of other abiotic resources (notably rare earth and other minerals used to manufacture devices)[35]. A more accurate national estimate is provided by consulting firm Citizing – as part of the French Senate's task force on digital technology's environmental footprint – which concludes that digital tech represents around 2% of France's carbon footprint[36]. It also warns that it could increase significantly if nothing is done to contain it (+60% by 2040 or rising to 6.7 % of the national carbon footprint)[37].

Digital technology's environmental footprint involves a complex and globalised ecosystem that includes electronic communications operators, data centres, manufacturers of network equipment, electronic components and devices, and content and service providers, each with its own chain of suppliers and sub-contractors. This ecosystem is by no means confined to France: internet users access different services and content via data centres that may be located abroad, while digital equipment is often the fruit of global value chains, whose production is situated in countries that are more carbon-heavy than France.

29. CGE, *Making digital technology more energy efficient*, December 2019.
30. See Glossary. To contain these effects, service providers are working to optimise their video stream encoding but, for now, these developments are also coinciding with higher definition and a still ongoing increase in data traffic.
31. The Shift Project, *Climate: the unsustainability of online video*, July 2019.
32. Sandvine, *The Global Internet Phenomena Report*, pp 6-7, 2018.
33. France Strategie, *Controlling digital technology's consumption: technological progress will not suffice*, October 2020.
34. The Shift Project, Lean ICT: *Achieving digital sobriety*, October 2018.
35. GreenIT.fr, *Digital technology's global environmental footprint*, September 2019.
36. French Senate, *Task force – Achieving a green digital transition*, June 2020.
37. These estimates suppose that France will comply with the commitments it made under the Paris Climate Agreement in 2015 and the National Low Carbon Strategy projections regarding other sectors.

In this respect, the **networks as such represent only a fraction of digital technology's carbon footprint in France: around 5% according to the Senate report**[38]. This does not mean that France's electronic communications operators have absolved themselves of exploring ways to be more energy efficient. The latest technologies deployed are often greener than their predecessors, in fact[39]. Fibre consumes less than ADSL[40] on the access network[41]; by the same token, 5G is designed to be more energy efficient than 4G when handling the same amount of traffic. Per Gb transmitted 4G consumes less energy than 3G, and 3G consumes less than 2G[42].

In practice, **electronic communications operators' direct greenhouse gas emissions are due primarily to electricity consumption just on their networks,** and this even in France where the carbon intensity per KWh is much lower[43]. This electricty used by the networks can be broken down according to the segment being examined. Electronic communications networks are made up of several parts: access networks that connect end customers (premises), (regional) backhaul networks [44] and (national) core networks. Operators' footprint nevertheless extends beyond just that of the networks proper, since **the access boxes (routers) they supply also have a footprint**, created by their production and consumption.

Mobile
Copper (ADSL)
Fibre

Access network

Backhaul network and upstream

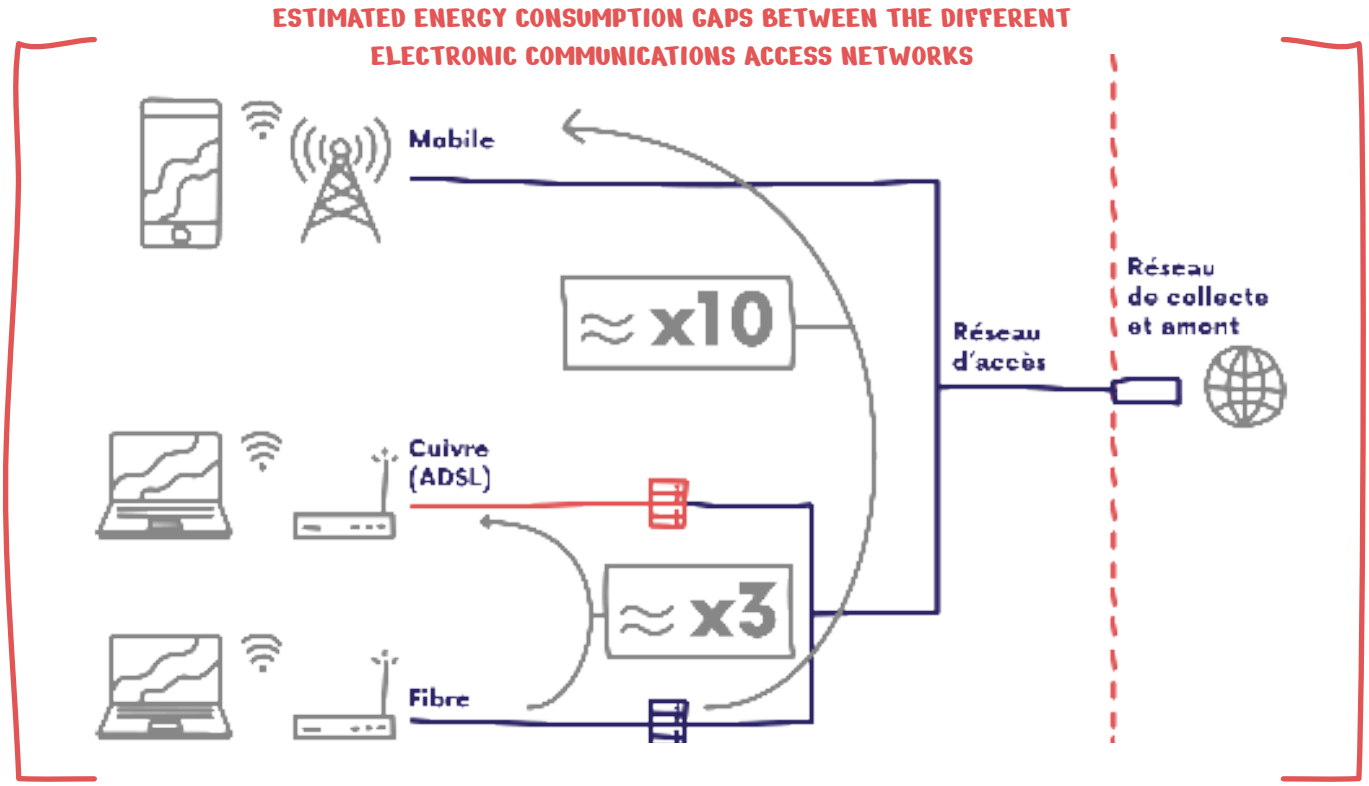


Figure 3. Estimated energy consumption gaps between electronic communications access networks

38. French Senate, *Task force report – Achieving a green digital transition*, June 2020.
39. Arcep, Future Networks – Digital technology's carbon footprint, October 2019. France Stratégie indicates different levels, but confirms the trends and the size of the gaps in its report: France Stratégie, *Controlling digital technology's consumption: technological progress will not suffice*, October 2020.
40 and 41. See Glossary.
42. Because fixed access technologies depend relatively little on the amount of traffic they are relaying, their consumption is indicated in Watts per line, contrary to mobile techologies which are heavily affected by traffic levels, and measured in kWh/Gb.
43. Arcep, *Future Networks – Digital technology's carbon footprint*, October 2019
44 and 45. See Glossary.

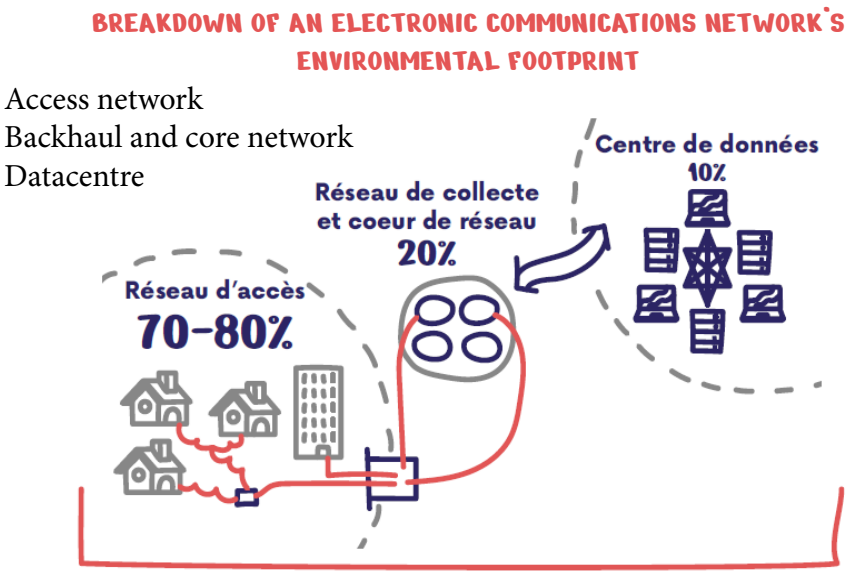


Figure 4: Breakdown of an electronic communications network's environmental footprint

The access segment is the heaviest consumer of energy, accounting for between 70% and 80% of a network's total power consumption[46]. The remainder is shared between operators' backhaul and core netorks (20%) and their data centres (10%)[47]. Lastly, fixed networks appear to consume less energy overall than mobile ones. Still according to France Stratégie, mobile networks account for 70% of an access network's power consumption, making them electronic communications networks' greatest source of energy use[48]. These results are no doubt due to some extent to the fact that, contrary to radio equipment, fixed equipment's energy consumption depends relatively little on the amount of traffic they are relaying[49].

Compared to networks, devices account for 81% of digital technology's GHG footprint in France, most of which can be attributed to their production stage (and thus very often occuring abroad). Of this eqiupment, televisions alone represent close to a quarter of the total emissions linked to devices, compared to 13% for smartphones[50]. These results appear to be tied in particular to screen size: the bigger the television the larger its resulting carbon footprint[51]. Because of the tremendous number and variety of devices found in homes and businesses, each being used for different tasks and involving different players, it is difficult to obtain a more precise assessment.

Lastly, data centres also have a substantial carbon footprint, and are responsible for around 14% of digital technology's GHG emissions in France[52]. These data centres have managed to optimise some of their systems and drastically reduce their energy consumption over the past several, and so to limit their direct GHG emissions.
A substantial portion of these improvements have been to data centres' cooling and air conditioning systems' consumption[53] which, according to a recent study[54], have enabled them to keep electricity consumption growth at 6% between 2010 and 2018, even though their computing power has more than quintupled. Data centre operators' ability to sustain this rate of improvement in future remains uncertain, however, and the European Commission is expecting their electric energy consumption to rise by 28% between now and 2030[55].

As indicated earlier, **GHG footprint** is a crucial issue, particularly with respect to climate change, but it is **not the only consequence** of digital technology's environmental impact. As mentioned above, GreenIT.fr has underscored digital technology's other external effects on the environment. The report from Senate task force on digital technology's environmental footprint recalled this fact as well, and points to the dominant role that devices play in this area. They are estimated to represent "75% of the resources consumed, and 83% of the water consumed"[56] by the sector worldwide. According to

46, 47 and 48. France Stratégie, *Controlling digital technology's consumption: technological progress will not suffice,* October 2020.
49. Arcep, *Future Networks - Digital technology's carbon footprint,* October 2019.
50. The remainder of the emissions generated by devices is shared between laptop computers (14%), desktop computers (10%), internet routers and set-top boxess (12%), displays (11%) and other connected objects. Citizing, *Digital technology's carbon footprint in France: are public policies enough to handle the rise in usage?,* June 2020.
51. ADEME, *Modelling and evaluating the environmental impact of consumer electronics goods and services,* September 2018.
52. Citizing, *Digital technology's carbon footprint in France: are public policies enough to handle increasing usage?* June 2020.
53. A data centre's energy efficiency is mesured by its PUE (*Power usage effectiveness*) which is the ratio between the total energy used and the energy required by the computer equipment. This means that reducing the cooling and air conditioning systems' power consumption made it possible to decrease the total energy required by the computer equipment, as the most effecient data centres' PUE dropped from 2 to 1.1 in only a few years.
54. Masanet E., Shehabi A., Lei N., Smith S., Koomey J., *Recalibrating global data center energy-use estimates.* Science. 367. 984-986, 2020.
55. European Commission, *Energy-efficient Cloud Computing Technologies and Policies for an Eco-friendly Cloud Market,* 2020.

a White Paper authored by Iddri, FING, WWF France and GreenIT.fr[57], mobile phone production requires 60 different precious metals, of which only some 20 are recyclables, and 32 kg of raw material is needed to produce a single two-gramme electronic chip[58].

More and more studies are being done on the sector's environmental footprint. They may sometimes diverge in their exact estimates, which is largely due to their underlying hypotheses. However, all **agree on the trends at work, and on the sector's order of magnitude,** even if a certain lack of analysis of sources of the environmental footprint (consumption of scarce resources, for instance) other than GHG is becoming apparent.

These studies have enabled civil society and public policymakers to gain an awareness of the environmental issues and challenges raised by the digital sector. To pave the way for efficient government action, and to create the right incentives for economic stakeholders and users, **it would seem vital to complete this information with detailed figures,** to have a more granular view of the situation. This supposes defining harmonised analytical methods and standardised collection processes, to be able to then identiy, implement and eavluate all of the actions that might need to be deployed.

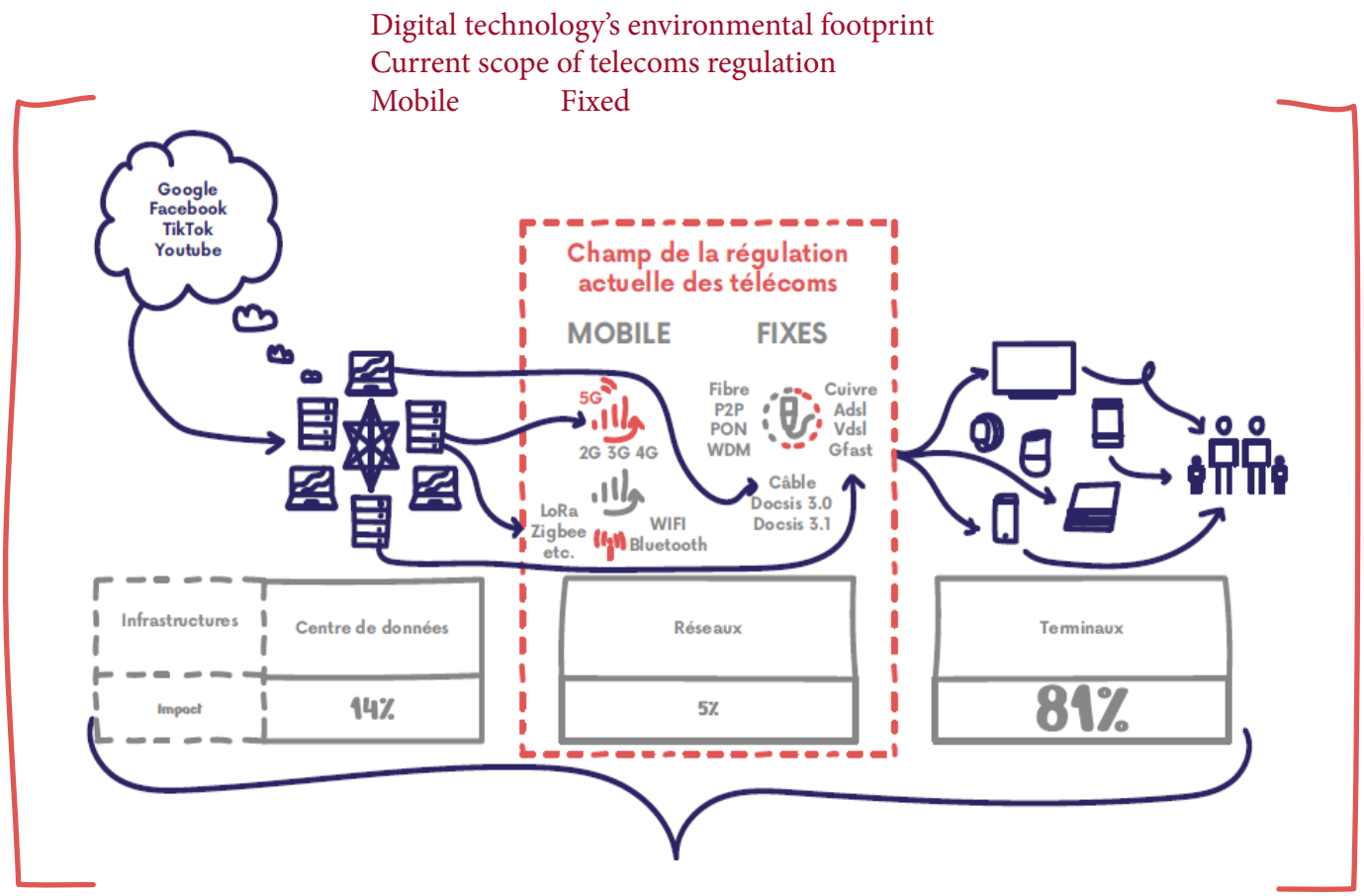


Figure 5. Breakdown of digital technology's environmental footprint in France on the internet access chain

56. French S*enate, Task Force report - Achieving a green digital transition June 2020. NB: these figures are tken from the GreenIT.fr report, Digital technology's environmental footprint mondial,* 2019.
57. Iddri, FING, WWF France, GreenIT.fr, *White Paper – Digital and the environment, How the digital transition can accelerate the green transition,* 2018.
58. Williams E., *The 1.7 Kilogram Microchip: Energy and Material Use in the Production of Semiconductor Devices,* United Nations University, 2002.

1.2 Developing a method for analysing digital technology's environmental footprint

One method for analysing digital technology's environmental footprint could be to **develop accurate measurement methodologies** (1.2.1) based on an **approach that must be coordinated** between the players (1.2.2).

1.2.1 Establishing more precise measurement methodologies

As noted above, a host of studies on digital technology's environmental footprint have been published over the past two years, which has provided a consolidated view of the trends and orders of magnitude, particularly with respect to carbon footprint. Looking beyond this macro perspective, it seems necessary to develop a more detailed view, and to define precise measurement methodologies to obtain a more granular assessment, to then be able to determine the right levers for action and evaluate their implementation. In this part, after having set forth the reasons for putting such an evaluation system into place, we will analyse the obstacles that need to be removed to achieve this.

> Divergent assessments

If all of the existing studies indicate similar trends, and all agree that digital technology's environmental footprint is growing, because of a lack of more precise data, they necessarily rely on sometimes different underlying hypotheses and scopes of analysis.

The Shift Project[59], for instance, provides an estimated breakdown of digital technology's GHG footprint between the different players as follows: 19% from data centres, 16% from the network and 65% from devices, whereas the Citizing report[60] breaks it down as 14%, 5%, and 81%, respectively. This **difference in the estimates is no doubt due to geographical scope:** the Shift Project's study is a global analysis while the Citizing report analyses the situation in France. This disparity in the scale of analysis leads to a disparate assessment of the findings, and notably the role played by the networks, in addition to providing a good illustration of the need for granular analyses.

Disparities in estimates can also be due to methodological choices. The Economic Council (CGE)[61] obtains a national estimate of digital technology's carbon footprint of 11 million tonnes of CO_2 equivalent (tCO_2eq) in 2018, compared to 15 million tCO_2eq in 2019 for the Citizing study. The two studies do not diverge in the conclusions that must be drawn, but the more than 30% disparity in the carbon footprint is concerning. To this point, each of the studies includes different hypotheses that may well influence their estimates. The Citizing study appears to cover a broader overall scope (factoring in networks' and data centres' production stage, a larger array of connected objects, etc.) whereas the CGE concludes, for instance, a much higher carbon intensity per KWh: 81 gCO_2/KWh compared to 57.1 gCO_2/KWh for Citizing.

59. The Shift Project, Lean ICT: *achieving digital sobriety*, October 2018.
60. Citizing, *Digital technology's carbon footprint in France: are public policies enough to handle increasing usage?* June 2020.
61. CGE, *Making digital technology more energy efficient* December 2019.

This lack of common and shared methodology, which is due in part to a lack of available data, forces the players to establish a certain number of personal hypotheses, which makes it difficult to compare their results. **It would therefore seem useful, first, to have common methodologies whose hypotheses and basic scope and scale are shared by all of the players and, second, to make the data needed to apply these methodologies readily available.**

> Lingering speculation

Certain questions appear not to have found a clear, or at least more detailed answer. To give an example: fixed networks appear to consume less energy than mobile ones (see above). Some players have nevertheless brought some nuance to that observation. The Senate report states that "mobile networks will become more energy efficient than fixed, wireline and Wi-Fi networks by 2034".[62] It therefore seems vital for all of the players to come together to clearly define identical methodologies, so that everyone is using the same indicators.

By the same token, the rebound effect[63], which is regularly cited when talking about digital technology, is today still poorly evaluated and few studies tackle its main determinants, and which levers to use to minimise it. To recall, the rebound effect[64] refers to a situation in which a technological innovation helps to improve a given application's energy efficiency, which should in theory reduce this application's total environmental impact, but in actual fact drive an increased use of this application such that – all things being equal – the expected gains are reduced or cancelled out by the resulting overall increase in usage.

> Building metrics

If there are numerous studies that use a variety of data and indicators based on a different set of hypotheses, in an attempt to characterise digital technology's carbon footprint, some topics are still hard to process due to a lack of recognised common metrics. How to record digital technology's environmental consequences, particularly beyond its carbon footprint? What needs to be counted and how to count it? How to develop the right methodologies, to measure both an individual footprint and an entire sector's footprint, while avoiding double counting? **The work done by Négaoctet[65] on the application of Article 13 of the law on combatting waste and promoting the circular economy[66] (the AGEC Act) and ADEME's "Perfecto" project"[67] are two notable steps forward** in this area, in that they develop a system for assessing the environmental impact of digital services (cf. *infra*). As this is a complex task, defining these metrics will be an unavoidably lengthy yet indispensable step in the process.

The challenges lie as much in determining the environmental criteria as the stages in the examined products' and services' life-cycle. For instance, *Power usage effectiveness* (PUE)[68] – which is the ratio between the facility's total energy use and how much energy is used to power its computer equipment – only measures a data centres' energy efficiency when operating. In other words, it does not include the previous or subsequent stages (namely production and recycling) and does not create the ability to assess a datacentre's efficiency relative to the computing power and storage capabilities it provides (as it is only a ratio for measuring the power allocated to its cooling and its air conditioning). Here, a life-cycle assessment (LCA)[69] should be able to offer some solutions, even if not all of the questions it poses have yet been answered.

62. Citizing, *Digital technology's carbon footprint in France: are public policies enough to handle increasing usage?* June 2020.
63. See Glossary.
64. The rebound effectwas laid out for the first time by W. Stanley Jevons ("The Jevons Paradox" cf. W. Stanley Jevons, *The Coal Question; An Inquiry Concerning the Progress of the Nation, and the Probable Exhaustion of Our Coal Mines*, 1865.)) and later updated by economists Daniel Khazzoom and Leonard Brookes ("The Khazzoom-Brookes postulate" cf. Saunders, Harry D, *The Khazzoom-Brookes postulate and neoclassical growth. The Energy Journal.* 13 (4): 131–148,,1992). The paradox lies in the fact that any development of an application or a technology that improves an activity's energy efficiency must, a priori, involve a reduction of this activity's overall energy impact. However, as Jevons observed in 1865, that overall coal consumption increased in England after the introduction of the steam engine, despite the latter being more energy efficient. Watt's innovations made coal a more profitable source of energy, driving more widespread use of his steam engine in manufacturing, which in turn drove up overall coal consumption.
65. NegaOctet is a research project devoted to developing and testing a standardised system for assessing the environmental impact of digital services using a life-cycle assessment (LCA) approach, with a view to achieving ecodesigns.
66. Act No. 2020-105 of 10 February2020 on combatting waste and promoting the circular economy
67. "The PERFECTO 2020 call for research, development and innovation (RDI) projects seeks to enable the emergence of more eco-friendly products, goods, services and processes, thanks to the adoption of ecodesign and/or changes to a company's business model", ADEME. https://appelsaprojects.ademe.fr/aap/PERFECTO2019-120
68. See Glossary.

> Mobilising data

Certain data appear crucial to building these indicators. Although some data already exist, they are not sufficient. *Product Category Rules* (PCR)[70], for instance, which are used to prepare a given product's or family of prducts' environmental statement, and so to evalute the different environmental impacts, are too often unavailable. Moreover, when they are supplied, they are typically not up to date, and do not necessarily represent the latest developments, as the pace of innovation in the sector is tremendously fast. The aforementioned Négaoctet project is working on establishing PCR for digital services.

In some cases, it is the information systems that make it impossible to relay this type of data. For instance, electronic communications operators in France today appear unable to provide information on the amount of data traffic generated per user on their fixed networks (even though they are able to measure the total volume of fixed network traffic), contrary to mobile networks.

Naturally there needs to be a tradeoff between seeking exhaustive data and the efforts to be made on the processes and infrastructures used to collect these data. And these data can always be supplemented, depending on the goals set for the indicators they serve, hypotheses that all of the stakeholders will have agreed upon.

Today, there appear to be several crucial steps to take, to achieve this goal:

- **indexing useful data** (that are already available or not) by drawing on existing work[71] if possible, and identifying opportunities to make these data accessible (obligation of publication, collection from government agencies, anonymisation to protect trade secrecy...);
- **relying on common definitions** to ensure consensus on certain data;
- **defining operational indicators,** obtained through a tradeoff between precision and ease of mesurement, taking into account consensual data made available, and potentially completed by hypotheses on which the players agree.

Work in this area has already begun, with examples that include the joint mission the Government assigned to ADEME and Arcep to quantify digital technology's environmental footprint, and the adoption of Article 13 of the AGEC Act, which aims to index certain data that will be useful for quantifying digital technology's environmental footprint. This type of work will help eradicate several remaining grey areas, and obtain a more granular assessment of the issues and dynamics at work. Decision-making, identifying precise courses of action, and monitoring their implementation will all be faclitated, and so enabling public authorities to take proportionate and effective action. These indicators could also create the ability to individualise measurements, so that every stakeholder can become aware of their footprint (individual users and businesses, manufacturers, etc.).

1.2.2 Coordination is key

Establishing common methodologies for measuring digital technology's environmental footprint and an action plan to curtail its consequences require a coordinated approach.

First, **a great many publications and works have appeared** over the past two years. As mentioned above, certain disparities in the findings – due to different scales of analysis and hypotheses – create uncertainties over their applicability, and the relevant actions to put into place. Which is why collaboration seems key to reaching a point where everyone agrees on the indicators to monitor and the precise methodology underpinning their construction.

Next, **digital technology involves a wide range of players** and so a wide range of expertise, including knowledge of network and data centre engineering, devices, but also, for instance, the development of online services and applications, etc. Each of which requires its own distinct set of complex expertise.

69. Life-cycle assessment (LCA) is a method used to track and quantify the physical material and energy flows associated with human activity at each stage of a product's life-cyle. See Glossary.
70. See Glossary.
71. The findings of the European Commission, *Study on greening cloud computing and electronic communications services and networks: towards climate neutrality by 2050*, will be an important tool here.

Analysing digital technology's environmental footprint therefore requires extensive collaboration between environmental experts and digital technology experts, from across the entire ecosystem and for every stage of the examined products' life cycle (production, usage, end of life/recycling). The dialogue between these different sets of expertise is necessary to building methodologies that are universally recognised, and creating the ability to make a useful contribution to public debate over the kind of society we want to be. Equally essential is to incorporate experience sharing and feedback from stakeholders into this work.

Lastly, in addition the work mentioned earlier on securing access to more data, **modelling will be required** to evaluate digital technology's environmental footprint. These modelling exercises will need to strike a balance between seeking a generic model, simplified to some degree but applicable to all, and an individual model that accurately relfects each player's choices, but is potentially too complex. Only **a coordinated approach** between industry players, researchers and public authorities **will make it possible to achieve this balance,** which will ensure the efficiency of a relatively simple model.

Furthermore, **the digital technology sector's global nature also means that a dialogue needs be developed with players outside our borders,** who influence the environmental footprint created by our usage at home. These stakeholders may be private sector players (electronic device and equipment suppliers, content providers, NGOs and associations, *think thanks*, etc.) or from the public sector (supranational organisations, federal governments, standardisation bodies, sectoral regulators, etc.). This dialogue with international players can also serve to enrich the investigation and decision-making processes. Because local circumstances vary, problems are not necessarily viewed in the same way in every corner of the globe. Dialogue and trading best practices are important tools for comparing situations and fine tuning action plans.

Several positive initiatives in this direction are already underway. **At the international level, the International Telecommunications Union (ITU)** is working in concert with the industry to minimise information and communication technologies' (ICT) carbon footprint, as well as electronic communications' environmental footprint, for instance by drafting international standards (recommendations) in areas as wide ranging as smart cities, data centres and electronic waste (e-waste) management (ITU-T standardisation sector).

The ITU-T Study Group 5 (SG5) "Environment, climate change and circular economy," of which Arcep is a member, is responsible for examining and recommending ways in which the sector can tackle environmental issues, and especially the effects of climate change – in accordance with sustainable development goals (SDGs) – and diminish these effects. This study group also publishes guidelines for eco-friendly ICT use. To give an example, in 2011 ITU published an Overview and general principles of methodologies for assessing the environmental impact of information and communication technologies (ITU-T Recommendation L. 1400[72]) and, in 2019, criteria to be used for the evaluation of the environmental impact of mobile phones (Recommendation ITU-T L.1015[73]). More recently, ITU also drafted Recommendation ITU-T L.1470[74]) which compiles guidelines to align the global ICT sector's GHG emissions with the targets set in the Paris Agreement[75].

It provides detailed trajectories for reducing emissions for mobile network operators, fixed network operators and data centres.

In Europe, in autumn 2020 the European Commission began an examination of the indicators and standards used to study data centres and electronic communications networks[76]. The aim is to inventory and analyse the indicators, analytical methods and standards used to study data centres and networks, and so to assess potential transparency measures. The study findings are expected in late 2021. As indicated earlier, Arcep initiated a process of investigation with its fellow European electronic communications network regulators, and is co-chair of the "Sustainability" Experts Working Group that BEREC launched in 2020.

In France, the national Environment and Energy Management Agency (ADEME), is supporting the, Négaoctet research project to develop a common system for assessing digital services' environmental impact, based on a life-cycle assessment (LCA) approach, with a view to future eco-friendly design[77]. The work being done by this consortium has also benefitted the adoption of Article 13 of the AGEC Act.

ADEME is naturally a key interlocutor, with which Arcep is working closely and hopes to coordinate its actions. This includes the Government mandated joint mission to quantify digital technology's environmental footprint, and publish a report in late 2021.

These initiatives are not exhaustive, and by no means sufficient for tackling the need for a method to measure digital technology's environmental footprint, but they do lay the groundwork on which to continue to build an action plan to curtail digital technology's environmental footprint.

72. https://www.itu.int/ITU-T/recommendations/rec.aspx?rec=11015
73. https://www.itu.int/ITU-T/recommendations/rec.aspx?rec=13719
74. https://www.itu.int/rec/T-REC-L.1470/en
75. The main objective is to keep the average temperature increase below two degrees Celcius, and to try to limit it to 1.5 degrees to reduce the resulting dangers and effects of climate change
76. European Commission, *Study on greening cloud computing and electronic communications services and networks: toward climate neutrality by 2050.*
77. See Glossary.

PART 2 [listen]

DEEPEN UNDERSTANDING THANKS TO COLLABORATION PLATFORM PARTICIPANTS

To better understand and tackle the issues surrounding digital technology's environmental footprint, Arcep wanted to tap into stakeholders' work and knowledge. In other words, to delve into a new ecosystem. After having consulted the studies and government reports, including those cited in Part 1, Arcep felt the need to listen to the many voices of digital and environmental stakeholders. Through bilateral meetings with experts centred around a particular theme, but especially as a way to decompartmentalise debates and gather input from as broad a spectrum of players as possible, by developing a space for dialogue, through the "Achieving digital sustainability" collaborative platform (2.1). To better showcase their positions and proposals, all of the participants were invited to make a written contribution. It is these contributions that lend shape to this second part (2.2).

2.1 Workshops and discussions – Arcep/Ouishare's dialogue-driven approach with digital sustainability stakeholders

As mentioned in the introduction, on 11 June 2020 Arcep launched the "Achieving digital sustainability" collaboration platform, and called on associations, institutions, operators, tech companies and experts interested in the issue of digital technology's environmental footprint to participate in the endeavour. **The aim for the platform was to bring together and provide a forum for dialogue to all of the stakeholders involved in digital techology and environmental issues** (2.1.1). **They met for a series of online encounters** (2.1.2 – 2.1.9) to share their expertise, their views, their practices and their tools, but also their concerns and their questions, and to to fuel a wide-reaching, meaningful dialogue.

2.1.1 Enabling constructive dialogue

> General background

To give shape to these opportunities for dialogue, Arcep organised **a series of workshops on the environmental footprint of electronic communications networks (fixed and mobile), but also that of devices and applications, both essential components in the use of digital technology**. The Authority also created an online space called numeriquesoutenable.arcep.fr which provides written material to keep participants informed and enable them to continue the dialogue throughout the process. The purpose of these written works was to lay out preliminary conclusions and to launch the initial areas of investigation, whose results are presented in this progress report.

To carry out this work, Arcep chose to team up with an outside partner to facilitate the interactions and cultivate the dialogue between stakeholders. Ouishare[78] – a collective that explores and challenges societal transformations through live encounters, studies and concrete experiments[1] – was thus chosen to support Arcep in carrying out this work.

> Work programme

During the inaugural meeting, held on 9 July 2020, sixty five participants who had answered Arcep's invitation together identified the priority issues surrounding digital technology's environmental footprint to be addressed. Key topics emerged and, thanks to this initial feedback, in early **September Arcep was able to schedule a series of five thematic workshops**:

- *Adapting business practices to achieve digital sustainability – 8 September;*
- *Combating obsolescence to achieve digital sustainability – 13 October;*
- *Choosing our networks to achieve digital sustainability – 3 November;*
- *Rethinking digital content and services to achieve digital sustainability – 10 November;*
- *Designing networks to achieve digital sustainability – 24 November.*

78. Ouishare presents itself as "a community, an acclerator of ideas and projects dedicated to the emergence of a collaborative society founded on the principles of openness, collaboration, trust and value sharing".

Prepared jointly by Arcep and Ouishare, each of these workshops was geared to querying and fostering a dialogue amongst participants on several salient questions about the core topic, without claiming to be a thorough investigation.

More cross-cutting and societal issues tackled during the Workshop on 9 July did not address concrete actions but rather more matters of principle, delving into public policy and regulatory choices. As these topics warranted their own forums, **two "Big discussions" were held**:

- *How to achieve both connectivity for all and digital sustainability? – 25 September;*
- *How to safeguard both digital sustainability and user freedoms? – 17 November.*

These "Big discussions" provided an opportunity to identifyy potential areas of conflict between digital sustainability and digital technology's founding principles of regional development and users' freedom, and to articulate the challenge of reconciling the two. To facilitate these disscusions, and to ensure that it would not influence how the topics were addressed, Arcep entrusted Ouishare with the task of organising the exchanges and moderating these sessions.

These were fishbowl disccussions: every participant could jump in whenever they wanted by switching on their camera and joining the speakers' circule. There could never be more than four people in this circle at any one time, and turnover had to be regular. This format creates the ability to sustain a fluid, spontaneous and horizontal dialogue between a large number of participants.

French National Cybersecurity Agency, ANSSI, also took part in the process, responding to Arcep's invitation to participants to host their own workshops on particular topics that could be incorporated into the platform's overall investigative process. This led to the dedicated ANSSI workshop titled: *Cyberthreat, environmental threat, on 25 November.*

These initial events helped kicked off discussions and confirm several courses of action, while also revealing the complexity and many issues surrounding the chosen topics. **Arcep's work on achieving digital sustainability and this dialogue between players is due to continue over the long term**, starting in the coming year.

> Key methods and ingredients for cultivating dialogue

Ouishare helped Arcep to diversify its tools for dialogue and remote work that the current public health crisis demands, and because the need for social distancing makes holding multilateral meetings with a large number of attendees a complex affair. Using open source digital solutions that can store data in France, the fully digital workshops enabled participants to interact in a variety of formats.

Synchronous time

Ouishare brought its experience and its dialogue-structuring methods to nurture constructive debates and foster the emergence of concrete ideas and proposals. During the workshops, participants were able to trade views during plenary sessions and smaller break-out groups. Discussions with a smaller group of people created the ability to delve deeper into certain topics and enjoy more spontaneous talk. Different methods for giving people the floor also helpd to structure the exchanges. Lastly, every workshop was backed by note-taking systems to facilitate the discussions: either with the videoconferencing app's built-in comments tool, or a third-party solution that made it possible to use "Post-it" type tools.

Ouishare's outsider's vision also helped achieve **a good balance between technicity and accessibility when tackling the different subjets, to create a fluid dialogue and a framework of trust between players from very different backgrounds.** On the one hand, the idea of "all experts, all here to learn" was instilled, to put everyone on an equal footing, regardless of background: technical experts, representatives of private sector instituational affairs, community activists, academics, etc. – the goal of mutual enrichment was embraced from the start, and the discussions took place in a constructive and respectful atmosphere.

On the other hand, and as part of a desire to allow everyone to express themselves freely, participants were invited to speak as professionals within their organisation, albeit without their words being taken necessarily as commitments from their organisation.

Asynchronous time

The "Achieving digital sustainability" collaboration platform (numerique-soutenable.arcep.fr) also helped created a sense of continuity between the different events. Over the course of the weeks and months, Arcep provided preparatory documents for the upcoming workshops, which included background information, kick-off questions and a selection of key data. Particpants on the platform could also find information on previous workshops in the form of raw comments, Post-its when available, and screen captures of graphics (included here). Lastly, the courses of action to emerge from the discussions were published afterwards. Arcep wanted everyone to be able to express themselves on this platform, opening up the ability to share content, dive deeper into certain questions, propse supplementary workshops and to create a separate dialogue with other participants.

2.1.2 Workshop No. 1

Adapting business practices to achieve digital sustainability

What issues do services' and devices' marketing and distribution models raise? Service providers, operators, device suppliers, users... What role does each stakeholder play in defining business practices? What impact do devices' purchasing, rental and sharing models have? What advertising strategies and incentives would lead to more mindful consumption?

The topic was addressed in two parts. During the first, "Achieving digital sustainability, which of ICT companies' business practices should be heralded, improved or changed and, above all, why?" participants **indicated that, in their opinion, certain business practices led to a decrease in the lifespan of devices** (around 23 months for smartphones in France) and an increase in the number of devices **(IoT, etc.) in circulation. Participants stressed the need to supervise business practices such as advertising, promotional and customer loyalty practices that decorrelate the price of the device from its market value.** Depending on their sensibilities, proposals ranged from banning these practices to introducing incentive mechanisms for vendors and suppliers (inventorying best practices, for instance). **Transparency and improving the information provided to users were also put forth as additional tools required** to allowing them to maintain a critical view of business practices and to make informed buying choices.

In the second part "What balance should be struck between market models (new or refurbished, sale vs. rental, etc.) for devices (smartphones, ISP routers, connected objects, etc.) ?", **a consensus emerged over the fact that the current model, centred exclusively around buying a new device, had a negative impact on the environment**. Regarding other sales and marketing models: rental, sharing, refurbishing... participants stressed the need to sort through the available offerings, saying that a **consumption model was neither good nor bad per se, and that it is the system as a whole that needs to be virtuous.** For instance, device rental can be an interesting alternative if the end result is creating an incentive not to replace a device too frequently, and if it goes hand in hand with a process of refurbishing the product at the end of its life.

Once this point had been made, participants proposed **shining a light on consumption models inspired by the product-service economy, using financial incentives** (e.g. tax incentives) or **improving the information made available to users. Device sharing through the development of digital homes, or pooling equipment between a building's residents** emerged as possible solutions worth exploring.

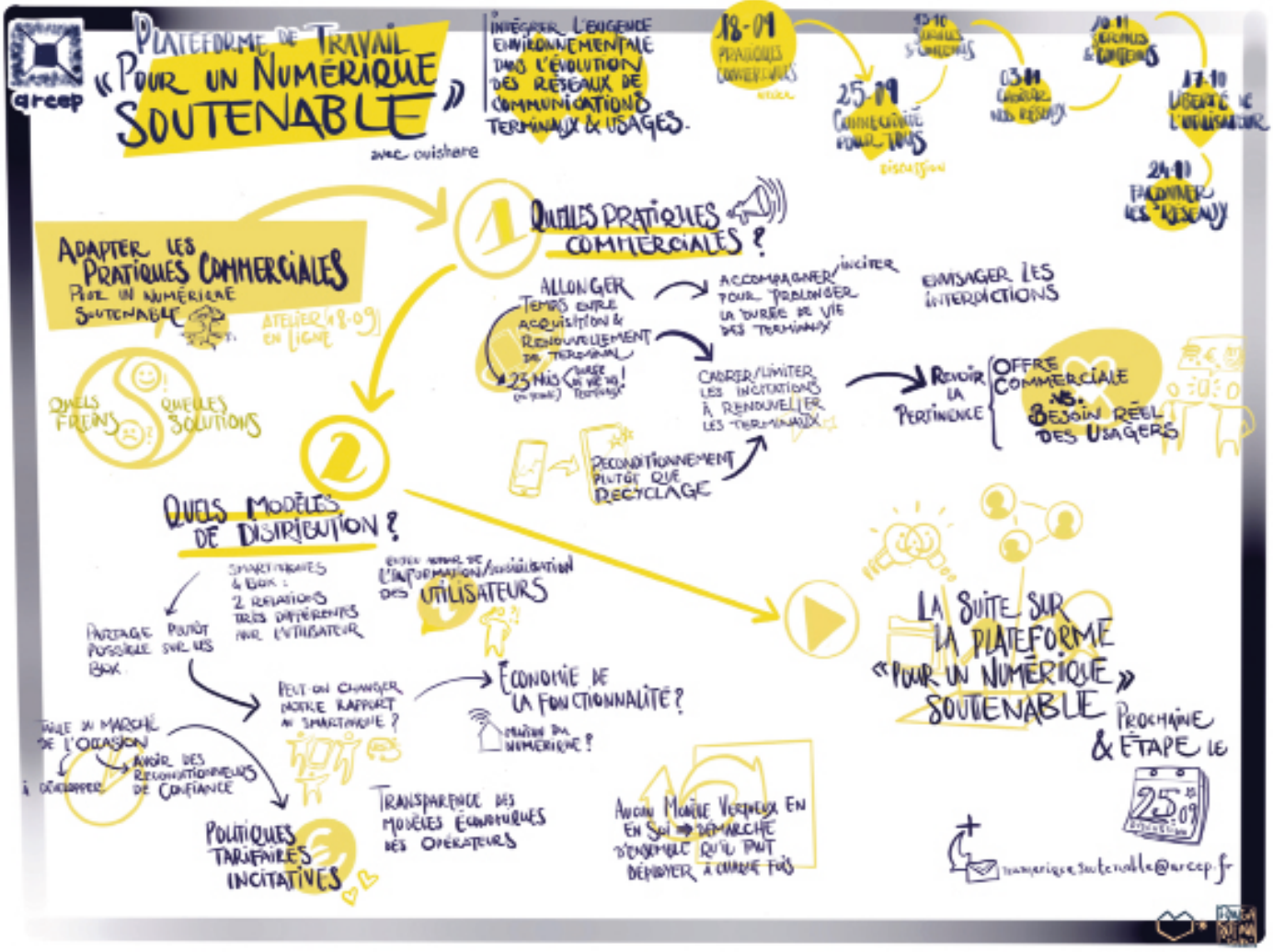


Figure 6: Workshop 1 graphic capture

2.1.3 Workshop No. 2

Combating obsolescence to achieve digital sustainability

Smartphones, ISP routers, connected objects... How to combat the different forms of digital technology obsolescence? And how to target each one? The challenge at hand varies tremendously, depending on whether we are tackling "cultural" obsolescence (fads and fashions, a desire for change, the cult of the new), software obsolescence (the influence of operating systems[79], applying ecodesign to applications and updates), or hardware obsolescence (repairability, recycling, adaptability to future technologies).

The work was broken down into two discussions. The first, "Identifying and targeting the different forms of obsolescence", talk focused on characterising the various kinds of obsolescence and their impact, to be able to then target the obsolescence-related practices that are the most damaging to the environment. During the second discussion **participants were asked to react to a list of recommendations compiled by Arcep teams and taken from government works and reports[80]**. The participants could then supplement these recommendations with some of their own, specify their scope of application, challenge their feasibility, and discuss why there were for or against them. The proposals were as follows:

- Separate corrective updates and upgrades for software and applications;
- Expand the legal scope of planned software obsolescence;
- Create systems to "*name and shame*" obsolescence practices;

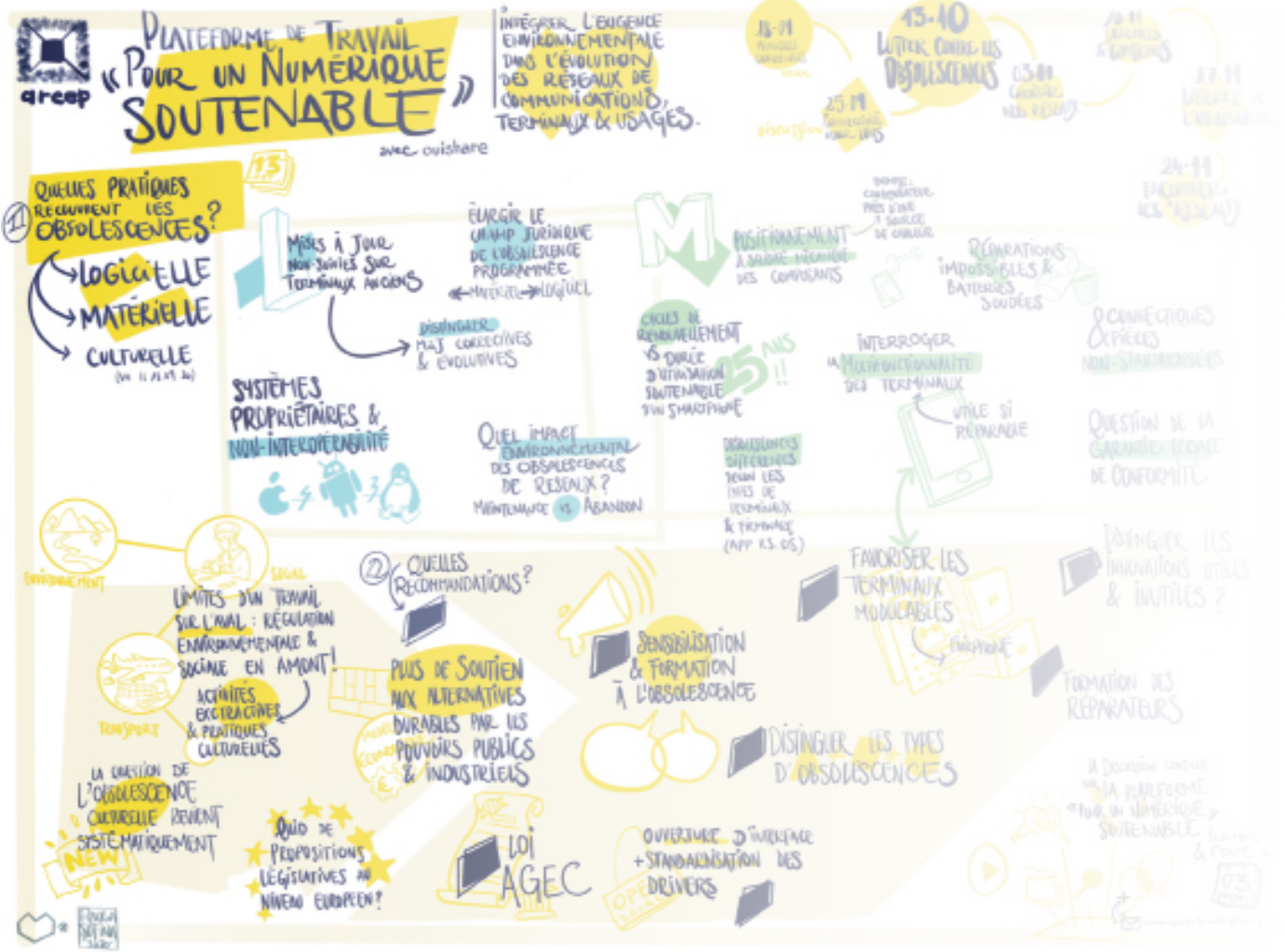


Figure 7: Workshop 2 graphic capture

79. See Glossary.
80. Notably by CNNum, GreenIT.fr and the French Senate.

• Promote repairability and resuse through incentives;
• Question devices' multifunctionality.

This workshop served to underscore the fact that a certain **number of practices remain particularly problematic and undermine efforts to extend devices' life.** Without being the central focus of the workshop (it was addressed more in Workshop 1), **the question of "cultural" obsolescence"** and the social and marketing incentives to replace old devices, and smartphones especially, **was of great interest to participants.**

By stressing the lack of quantified information on consumer behaviour and obsolescence, participants shifted their focus back to **software and hardware obsolescences**. Regarding software, the different players challenged **the actual need for (referring to "software bloat")** and requirements of certain operating system (OS) updates, pointing to the predominance of players like Apple and Google and the lack of alternatives. Regarding **hardware obsolescence, there was a great deal of talk about the notions of repairability and standardising replacement parts (displays, batteries...)**. In a more cross-cutting fashion, some players questioned the potential obsolescence of networks. The **Internet of Things (IoT)** also emerged as an important matter, particularly **the fact that work should be done to anticipate the effects of its development**. As to the proposals, this workshop was in keeping with the first measures deployed under the AGEC Act. **Building consumer awareness and providing training in ecodesign were both seen as crucial.** Lastly, some players advanced **proposals and questions about the "useful or useless" nature** of certain innovations and the possibility of having **modular devices** as part of a more sustainability-driven business model.

2.1.4 Workshop No. 3

Choosing our networks to achieve digital sustainability

When seeking to ensure connectivity, resilience and sobriety, how do fixed and mobile networks and technologies – on the one hand – but also 2G, 3G, 4G and 5G, as well as copper, fibre, cable and satellite systems complement or compete with one another? Are these areas of complementarity and competition opening the way for new ways of thinking, in terms of network shutdowns, switching technologies and replacing equipment bases to reduce the environmental footprint?

The choice was made to focus the workshop on two key issues, through a two-part discussion. During the first part, participants broke into smaller groups to talk about: **"What are the best networks to use at home or at work to reduce one's environmental footprint?"** By discussing use cases and borderline cases, they were then asked during the plenary session to draft three key messages for users and industry players. Debates focused initally on the founding premise, whereby wireline is more economical than Wi-Fi, which is itself more economical than mobile networks. Participants pointed out that **these networks do not play the same roles and are not meant to satisfy the same needs or support the same uses** (fixed access seems better suited than mobile to video streaming at home, for instance). The **coverage area's population density,** along with **the capacity of the devices' OS to switch from one network to another** are also criteria to be taken into account. It was also acknowledged that **fibre networks have proven to be intrinsically more economical than copper ones.**

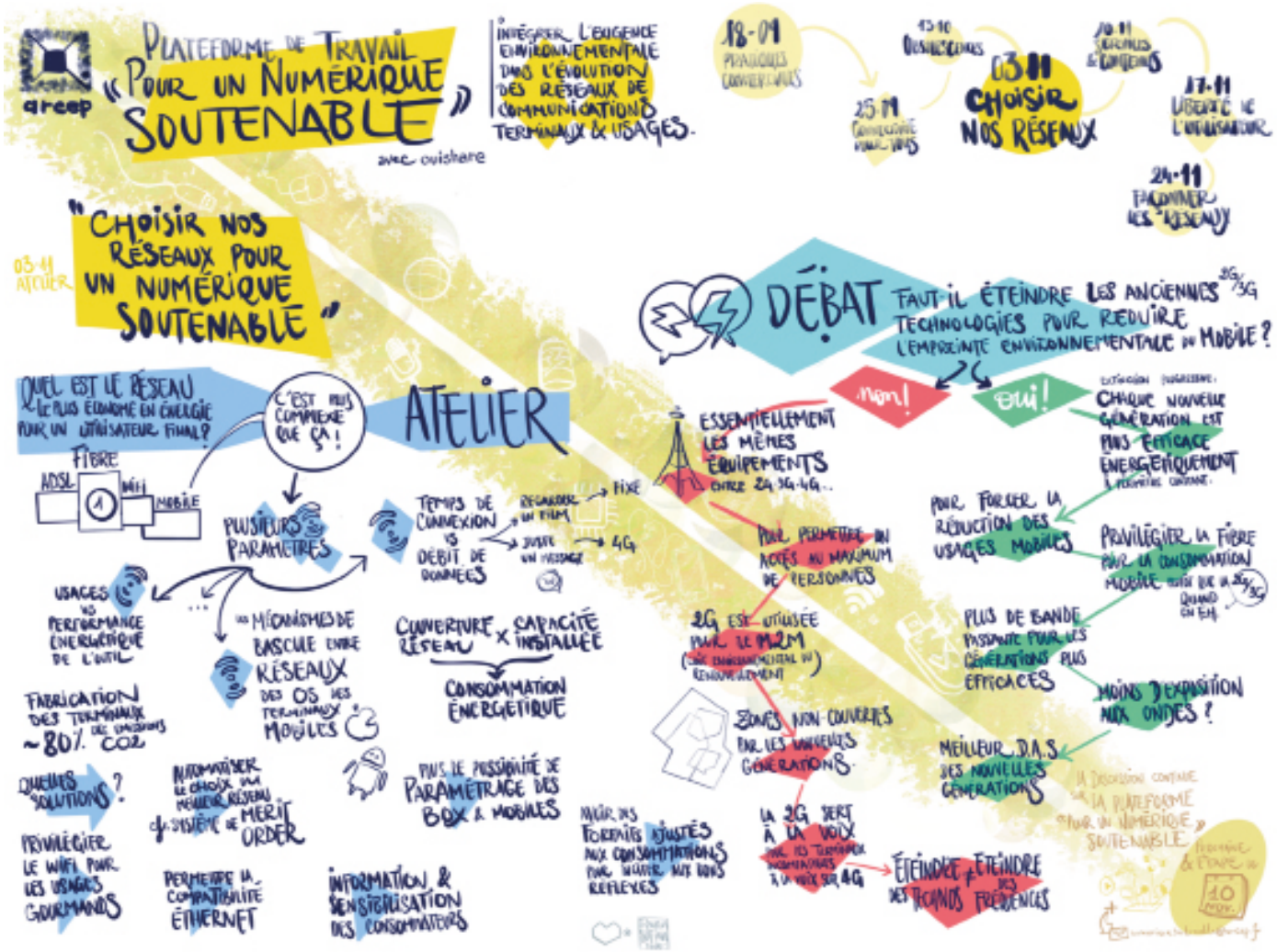


Figure 8: Workshop 3 graphic capture

Several levers and enablers were invoked:

- **raising users' awareness** of each technology's environmental footprint, as a way to encourage more virtuous behaviours, and possibly ban unlimited plans;
- **the central role that manufacturers and operating systems have** in facilitating virtuous behaviours, for instance by:
  - implementing **a smart network handover system** on devices themselves, based on network availability but also on how eco-friendly the application is: a sort of "*merit order*[81]" for usage;
  - **replacing equipment with a wireline connector**, capable of handling a heavier traffic load than Wifi;
  - installing **advanced automatic sleep mechanisms and energy saving tools**, especially on ISP routers and STBs.

In the second half, the question posed was: "***Should old 2G and/or 3G mobile systems be shut down to reduce mobile's environmental footprint?***". The participants, divided randomly into two groups, took part in a game of "for" and "against" phasing out these mobile technologies. The purpose of the exercise was to encourage participants to challenge their existing positions, and tackle this complex question in a more constructive way. Everyone then switched sides in the final ten minutes: the "fors" becoming "against" and vice-versa, giving everyone a chance to voice all of the points to be consid-

81. In the energy industry, the "merit order" refes to the order in which the different sources of electrical energy production are designated to deliver power, based on the cost of producing that energy. The most expensive sources are thus sollicited only during peak demand, when all other sources of production have already been tapped.

ered. The ongoing ambivalence on this topic was reflected in the diversity of the arguments that were made: **it is difficult to estimate the environmental impact of shutting down older generation mobile networks**. Several arguments for phasing out 2G and possibly 3G networks were put forth, and several arguments against were made. **On the pro-shut down side**, arguments included the fact that **newer generation mobile networks are far more energy efficient**: they were designed to provide greater capacity per energy unit, and capitalise on the latest enery-saving improvements to components (better backhaul performance, for instance). The main arguments made **against phaseing out 2G and 3G networks** pertained to hardware and sales: 2G and 3G networks **are still widely used** - whether by M2M devices or telephones that are not compatible with 4G services, and switching off these networks would **render a great deal of hardware obsolete.**

2.1.5 Workshop No. 4

Rethinking digital content and services to achieve digital sustainability

How are services and content relayed over the internet? What implications does this have in terms of ecodesign for websites and software, for instance, for managing and storing data, or digital stream compression strategies? Service providers, operators, displays: do some players already have best practices we can learn from?

Discussions flowed from the preliminary conclusions regarding certain bandwidth-hungry applications (notably video) and so digital content and services' environmental footprint, exploring: "*What scale, what uses, which players?*" warrant being priority targets for action. Participants **recalled the need to include devices' production stage in any assessment of an application's environmental footprint** – which must extend beyond just its **carbon footprint.** They also underscored that this assessment must be projected onto a **scenario that complies with the commmitments made under the Paris Agreement,** in other words a world capable of containing global warming to below 2 degees Celsius. Within this context, they concluded that **tradeoffs would be needed regarding the development of certain usages** or, at the very least, to **optimise services** in such a way as to minimise their environmental footprint. **Ecodesign** must **make it possible to achieve a plateau effect on traffic** and to minimise the amount of data being relayed over the network.

The participants reviewed a host of uses, and particularly video, video games, streaming, e-commerce, virtual reality, augmented reality, social media, and viewing content on a website in general. Questions specific to business and the Internet of Things were touched on only briefly.

Next, the participants broke out into two groups to focus on two major types of digital content: video and video games for one, and websites and social media for the other. The discussions were framed by the following questions: *"What concrete measures can be taken to limit this digital application or service's environmental footprint? What types of player does this concern? How efficient and feasible will these different courses of action be?"*

Several courses of action were put forth, each with its own **set of constraints**: **user awareness/education** along with the limits of their **accountability, adapting the content's resolution to the playback device, the need for closer dialogue between ISPs and content and application providers[82], as well as banning unlimited plans and video autoplay.** Finally, another sample proposal was explored: **implementing ecodesign** and **the greenest design by default** giving users the ability to re-configure their device later. What ultimately emerged was that it was crucial **to work together on examining the purpose of digital technology and of its underlying business models, while protecting users' freedom of choice.**

Figure 9: Workshop 4 graphic capture

82. See Glossary.

2.1.6 Workshop No. 5

Designing networks (architecture, sharing) to achieve digital sustainability

Each network is composed of "pipes" and "equipment" that are designed to make the network as efficient as possible. What traffic-based solutions can minimise environmental impact? Are some network architectures more efficient than others? What gains can we expect from network sharing, distributed networks, small cells and advanced sleep modes?

To tackle the technical themes of this final workshop, Arcep want to take a more educational approach to moderating a debate, and a discussion between experts **on the physical and tactical levers to optimise** networks' environmental impact (in terms of energy and hardware efficiency).

Four solutions were discussed: advanced sleep modes for certain network equipent, fixed and mobile network sharing, *edge computing systems*[83] and *small cells*[84].

After a first briefing during which participants educated themselves on the technologies being discussed, the players were invited to discuss in break-out groups, and later in a plenary session, **the most relevant traffic-based solutions and how to combine the different levers** to achieve more environmentally efficient network architectures.

Participants noted that, for them to result in a meaningful reduction in environmental impact (starting with networks' energy efficiency), implementing the practices and levers listed above required **detailed knowledge of the networks' coverage and the traffic** they relay. Thanks to this knowlege, it will then be possible to **identify the locations where the different levers could actually be applied efficiently** (e.g. deploying small cells in heavy traffic areas, or mobile network sharing in sparsely populated areas). Lastly, participants noted that the extent to which these levers are used also needed to be determined based on **the negative impact they could have on other aspects of the networks' operation,** such as **quality of service**, **the equipment's lifespan** (network sleep modes were discussed with respect to these first two aspects) and **protecting competition that benefits end users** (notably on the matter of sharing mechanisms).

83. Edge/fog computing applies as much to fixed as mobile uses and consists of disseminating data processing equipment close to users, by replacing the "big" centralised data centres with "mini" data centres that process information in local facilities (e.g. at a cell site) and in smaller quantities (since more localised). See Glossary.

84. Small cells are akin to mini low-power, low range (around 100 m) mobile sites. Not widely deployed in France up to now, small cells can be an architectural choice – used to increase mobile networks' local caapcity and/or target traffic clusters (e.g. a metro station exit) in a "surgical" fashion – or deployed in response to a physical constrant (for instance to use low-range high, millemetre wave frequency bands, e.g. 26GHz). The use of small cells, alongside "classic" cell sites, creates the ability to offload traffic from classic cell sites to small cells, and so to activate sleep mode more efficiently and for longer periods of time on small cells with no traffic. The use of small cells also eliminates the need to increase the network's density by installing more "classic" cell sites, which consume more energy than small cells. It would also help to decrease the network's power consumption, while challenging this equipment's negative externalities (increased signalling, hardware and materials consumption...). See Glossary.

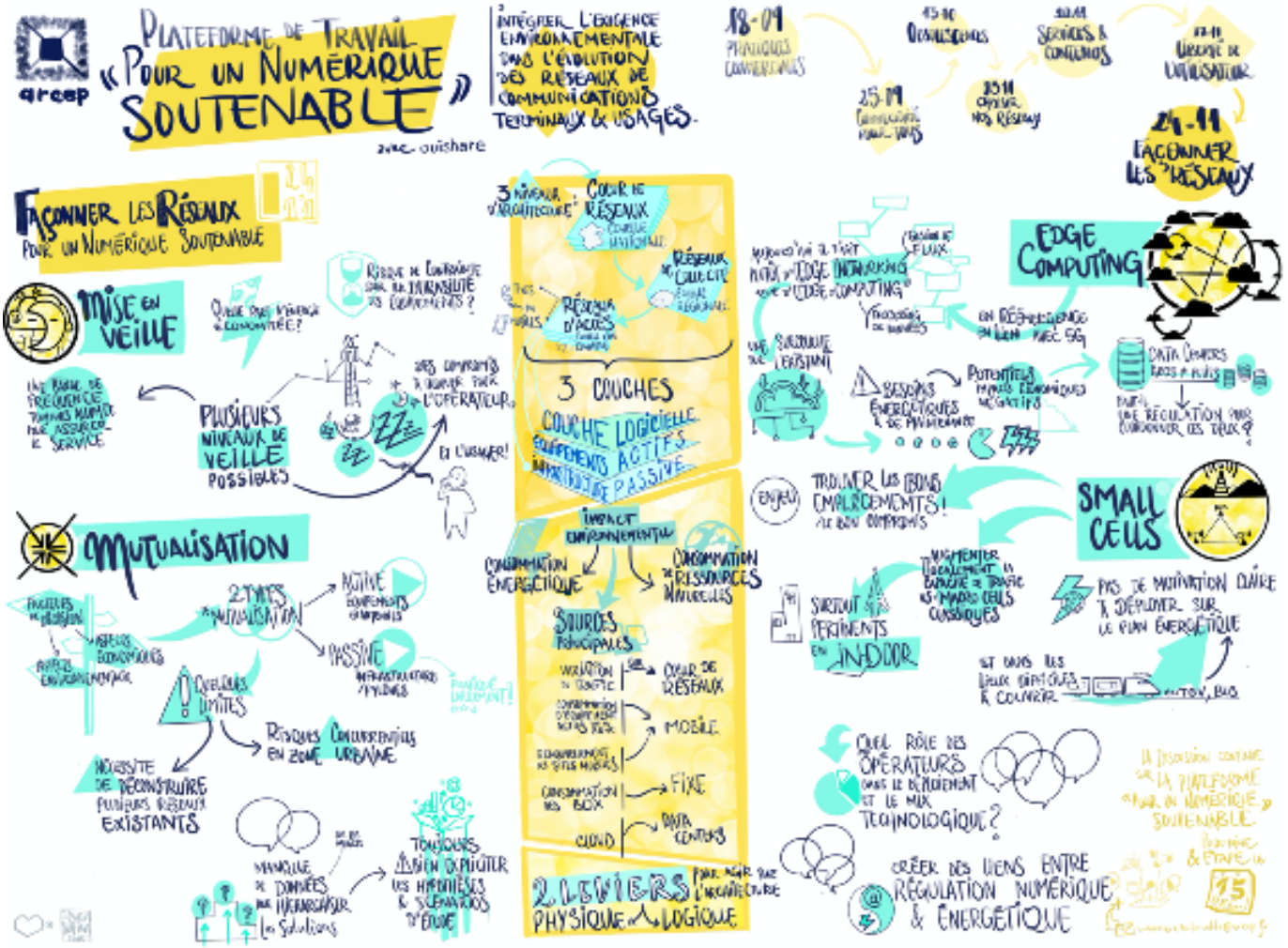


Figure 10: Workshop 5 graphic capture

2.1.7 Big discussion No. 1

How to achieve both connectivity for all and sustainability?

Regional development, connecting white spots and ensuring that everyone has equal access to communication networks are all challenges of public interest. At the same time, the urgency of climate change could lead some to scale back infrastructure deployments. How to reconcile these two imperatives? How to determine which coverage, and which networks, are truly necessary? And for what needs? Who decides and based on what criteria?

This session was structured into two parts. The first was devoted to discussing the following points: "Taking an objective view of connectivity and quality of service requirements. What weight to give to each objective? What rollout criteria and strategies to apply?" The following questions were addressed in the second part: "Are these technical or policy issues? What decision-making process to use? What balance of power between the government, citizens, industry players and the regions or territories?"

During this Big discussion, which had a very free-flowing format, participants lingered on a number of fundamental questions. Some took the opportunity to **stress the fact that digital technology's environmental footprint was growing, and that it had become a pressing issue.**

Figure 11: Big discussion 1 graphic capture

If there was consensus on the first statement, doubts were raised over whether we had sufficient knowledge of the issues at hand and, for instance, the ability to measure "**digital technology's capacity to make other sectors greener"** to set it against the impact of the digital sector itself **("challenge the myth of digital technology's energy efficiency").**

Participants underscored **how vital connectivity** is everywhere in France, which is an integral part of Arcep's responsibilities. They nevertheless stressed the **need to challenge the uses that are made of it, and whether an ever increasing number of connectivity technologies is truly necessary.**

Next – and providing a perfect example of how complex the subject of network rollouts can be (involving temporal, geographic and technical disparities) – they commented on the role and involvement of multiple players. It was mentioned that **elected officials and local authority representatives were under tremendous pressure from** local populations and businesses **to improve connectivity in their area**. **Operators**, meanwhile, need to juggle between what might **seem contradictory coverage and energy-saving demands** (the latter of which has an economic benefit). It was then recalled that these major issues **required proper consumer information** to enable them to become aware of the impact of their usage (buying smartphones, watching videos). This was nevertheless nuanced by the consensus that "**personal responsibility must not supplant Government accountability".** Lastly, some discussions covered the ability of **government action to affect the supply side of the equation, to restrict usage,** which naturally raises still unresolved **political and acceptability issues.**

2.1.8 Big discussion No. 2

How to safegard both digital sustaintability and users' freedoms ?

Today, the principle of an open internet (and net neutrality) gives users the right to access the content and services of their choice. For the sake of digital sustainability, can we define some uses as more useful and others as more futile? How do we decide, and in the name of what? What role do incentives play and are restrictions the right solution? Where does responsibility lie: with industry players or consumers?

Faced with this array of questions, the participants chose to begin by looking at **the impossibility of defining useful vs. useless uses,** pointing out that "what is useless to some may be useful to others". Furthermore, the **architectures of choice** are constructed in such a way that **users often find themselves faced with new technologies, special deals, marketing incentives and social norms that cannot help but influence their desicions and behaviours.** Here again **consumer awareness** emerged as **being important but not sufficient to move the needle.** Stressing that, if growing citizen awareness is real and essential, **government authorities** need to accompany this awakening through **decisive actions,** and potentially by **changing the laws.** Some, however, fear that **supervising every use will lead to a detrimental "standards war".**

The participants also appeared to prefer a more global perspective, querying **enterprises' business models and their accounting parameters.** Some stated that **clear definitions** of what constitutes **an eco-friendly and socially responsible**

Figure 12: Big discussion 2 graphic capture

product or service; while others lamented that here were **still no benchmark variables** that woule enable **private sector players to take concrete and effective action.** Some questions still remain, apparently: **should we work to reduce data consumption? Usage? Or rather more directly target these uses' environmental impact and carbon emissions?**

The aim of these discussions was not to provide precise answers to such broad questions. The participants did nevertheless make some headway on possible solutions such as **training industry professionals** (engineers but also players involved in marketing) to **avoid the *greenwashing trap***. They also suggested **creating an Environmental observatory,** and **analysing forward-looking scenarios** to better anticipate the impact of future innovations.

2.1.9 Partner workshop

Cyberthreat, environmental threat, hosted by ANSSI

The goal of this collaborative workshop was to explore, for the first time, the links between cybersecurity and the environment by tackling the following questions:

Considered a subset of digital activities in terms of its impact on the environment, what role can and must cybersecurity play in creating more envionmentally sustainable digital techology? Does it have any particular properties in this area that warrant examination? How to achieve better control over cybersecurity's environmental impact without giving up on the ever expanding need for security and digital trust?
Beyond that, are there overlaps between the two fields, similar if not shared challenges? What synergies might be found between specialists from the two fields?

The workshop provided an opportunity to identify **several overlaps between the two areas,** even if their backgrounds differ. The first thing to note are the shared concepts and characteristics, **including the notion of risk, of crisis, of ecosystems to protect, and the latters' resilience.** The environment and cybersecurity also raise many of the same challenges, such as developing sustainable digital tech, building a resilient society, beyond digital technology, and the need to persuade decision-makers, especially in the corporate world, that failure to take action today could threaten their business and their business models tomorrow.

Group discussions made it possible to identify several types of environment-related objectives for cybersecurity. The first is to get a better handle on the field's environmental impact. This requires training cybersecurity specialists on these issues, obtaining a detailed analysis of cybersecurity activities' environmental impact, and the combination of secure communications imperatives and environmental ones (e.g. reducing ICT's energy consumption, combatting obsolescence).

The second is to pose the question of **what cybersecurity can do for the environment.** The battle against cybercrime can play an important role in preventing harm to environment, and in securing the technologies used to optimise energy production and consumption. Conversely, it seems equally important to take into account how environmental crises affect cyberthreats, such as the resurgence of malicious acts in cyberspace or threats to equipment's physical safety (e.g. data centres overheating during heatwaves).

Lastly, participants stressed the need to explore synergies between the field of cybersecurity and the Green transition, in particular to promote the emergence of shared approaches to developing secure and sustainable digital technology, and laying the groundwork for cooperation, including technical, on this dual objective.

From a more concrete perspective, and in response to the challenges that were identified, several potential courses of action were proposed:

→ **Highlight the risk-based approach** by taking into account the impact that cyber-threats have on environmental threats, and vice-verse, without diminishing security imperatives.

→ **Educate cybersecurity players and increase their awareness** of environmental issues, first to help create more sober cybersecurity and, second, to ensure that low and green tech are not deprived of a security component.

→ **Initiate a dialogue between public sector players in charge of cybersecurity matters (e.g. ANSSI) and the digital transition (e.g. ADEME).** But also, more broadly, encourage initiatives from all of the players in the cyber and environmental ecosystems, including those with a European and international dimension.

→ **Champion an umbrella concept for shared digital goals, namely "sustainable by design"** which combines the concepts of "secure by design" and curtailing **planned projects' carbon footprint "by design".**

The complete version of the ANSSI summary can be found in the annexes

2.2 Contributions from the ecosystem's players

ADEME
AFNUM
AKTIO
ALTITUDE
AVICCA
BÉATRICE BELLINI
BOUYGUES TELECOM
CGDD
CLCV ILE DE FRANCE
CNNUM
COMMOWN
VINCENT COURBOULAY
COVAGE
CRITEO
CSA
DIGITAL GREEN
ERICSSON
FACEBOOK
FAMILLES RURALES
FABRICE FLIPO
FRANCE URBAINE
FFTELECOMS
FRANCE VILLE DURABLE
GIMELEC
GOOGLE
GREENIT.FR
HADOPI
HALTE À L'OBSOLESCENCE
PROGRAMMEE
LES AUGURES
MÉTROPOLE EUROPÉNNE DE LILLE
NÉGAOCTET
NUMERISAT
OVH CLOUD
QARNOT
GAUTHIER ROUSSILHE
SNCF
TELECOOP
THE SHIFT PROJECT
TIBCO
UFC QUE CHOISIR
VODAFONE
WIFIRST

ADEME

ENVIRONMENT AND ENERGY MANAGEMENT AGENCY

"Having ecodesigned digital services means systematically incorporating environmental considersations when designing and developing products with the aim of reducing their environmental impact throughout their life-cycle, while delivering an equal or superior service. "

ADEME – which is the State operator **shepherding our country's transition to a low-carbon model** – is convinced that the digital revolution can be a powerful lever for meeting the environmental challenges we face today.

Digital technologies, progress in electronics all open up **a host of opportunities,** immense possibilities to move towards sharing, pooling and optimising resources. Resources that are at the very heart of the green transition.

The global population more than doubled over the past 50 years (from 3 billion to 7 billion), while resource consumption nearly quadrupled (from 23 billion to 85 billion tonnes).

The very paradox of the digital transition lies in the fact that it disrupts a host of practices and models, while also remaining stuck in the **productivity-driven and environmentally predatory cutlure that typifies the previous century**.

We need to pave the way for synergies between the two transitions, the digital and the green, as the first cannot be accomplished without the seond.

ADEME believes this requires several courses of action:

→ First, work on deepening our knowledge and **understanding of digital technology's effects**, because we cannot control what we don't understand. Today, our knowledge of the effects that deploying new technologies in terms of energy and resource consumption, and greenhouse gas emissions remains vague and not widely shared. Obtaining a detailed green audit requires an assessment of a product's entire life-cycle, using a multi-criteria approach. ADEME also plans on continuing to work on establishing methodologies for developing knowledge of the environmental impact of digital's different building blocks. This will lay the technical foundation for pursuing the work that has already begun on measuring digital products and services' environmental impact.

→ The second is working on **reducing the environmental footprint**, in particular by developing the **ecodesign** of equipment, processes and recycling systems, and so **extending devices' useful life**.

We now have a Law that sets our country firmly on the path towards a circular economy, with the goal of gradually dissociating economic growth and the consumption of raw materials, thanks to more efficient resource consumption and utilisation.

Having ecodesigned digital services means systematically incorporating environmental considerations when designing and developing products (goods and services, systems) with the aim of reducing their environmental impact throughout their life-cycle, while delivering an equal or superior service.

ADEME is committed to fostering the emergence of highly eco-friendly digital products, goods and services, through the adoption of ecodesign initiatives, using our support mechanisms to help finance enterprises in this area.

Extending the useful life of digital equipment and services is equally important, as 75% of digital technology's environmental impact can be attributed ot the hardware production phase. This also helps fuel the circular economy and so a reduction in the amount of waste produced and the resources consumed, while also avoiding or postponing the purchase of new products. The repair sector in particular can generate new jobs that can only be performed locally, and help increase French people's purchasing power.

ADEME has been working on these issues with all of the stakeholders for several years, and will continue to do so, notably its observational studies, the examination of how prolonging the useful life of digital products affects their environmental impact, along with the work being done on implementing repairability and durability indexes.

→The third path **is to work on behaviours** as, if there are products, there are also users.

We need to educate consumers in the proper use of technologies, and to raise awareness about the consequences of consumption. Questions of over-equipped users, the rate of replacement and combatting waste are thus central challenges in achieving mindful consumption.

Of course another fundamental driving force is using digital services as a potential accelerator of the green transition. The **democratisation** of digital tools opens the way for a host of practices, as do the opportunities they create to put people and business in contact with one another, to access shared data and computing power: every sector benefits from these contributions to the circular economy, mobility, energy production...

We need to be able to measure net environmental gains, between what digital services can offer today and tomorrow, and the effects of their existence and operation.

AFNUM

FRENCH DIGITAL INDUSTRY ALLIANCE

"We support the creation of an Observatory of digital technology's environmental impact, to obtain a snapshot of the current state of affairs, including the gains that digital technology enables in every sector of the economy."

Digital technology is the centre of everyone's attention today, as much because of its ability to be a lever of the Green transition, as its environmental footprint. 2020 saw a surge in the number of initiatives in this area, both in France and at the European level. The workshops hosted for Arcep were therefore a welcome opportunity to engage with all of the stakeholders, to gauge the extent of their knowledge on the subject, and to reaffirm industry players' interest and commitment.

We believe that, to achieve increasingly responsible digital tech, stakeholders first need to reach **consensus on the scope** of the field of endeavour, using **calculation methods and indicators that are common** to all of the players, to obtain **an objective measure of its impact and potential**. To this end, **we support the creation of an Observatory of digital technology's environmental impact, to obtain a snapshot of the current state of affairs, including the gains that digital technology enables in every sector of the economy** (health, agriculture, mobility, industry, smart home, smart building...)

We also need to **make all of the players along the digital technology value chain accountable,** each according to their maturity and potential to improve their practices, drawing on the **existing legal framework**, and through **as much harmonisation at the European level as possible,** to provide businesses with greater clarity and create a more efficient single market. **A differentiated approach based on the type of product and type of market** (B2B, B2C) will be crucial to taking into account specific features and initiatives that are already in place.

In France, the law passed in February 2020 on combatting waste and promoting the circular economy is a major milestone in aligning the digital and green transitiions, and AFNUM is involved in a range of areas (repairability and durability indexes, reuse funds, spare parts, warantees, software updates...). The circular economy action plan and the **European Commission's** New Consumer Agenda will be translated into concrete European laws in 2021, which will also need to be factored in. Generally speaking, we believe it is imperative not **to overlook the support provided by the current legal framework** when thinking about possible courses of action.

Among those levers we perceive as key, we are calling for work to be done on **developing training, education and other skills-building intiatives,** notably in the product repair sector (increasing connectivity in products makes them more complex to repair) and in the ecodesign of services.

The goal, among other things, is to create **more informed users to make them more responsible,** thanks to reliable, verifiable and practical tools, giving them the means to make informed choices and so increase their awareness of the impact of their behaviour. From a more general perspective, fostering **awareness from a very young age** about digital technology and the consequences of using it also seems an essential step.

By the same token**, sustainable government procurement** would provide an opportunity to lead by example, setting out clear and detailed goals, and objective and verifiable criteria, to encourage every player along the digital technology chain to develop best practices.

Digital sustainability will also not happen without **supporting innovation**, which cultivatets the emergence of new tangible and intangible solutions, products and services, which are increaseingly powerful and eco-friendly.

Finally, all of these tools will only be effective with **proper market monitoring,** which is crucial to ensuring that changes to market dynamics and business models occur in a way that protects fair competition and equity between economic stakeholders.

AKTIO

"Clearly, having reliable information on the carbon footprint will not be enough to reduce it: it will above all be sobriety in usage, ecodesign, and the replacement rate for equipment that will make all the difference."

Carbon transparency: key to achieving responsible ICT

Digital technology represents around 4% of global greenhouse gas emissions, a figure that is starting to be widely known, even by the public at large. But the key word here is "around": **estimating this impact is a complex affair because of products' technical complexity**, and the complexity of the value chains, the networks and uses.

If we want to obtain a more accurate assessment of this carbon footprint, for instance to calculate indicators that speak to the general public, the lack of detailed and specific data makes it a difficult exercise:

→ 1 hour of streaming in HD? Between 18 and 400 gCO2eq depending on the studies and the countries...

→ 1 hour on social media? First, we need to know on which sites, using which device, and what form of connectivity (WiFi, Ethernet, xDSL, Fttx, 3G, 4G...)

Every result requires multiple hypotheses, and conflicting figures could well undermine the entire industry's credibility.

Clearly, having reliable information on the carbon footprint will not be enough to reduce it: it will be above all sobriety in usage, ecodesign and the replacement rate for equipment that will make all the difference. However, without this information, it is impossible to rank decision-making priorities effectively, either as consumers or players along the digital technology value chain.

With the **Law in support of the circular economy (AGEC Act)**, telecoms operators will be required to inform their customers of the carbon impact of their usage, starting in January 2022. This is a major step in the right direction, and we have made two proposals, to ensure its proper implementation, and to take it a step further:

1) Make all of the hypotheses and the details of the life-cycle assessment (LCA) of digital products and equipment available to the public

The current regulation makes it possible to obtain a "gross" figure, e.g. "production of an iPhone 12 Pro 128Gb represents 75 kgCO2eq". To be able to fully understand and take effective action on digital technology's impact, all of the calculations made to obtain the result must be publicly available, along with the hypotheses regarding logistics, consumption during the usage and end of life processes and recycling stages. Ideally, this publication would be delivered via APIs to facilitate the emergence of tools that make use of these data.

2) Make it mandatory for digital technology companies – major corporations, mid-size companies and SMEs – to publish their annual carbon audit of all of their direct and indirect emissions, and their associated action plan.

Today, a carbon audit is only mandatory for companies with more than 500 employees, and only every fours years. Extending this obligation to SMEs would enable all of the sector's players to share this benchmark, and making it annual would create the ability to be synchronised with businesses' decision-making processes, notably budgetary ones.

One of the difficulties of the exercise lies in assessing indirect emissions, particularly those generated during downstream transport, sales and usage. Having detailed LCAs and carbon audits on all of the players would remedy this lack of data.

We are fortunate to have large legacy corporations and new fast-growing digital startups who, together, could **drive the entire ecosystem towards greater transparency.**

With **carbon transparency**, consumers and enterprises could, each in their own way, help reduce digital technology's footprint, which is a powerful tool to help decarbonise all of the other sectors. Without carbon transparency, there will be no responsible digital technology, and without that we cannot acheive our green transition!

ALTITUDE

"The discussions revealed the lack of detailed and realiable analyasis of digital consumption, including a life-cycle assessment, and its net contribution to global warming."

Altitude would like to thank Arcep for this opportunity to express ourselves on this important subject that concerns us all, well beyond France's borders.

The Altitude Group shares Arcep's and public authorities' recommendations regarding the effects that global warming has on our way of life, and is committed to fully taking part in efforts to reduce, in particular, digital technology's contribution to greenhouse gas emissions. One of the latest examples of the Group's involvement and commitment: the brand new offices at the Val de Reuil headquarters have solar panels on the roof.

In the same vein, and without giving an exhaustive list, the Altitude Group has taken **a series of actions to reduce its own GHG emissions**:

- → Remplacing our fleet of cars with hybrid or electric vehicles,
- → Optimising technicians' travel time,
- → Ecodesigning our networks,
- → Building our personnel's awareness of environmental issues,
- → Processing work site waste.

The Altitude Group is committed to accelerating the pace of all of its actions over the course of 2021, and has begun hiring staff specifically to achieve this.

The Altitude Group believes that digital technology should not be seen only in terms of its GHG emissions. Its absence or limited availability can contribute to economic and/or social exclusion, while its presence enables the development of innovations and engery savings, and so a reduction in GHG emissions. Here, the Group underscores that **the discussions revealed the lack of detailed and reliable analysis of digital consumption, including a life-cycle assessment, and its net contribution to global warming**. Before the Authority takes any measure that might dimish a potentially beneficial effect of digital technology, these estimates need to be refined to be able to then make informed decisions based on factual, documented and quantified elements.

At the same time, and to mount an immediate response to the climate emergency, the Altitude Group remains at the Authority's disposal to participate in what could be an Experts Working Groups on the environment, to create an opportunity for all of the stakeholders concerned to exchange and define green best practices, to allow the sector to advance together in the right direction. Forums of this kind could help inform the Authority's actions, while awaiting more restrictive measures based on reliable estimates of the net impact of each digital product and service. Here, the Altitude Group notes that discussions focused chiefly on mobile use and applications. It is likely that **actions can also be taken on fixed neworks to reduce GHG emissions**. Non-hardware aspects (e.g. after sales service calls) seem to have been completely overlooked, for instance, even though once FttH networks are fully deployed, they will represent a significant source of the emissions that operators could target.

In conclusion, the Altitude Group invites the Authority to foster awareness and proactive initiatives from the players, while also limiting enforcement measures in those areas where the net effect in terms of GHG emisions is known and the information reliable.

AVICCA

"Avicca [...] naturally wants to take part in any examination of its environmental impact. One concrete manifestation of this desire can be found in the series of partnerships formed with the private sector."

For more than 15 years now, l**ocal authorities** have been authorised to build, operate and market electronic communications networks, primarily in those areas where **private investment is lacking.** At a time when some of them have already managed to deliver optical fibre access to their entire population, others are taking a pragmatic approach of using every available technology, both wireline and wireless, to supply superfast access.

These recognised **regional digital development** actions have focused largely – but not exclusively – on building out infrastructures. As a result, there has been a great deal of feedback on the design, construction, maintenance, interplay... of the networks, but also on their utilisation. Avicca is the national association of cities and local authorities dedicated to helping as many people as possible reap the benefits of digital technology, and so naturally wants to take part in any examination of its **environmental impact**. One concrete manifestation of this desire can be found in the series of **partnerships** formed with the **private sector,** focused specifically on this forward-looking issue.

As vast as it is, this topic needs to be broken down to obtain a clear picture of its **hardware** (networks, technologies, devices...) aspects as much as its **operational** ones (usage, individual and collective behaviours, etc.). The growing literature around this topic is revealing both the **variety** and **complexity** of the effects on the environment, from the consumption of raw materials to energy needs, all of which must be assessed and then measured against the resulting services being provided.

As many questions that create a direct challenge to local authorities' **strategic policies**, but also their organisational methods, and even how they exercise their skills, which is something else that digital technology can change. The work done through the "Achieving digital sustainability" platform created the ability to identify **all of the levers available to local authorities,** to fully capitalise on the pros of digital technology, while also **measuring** its cons.

BÉATRICE BELLINI

LECTURER IN MANAGEMENT SCIENCE, UNIVERSITÉ PARIS NANTERRE

HEAD OF THE POSITIVE BUSINESS CHAIR[85]

"Update management practices (finance, marketing, strategy...) to become more sustainable."

It may seem surprising to be including a piece about management in a report on sustainable digital technology. But the Covid-19 crisis reminded us that sustainability is tied not only to the attention paid to the social and to reducing environmental impacts, but also to organisations' economic viability. In corporate social responsibility (CSR) policies, there is often a tendency to consider social and environmental aspects separately from core business practices. It is nevertheless difficult to develop actions that will harm organisations' economic profitability, and so threaten their future. To be truly efficient, then, an integrative approach seems indispensable. This is the central purpose of the work of our university's Positive Business chair: **to update management practices (finance, marketing, strategy...) to become more sustainable.**

The **business model** is the core and engine of economic ecosystems. It is composed of three main components:

→ The **value proposition** made to the customer;

→ **The value equation** that creates the ability to generate financial profits from the activities;

→ The **value structure** that influences the decision of whether or not to outsource certain functions.

Below, we present two avenues of exploration regarding this business model, which we believe are crucial to achieving a relevant approach to digital sustainability.

→ First, organisations need to shine a light on their positive social and environmental initiatives in their **value proposition,** or when promoting their products and services, as that can translate into economic development by generating revenue. This involves clearly highlighting a social and an environmental quality of the product or service being marketed to the customer, to generate value and justify a responsible price supplement. This marketing approach is also entirely in line with the way the market is going, towards more ecologically responsible positions, driven not only by regulation but also by citizens' expectations. It is essential to train marketing teams in these concepts to gain a competitive edge.

→ The second point concerns **assessing the relevance** of the solutions being marketed, in terms of the resulting decreased impact that stems from commitments to certain targets: the idea of order of magnitude. Because we live in a finite world, the business models that are the most likely to increase organisations' consumption of resources is the product-service system. Often confused with the circular economy, this model is based on the sale of usage and no longer of the product, with the producer maintaining ownership of said product. This in turn generates an incentive to make this product more long lasting but also to reconsider the relationships between the players along the entire chain. The appeal of the model must nevertheless not be penalised by the proliferation of the digital data it involves, which would drive an increase in energy consumption – aka a digital product-service economy. This is a crucial looming issue, given the impact that the digital revolution is having on our way of life.

85. http://positivebusiness.parisnanterre.fr

BOUYGUES TELECOM

"Despite their efforts [...] operators will not be able to both drastically reduce their greenhouse gas emissions and, at the same time, increase their networks' capacity to meet customers' ever growing demands, fuelled in part by society's adoption of more environmnetally sober behaviours, such as telecommuting."

Climate change and the effects it has on our ecosystems represent threats that demand swift and efficient action. At the heart of this response mechanism, digital technology must satisfy a dual requirement. We expect it to be more environmentally sober itself, but also to accelerate the green transition by helping to decarbonise other sectors (Smart Cities, telemedicine, remote learning, Smart Buildings, tele-presence...).

In this regard, it is clear that the question of digital technology's sustainability cannot be assessed in an isolated fashion. It must **include all of the sectors** with which it interacts and overlaps, to be able to **thoroughly** assess ecological gains and costs. It is therefore the entire system that needs to be analysed while weighing, when necessary, how the increase in digital use helps to reduce the overall carbon footprint[86]. This approach is also necessary to **establishing clear trade-offs,** to avoid giving operators contradictory objectives, clumsily juxtaposing sobriety and regional development, or net neutrality and restricting usage.

Despite their efforts, which have resulted, notably, in the introduction of more efficient technologies (FttH vs. xDSL, 5G vs. 4G), **operators will not be able to both drastically reduce their greenhouse gas emissions and, at the same time, increase their networks' capacity to meet customers' ever growing demands, fuelled in part by society's adoption of more environmentally sober behaviours, such as telecommuting[87].**

In truth, solving this equation inevitably goes by way of a **collective effort, shouldered evenly by all of the players** along the chain. It is clear that a policy of sobriety that is applied only to operators cannot be truly efficient, and would have the added effect of aggravating existing imbalances in how regulation is organised[88]. To give an example: it is regrettable that the Law on the circular economy requires only operators to publish information on the greenhouse gas emissions generated by their customers' fixed and mobile network use, and absolves content platforms from doing the same.

But operators do need to do their part. And they have already But operators do need to do their part. And all have begun to do so. Environmental imperative**s are already an integral part of how Bouygues Telecom organises its business.** First, at the network level, Bouygues Telecom applies a policy of reusing equipment and data centres that are no longer being used in their original location. If it cannot be reused, this equipment is resold after having been refurbished and, if they cannot be resold, they are recycled and routed towards specialised chains in Europe.

Next, regarding mobile devices, Bouygues Telecom has been working for ten years with Recommerce, a leading French company specialised in refurbishing hardware. This partnership has created the ability to collect and refurbish a very large number of mobile devices (close to 2 million thus far) from customers. The focus is also on extending the life of devices by offering customers special rates for taking them to WeFix to be repaired. Bouygues Telecom believes that **assessing a smartphone's life-cycle** must not focus only on its life with its initial user, but include its entire life, and so its possible **reuse** by successive owners.

Ultimately, if the digital sector must absolutely work on reducing its environmental impact, the tools that could be deployed to steer these efforts must avoid the **trap of a "silo" approach,** which would ignore the other pieces of the puzzle. This is needed, first, within the sector itself, to ensure a fair distribution of constraints between all of the players. It must also look beyond digital technology, on the one hand to factor in the positive externalities it can have on other sectors' ecological impact and, on the other, not overlook how it can help realise our hopes for society's future organisation.

86. Several analyses are performed today, and there is still very little consensus on the findings. According to the GSMA, 1g of CO2 emitted by the digital sector prevents the emission of 10 g by other sectors. Other studies put this ratio at 1 to 3.

87. If every new technological generation proves more sober than the previous one, per Gb relayed (by a ratio of 1 to 3 between 5G and 4G, according to our observations) the roughtly 40% annual increase in usage inevitably translates into increased energy consumption by our networks

88. Bouygues Telecom cites as an example the Arcep report, "Devices, the weak link in achieving an open internet", February 2018.

COMMISSIONER-GENERAL FOR SUSTAINABLE DEVELOPMENT (CGDD)

MINISTRY FOR THE ECOLOGICAL TRANSITION

"Although recent, awareness of digital technology's environmental impact is indeed growing.

But this impact needs to be better understood, assessed and immediately controlled."

The digital and ecological transitions are two of the greatest challenges of the 21st century. And they must be tackled together.

This convergence is, first, **an opportunity to accelerate the Green transition. This will go by way of more and more widely available open data** that are of environmental value, and their reuse by private and public sector players and associations. This will also require the better, and **fully transparent,** mobilisation of artificial intelligence in every aspect of the transition: from more sober use of even our decarbonised energy, to optimising our traffic flows, reducing the cost and increasing the efficiency of home renovations, working to achieve more efficient production of biodiversity...

But this convergence must also be **consistent with our planet's limitations,** keeping temperature increases to 1.5°C above what they were before the industrial era, and safeguarding biodiversity. Digital technology's very development has an environmental impact, and its growth trajectory has overshot France's overall growth trajectory, both in terms of CO2, of abiotic resource exhaustion, and pressure on fresh water use. For instance, digital technology's CO2 emissions have increased by around 450 million tonnes in the OECD since 2013, whereas global emissions have decreased by 250MtCO2eq. **Although recent, awareness of digital technology's environmental impact is indeed growing. But this impact needs to be better understood, assessed and immediately controlled**.

France's Ministry for the Ecological Transition supports the development of **digital technology that is environmentally sober and responsible,** and this at every stage of its life-cycle, taking into account the provisions of the Law on Energy and Climate (with a target of being carbon neutral by 2050) and the AGEC Act (durability index, information on greenhouse gas effects of our data consumption, combatting planned obsolescence...). Its departments will remain committed to meeting upcoming digital challenges, to ensure deployment that is consistent with our environmental imperatives.

Lastly, in its role as economic actor, the Ministry for the Ecological Transition is working with its partners (DINUM, DGE, DAE...) to curtail digital technology's environmental impact and to support R&D and projects in this area. Following through on the presentation of inter-ministerial roadmap on 8 October 2020, by the Ministers for the Economy and Finance and the Recovery, for the Ecological Transition and Digital Technology; a new inter-ministerial roadmap is currently being finalised.

CLCV ILE DE FRANCE

CONSUMPTION HOUSING QUALITY OF LIFE

"CLCV wants to see a return to the principle of sobriety, by examining the right way to achieve it, through reduced energy consumption and a circular economy."

5G no doubt marks a turning point in digital technology's development, and will drive a significant improvement in ultra high-speed mobile networks.

As we strive for energy sobriety and the sobriety of electromagnetic waves, however, CLCV notes that **not a single scientific study** is available on digital technology's impact in this area.

Despite which, reducing energy consumption is by far one of the main levers for increased action on climate change.

Very little study has also been done on the consumption of natural resources for **equipment production.** The transition to 5G will require consumers to buy a new compatible device and to get rid of their current one, which is not consistent with the notion of a circular economy that CLCV supports. Creating new connected objects further contributes to the exhaustion of non-renewable resources.

The deployment of 5G should have been preceded by such studies, but instead the priority has been on deploying additional antennae and marketing new smartphones.

By the same token, there is a dire lack of data on the **health impact** of the frequency bands used for 5G. Which is why CLCV wants to see continual monitoring of 5G's potential impact on health, and particularly the still little known long-term effects.

If the industry's **constant pressure** on consumers creates a new need out of whole cloth, which efficient **marketing** will persuade a large swath of people they cannot do without, the improvements ushered in by 5G – increased speed, device density and lower latency – do not open the way to significant innovation potential for consumers, like they do in the B2B market.

Consumers may well bear the brunt of the guilt for increased data consumption and its environmental consequences.

Lastly, the battle against the digital divide appears to have been relegated to the back burner, at a time when public health crises have made this divide even more difficult to accept. 5G seems to aggravate the situation on a local level even further.

CLCV wants to see a return to the principle of sobriety, by examining the right way to achieve it, through reduced energy consumption and a circular economy, and rules for recovering incompatible devices, as part of quantified objectives imposed on operators.

CNNum

NATIONAL DIGITAL COUNCIL

"To achieve digital sobriety and eco-friendly digital technology, our entire economic system and way of life will need to change."

France's National Digital Council – an independent advisory board responsible for advising the Government on digital technology – is honoured to have been able to contribute to Arcep's work on digital technology and the environment.

In response to a **referral** from the Minister for the Ecological and Inclusive Transition, and the Secretary of State for Digital Affairs, the National Digital Council, in partnership with the High Council on Climate, published a **roadmap on the environment and digital technology last July**[88]. This roadmap contains **50 proposals**, established in concert with more than fifty stakeholders, including Arcep, all committed to achieving more sober and more eco-friendly digital technology, which will help further an inclusive ecological transition. This roadmap has three strands, which echo the three parts of the Arcep report: "Think – Listen – Act":

→ Strand 1: adopting **digital sobriety** as a guiding principle to reduce digital technology's environmental footprint, and reaching net-zero greenhouse gas emissions by 2030, with no offsets and 100% ecodesigned digital goods and services;

→ Strand 2: **leveraging digital technology to achieve an inclusive green transitio**n to give it meaning, capitalising on its assets to reach sustainable development targets, and reduce greenhouse gas emissions substantially between now and 2040, thanks to these very technologies, and to reconcile high-tech and low-tech to achieve the major objectives of the inclusive ecological transition;

→ Strand 3: using the tools and levers for achieving **responsible digital tech**, whose aim is to cultivate that responsible digital tech to achieve sustainable objectives by 2022, create a toolkit for taking cross-cutting actions to realise a convergence between the ecological and digital transitions.

Like Arcep, the Council believes that **data** play an important role in regulation, as they help to inform citizens and regulators alike. The Council thus supplemented this roadmap with an opinion on environmental data of general interest[89] in which it is proposed that environmental data be considered of general interest and therefore constitute a building block in the ecological and inclusive transition.

Between now and the end of the year, the Government is expected to publish an inter-ministerial action plan on digital technology and the environment[90]. An action plan from the European Union is also on the wishlist, as the digital and green transitions are among the Commission's top priorities. **To achieve digital sobriety and eco-friendly digital technology, our entire economic system and way of life will need to change**.

89. National Digital Council, *Roadmap for the environment and digital technology - 50 measures for a national and European responsible technology agenda: achieving digital sobriety for a successful ecological and inclusive transition and meeting sustainable development objectives.* Report submited to the Minister for the Ecological and Inclusive Transition, and the Secretary of State ofr Digital Affairs, July 2020. https://cnnumerique.fr/environment_numerique.

90. National Digital Council, Making environmental data pubilc interest data, Opinion submitted to the Minister for the Ecological and Inclusive Transition, and the Secretary of State ofr Digital Affairs, July 2020. https://cnnumerique.fr/environment_numerique.

91. Announced in October 2020 by Barbara Pompili, Minister for the Ecological Transition, Bruno Le Maire, Minister for the Economy and Finance and the Economic Recovery,, and Cédric O, Secretary of State for Digital Affairs, responsible for the digital and electronic communications transition, during a symposium on "Digital and the Environment: let's merge the transitions". This interministerial strategy is expected to include three courses of action: better understand digital tech's environmental footprint, reduce digital technology's environmental footprint, and make digital technology an engine of the green transition. For more information on the symposium on "Digital and the Environment: let's merge the transitions" held on 8 October 2020. https://www.ecologie.gouv.fr/colloque-numerique-et-environment-faisons-converger-transitions.

COMMOWN

COOPERATIVE FOR RESPONSIBLE ELECTRONICS

"Innovation efforts in the coming years should be geared to low-tech, open source and open hardware."

The aim of our cooperative (SCIC) is to **curb every obsolescence mechanism**. To this end, we choose sustainably designed devices like the Fairphone, and we adopt a business model based on usage rather than ownership. This is how we maintain control over our devices for as long as possible, and have a vested interest in their longevity. Whenever the opportunity arises, we advocate for community interests. Our actions are typically based on several driving forces:

1) Questioning these needs

It is crucial that we question the need for each new innovation, in this time of climate emergency! Let us recall that we are on a path to +7°C by 2100, and there is real cause for alarm over the exhaustion or production peaks for a host of non-renewable resources in the coming decades[92] [93] [94]. We need to challenge "new" use cases for 5G, and for digital technology in general, by asking one simple question: do we really need this technology? We must focus only on **digital technology's essential uses**: those that enable us to **become more resilient.**

Do we really need:

→ Smart CCTV cameras[95]? NO.

→ To be able to sleep at the wheel of an autonomous car? NO.

→ To have drones capable of operating beyond the line of sight[96] ? NO.

→ To protect a means of accessing information in a horizontal fashion? YES.

→ To connect people to one another through sober communication tools? YES.

2) Think sober

Regardless of the chosen trajectory for reducing CO2 emissions, our society will need to **learn to do less with fewer resources**[97]. So requiring 5G rollouts from operators by basing auction prices on future traffic increases, while kicking off a dialogue on "digital sustainability" is schizophrenic to say the least. On the contrary, **innovation efforts in the coming years must be geared to low-tech, open source and open hardware, to create a resilient, decentralised and sober** network infrastructure and devices.

It is worth wondering whether we really need to have several parallel network infrastructures. A single public operator or with the status of an SCIC could guarantee that it is operating in the collective interest, and would create the ability to share resources.

3) Bring public interest back to the fore:

To be truly in line with Arcep's slogan, networks must be able to develop while being mindful of the commons (resources, biosphere...). A **common good should be managed democratically**. But the government buried the moratorium on 5G proposed by the CCC, and so completely discredited the "democratic" approach of this consultation process.

4) Break with "consumer awareness" strategies:

In terms of dialogue, new consumer awareness measures will no doubt emerge from this work. The consumer has been fingered by environmental policies as being the chiefly culprit, either directly or indirectly, for a good many years. **Deflecting accountability** in this way makes it impossible to take truly **game-changing** measures that are equal to the issues we are facing today. A repairability index is a recent demonstration of this bias. It is unrealistic to think that having clear information is enough to alter demand and influence production methods (rapidly). **Drastic regulation of** digital product **advertising**, extending **manufacturer warrantees on electronics to five years**, and **standardising replacement parts** to ensure their **interoperability/backwards compatibility:** here are some examples of eco-responsible measures.

92. https://www.lemonde.fr/blog/petrole/2019/02/04/pic-petrolier-probable-dici-a-2025-according to-lagence-internationale-de-lenergie/
93. https://www.lefigaro.fr/sector/high-tech/2018/02/21/32001-20180221ARTFIG00227-redoutant-une-penurie-de-cobalt-apple-veut-traiter-en-direct-avec-les-mineurs.php
94. https://www.liberation.fr/france/2019/09/17/7-c-en-2100-coup-de-chaud-sur-le-rechauffement_1751963
95. https://www.gartner.com/en/newsroom/press-releases/2019-10-17-gartner-predicts-outdoor-surveillance-cameras-will-be
96. https://droneii.com/drones-and-5g-improving-drone-connectivity
97. https://www.bl-evolution.com/publication/comment-saligner-sur-une-trajectoire-compatible-avec-les-15c/

VINCENT COURBOULAY

PROFESSOR-RESEARCHER AT THE UNIVERSITÉ OF THE ROCHELLE

"We are entering into a time of action, an era where entreaties are no longer enough for citizens, decision-makers and entpreneurs."

Measure before you leap

I won't reiterate digital technology's social and environmental effects. Nor will I reiterate the benefits of deploying a digital society. Others have done so before me, and it would take more than this contribution to summarise it all. So what? **We are entering into a time of action, an era where entreaties are no longer enough for citizens, decision-makers and entrepreneurs.** I recommend the institutional organisation of a voluntary process that would enable us to establish an urgently needed framework for thinking about, establishing policies and taking action to promote ethical technology. A structured five-pronged approach: Understand->Measure->Prevent->Reduce->Offset. After more than 10 years of striving, through a selfless act like the one led by France's Institute for Responsible Technologies (ITR), we have at last managed to make people understand why digital technology is a Pharmakon, both poison and remedy, as described by Jacques Derrida and Bernard Stiegler.

So let's look now to **measurement.** Because, yes, we must measure before we leap; it is the very springboard to action. I am always surprised to see people heading down the carbon neutrality path before even knowing how much greenhouse gases they emit annually, or how much a gas-powered car emits over one kilometre. We often hear people hide behind phrases like, "it depends on the car". Which Is true in theory, of course, but this search for the exact figure inhibits action, especially since we know that the margin of error when it comes to digital technology is susbstantial. So let us forego this search for perfection, which serves no real purpose and may even provide a justification for inaction by delaying a commitment to move forward. Let us work together, seriously and scientifically, to determine the overriding trends and average values.

This work of reaching factual and quantified consensus on measurements requires an **active organisation** of post secondary education, by research and commitment from the government and players like ARCEP and ADEME to create the framework and carry it over to the European level, with backing from the societal and scientific powers that be. This can only be a positive thing for France. Once these data on the effects of digital technology exist, we must also ensure that they are viewed unquestionably as being of **general interest** and accessible to everyone. This prerequisite is the only one likely to shape the subsequent stages in our organisations of prevention and reduction of digital technology's negative effects, to focus almost exclusively on the leverage it can provide, without betraying users' **trust** or obfuscating any pollution transfers.

This is a tremendous challenge, no doubt the greatest challenge that awaits us in the coming year.

COVAGE[98]

"Covage chose to make an eco-friendly and responsible approach central to its operations, fuelled by the awareness that digital industry players have a major role to play."

Because fibre is more energy-efficient than the copper it replaces, every customer switching from the legacy copper network to our networks is helping to save energy. Fibre also enables better infrastructure sharing by connecting smart territories' mobile sites and connected objects?

One year ago, **Covage chose to make an eco-friendly and responsible approach central to its operations, fuelled by the awareness that digital industry players have a major role to play.**

To give everyone the ability to measure the impact of their different behaviours, and because it is important to know where we are starting from, an estimated **audit** of our CO2 emissions in 2019 was established based on four areas (transport, waste, water and energy consumption, deployment) and was monitored on a quarterly basis by an Environmental Steering Committee.

Which elements were monitored?

→ The transport section identified the CO2 emitted by each form of transportation used for Covage's operations. Two indicators also provide the ability to track the percentage of people who use public transport, and telecommuting days.

→ The waste section assessed our consumption of paper, disposable cups and unused optical fibre cable scraps from deployments.

→ The water and energy section supervises our water consumption and the energy bill for our heating, working and providing services to our customers.

→ The deployment section traces our emissions resulting from transporting materials (chiefly optical fibre cables) and our sub-contractors' activities. This section will thus be shut down once our networks have been fully deployed.

What have the figures revealed?

→ Deployment is the main source of our CO2 emissions: accounting for 62% of our total emissions.

→ Providing services to our activated customers is the second largest source of emissions for Covage, resulting from network equipment's energy consumption.

→ Transport is the number three source of emissions. Cars remain the biggest contributors, accounting for just over two tonnes of CO2 a year per employee.

What actions were taken in 2020?

→ Reducing our main sources of emissions: an in-house car pooling platform, acquiring hybrid vehicles, increased processing of construction site waste.

→ Even before the Covid-19 crisis, our employees were eligible for two days of remote working a week, and had access to videoconferencing installations in 21 sites across France.

→ Sharing best practices: an environmental charter, building climate change awareness with the Climate Fresco, local initiatives by members of staff.

→ Supporting social inclusion initiatives by donating computer hardware to refugee assistance associations, funding projects that offset our incompressible carbon emissions, etc.

Covage welcomes the process that Arcep has instigated to work together on achieving digital sustainability, and salutes the innovation of its open and richly diverse collaborative platform.

98. Since its creation in 2006, Covage has been deploying and operating optical fibre networks for residential users, businesses and local authorities, and thereby contributing to regional development and to companies' digital transformation.

CRITEO [99]

"Reducing data centres' environmental footprint will be achieved more by introducing a certain number of incentives that will enable every digital industry player to adopt more virtuous behaviours."

Our proposals for reducing software obsolescence:

Software obsolescence is often tied to the close interaction between software and hardware. For instance, a system's BIOS and firmware are key to servers' day-to-day maintenance , with two types of limitation: 1) intentional software locks (tied to components certification), and 2) unintentional software locks (tied to disparities between the firmware's or BIOS capacities' and the capacities of a more recent component).

For us, open source is the right path to solving software obsolescence, and we encourage lawmakers to consider implementing a system of having software patents enter into the public domain after a certain period of time, and so making them open source.

→ **SOLUTION #1**: We recommend a period of proprietary software maintenance and upgrade of five years, after which all of the software's components must become open source.

→ **SOLUTION #2**: To combat software obsolescence by promoting reuse, we recommend recognising a network of approved repairers, using a system of certification.

Our proposals for reducing data centres' environmental footprint:

As both tenant and end user of data centre providers, we believe it is important to stress that data centres' energy consumption represents only a fraction of their total footprint. Most of a data centre's carbon footprint is tied to the manufacture of the computer servers they house. According to ITRenew (The financial & sustainability case for circularity, Ali Fenn &Florian Fesch, April 2020) 77% of a server's carbon footprint is tied to its production stage, also referred to as its pre-operational stage. Twenty two percent of CO2 emissions come from their energy consumption during their operational stage (lasting an estimated 3-4 years) and only 1% of CO2 emissions are generated post-usage.

For us**, reducing data centres' environmental footprint will be achieved more by introducing a certain number of incentives that will enable every digital industry player to adopt more virtuous behaviour:**

→ **SOLUTION #1**: Rewarding eco-friendly data centres through a system of green certification (here, we include a PDF that lists the different environmental responsibility criteria used by Criteo during calls to tender for datacentre suppliers);

→ **SOLUTION #2**: Use regulation to promote open source systems, to foster equipment's repairability;

→ **SOLUTION #3**: Create tax incentives designed to prolong the length of computer hardware's use and amortisation period (e.g. lower or eradicate VAT on sales of second-hand equipment).

99. Criteo is a global technology company that provides reliable and relevant advertisements to marketing specialists around the world. The 2,700 members of Criteo's team work with more than 20,000 publishers and content providers around the gobe to deliver effectively targeted advertising on every channel by applying advanced machine learning techniques, drawing from unparalled datasets. Criteo gives companies of all sizes the technology they need to better understand and serve their customers. To find out more: www.criteo.com

CSA

FRENCH BROADCASTING AUTHORITY

"Online video represents 1% of global greenhouse gas emissions, in other words equal to those of a country like Spain."

From the production to the consumption of audiovisual or radio programmes, the **audiovisual sector's environmental impact i**s an issue that France's Broadcasting Authority, the Conseil supérieur de l'audiovisuel, is committed to addressing.

Individual TV viewing time today stands at 3 hours 30 minutes[100] a day, while 40.9 million[101] people in France listen to the radio every day. Added to these figures, which testify to French people's strong and renewed interest in audiovisual media since the start of the Covid-19 crisis, is the significant **rise in the consumption of audiovisual content on the internet**. Video streaming accounts for 60% of global internet traffic, a trend that is being fuelled by the development of ultrafast access networks, and the equally steady rise in the number of connected devices in the home: in the first half of 2020, 86% of French households had a computer and 77% of people ages 11 and up had a smartphone. In 2020, people in France watched an average 6.6 hours of online video a week, which is 8.1% more than in 2019[102].

Online **video represents 1% of global greenhouse gas emissions, or the equivalent of those of a country like Spain,** with 300 million tonnes of CO2 emitted each year, and this at a time when digital technology's energy consumption is rising by 9% [103] per annum.

This commitment can only accelerate, and several levers for action have already been identified, with a view to taking action, on the onz hand, in concert with all of the sector's stakeholders and, on the other, with consumers, as audiovisual networks provide a formidable tool for disseminating information and cultivating citizens' awareness.

Work has also begun as part of the Arcep-CSA Pôdigital technology, a forum for dialogue and joint action between the institutions. With the support of ADEME, the two authorities are committed to this dual objective of investigating the audiovisual sector's environmental impact, notably those of its broadcasting and content distribution components, and participating in building public **awareness.** To this end, the joint division will soon be publishing a scorecard on digital technology usage, which will **help foster a better understanding of uses and their impact.**

These projects are the first steps in a work programme that will grow and develop over time.

100. Mediametrie TV in 2019 – The new innovative media challenges, 2020.
101. Mediametrie survey of 126,000 Radio stations - Radio audience in France in September – October 2020.
102. "State of Online Video 2020" report Limelight Networks, 2020.
103. "Climate: the unsustainable use of online video" estimates from French research collective, the Shift Project, 2019.

DIGITAL GREEN

"One of the problems with digital technology lies in design issues, and specifically ecodesign."

Even between the different players at GreenIT.fr there is debate over digital technology's impact.

But the battle remains the same, whether it be over hardware pollution or energy efficiency. **One of the problems with digital technology lies in design issues, and specifically ecodesign.**

If most of the measures being taken today towards digital technology's green transition are focused on infrastructures and devices, it is crucial to take the **different uses** into account to begin a reduction of the entire ecosystem, and this includes data use and transfers on our devices.

As designers of digital services and content, we need to be aware of the environmental and social impact of our virtual productions. This encompasses, on the one hand, **digital technology's graphic aspects**, which requires thousands of **lines of code** for every new transcription of a visual interface and a multitude of exchanges between infrastructures and devices.

This process generates increasingly energy-hungry data transfer and pushes our devices to their maximum performance, to display sometimes superficial and especially optimisable content.

On the other hand, in addition to interface issues we also need to think about the use cases for digital tools, information access paths, the quality of the content on offer and data collection.

So it is the very nature of digital products that needs to be challenged, as much in a bid to achieve greater energy efficiency when browsing, but also to restore users' trust and define more eco-responsible **digital sovereignty.**

With the emergence of 5G networks and IoT (connected objects) the number of data being hosted and transferred will climb significantly.

We have to begin now to think about the internet's energy future, by making content creators and interface designers, as well as website and application developers, more accountable for the impact of their projects, for each one to act at their own level, to build a less polluting, more inclusive and sustainable digital world.

ERICSSON

"It would be strange, to say the least, to refuse innovation because of uncertainties over certain potential indirect consequences. [...] Avoidance through inaction is no better a solution than marching ahead, oblivious to the dangers."

Ericsson would like to thank ARCEP for launching its "Achieving digital sustainability" collaboration platform. We believe it goes a long way to enriching the current debate, and deepening our shared knowledge of this issues and possible courses of action. There are four dimensions that seem particularly vital to these discussions, and no doubt warrant being explored further still in upcoming debates.

First is undoubtedly **digital technology's global energy impact**. Before even formulating any recommendations or solutions to be put into place, we need to clarify what we mean by digital technology's impact on the environment. We need to recognise that there can be sizeable disparities here. Indeed, our studies show that digital technology's carbon footprint has been relatively stable for around ten years, whereas other sources indicate that it is growing by 8-9% a year. Without a greater consensus here, any subsequent action will invariably be complicated.

That being said, we are not denying how important this issue is, nor how urgent it is to take action, but that action needs to be efficient. Which brings us to the second dimension which pertains specifically to the **environmental impact of different uses and of different technologies**. These are also tricky aspects as their respective effects are often hard to analyse: assessing the impact of streaming on consumption is not immediate since most of the energy consumed by the networks is a fixed quantity and not based on traffic. A mobile network consumes less per subscriber, but fixed networks are more efficient per bit of relayed data. Wi-Fi is often viewed as an attractive solution, but a Wi-Fi router is rarely switched off at night (and the more devices and appliances we connect to it in the home, like heating and security cameras, the less we will want to switch it off, even at night or when we are away...). A mobile network provides the ability to access applications while on the move, and so becoming a part of our daily lives, and provides cheaper coverage in rural and remote areas.

We also need to think about how to **deploy 5G networks**, while not increasing the networks' consumption, and even by **reducing these networks' carbon footprint,** which is a commitment being made more and more by the ecosystem's different players. This naturally goes by way of 5G technology, which is ten times more efficient than 4G, but also by a broader examination of networks' architecture, introducing sleep functions and capping consumption, and by using artificial intelligence to help manage the networks.

The final dimension pertains to **the beneficial effects that 5G can have in other sectors,** but also the rebound effects of 5G deployment. We believe that 5G will usher in a host of gains, but it is equally clear that some of the gains in efficiency brought by 5G can pave the way for new uses to develop, whose impact will far outweigh any of the benefits generated by 5G. Which is why we feel it would be strange, to say the least, to refuse technological innovation because of uncertainties over certain potential indirect consequences. And, here, let us be clear, that avoidance through inaction is no better a solution than marching ahead, oblivious to the dangers. The only solution is to move forward, to view 5G as a tool that must serve our needs as well as possible, to estimate the possible rebound effects and to consider actions to eliminate or curtail them in an iterative fashion.

FACEBOOK

"We can confirm that technology is a positive force in making the world a greener place, notably by educating users through initiatives like Facebook's Climate Science Information Center, progress in using AI to optimise energy consumption, but also by simply limiting the need to travel thanks to remote working solutions."

According to the International Energy Agency[104], digital technologies currently represent around 1.5% of all carbon emissions worldwide.

At Facebook, we are striving to **minimise our ecological footprint**, to guarantee safe, healthy and fair working conditions for workers along our supply chain, and to join forces with others to design and share **solutions for combatting climate change.** Back in 2011, Facebook became one of the first tech companies to commit to using **100% renewable energy** to power its installations, a goal that we will have reached by the end of 2020. We have also set ourselves a target of reaching **net-zero carbon emission**s for our entire value chain by 2030.

Today, thanks to technological progress, data centres around the world only consume around 1% of all electricity, even though internet traffic has tripled since 2015 and data centres' workload – a measure of demand for services – have more than doubled[105].

As for online services, **progress has been especially remarkable for video and messaging.** At Facebook, we developed our own video compression solution and use an adaptive bitrate technology to optimise a video's resolution based on the user's device and connection. We automatically reduce video quality for inadvertent use, and disable certain functions when a user's device is almost out of charge. These measures help to reduce battery use and, for example, enable a feature like autoplay to now be very energy efficient. As to messaging services, the latest version of Messenger, for instance, starts up twice as fast and is a quarter of the size of its predecessor, using less energy and less storage space.

During Arcep's workshops, it was recalled that the main source of digital services' ecological footprint is devices' production and distribution, and not their use or the operation of the networks used to supply services[106].

The initiatives aimed at creating sustainable digital services should focus above all on these challenges, where there is the greatest potential to reduce the carbon footprint. Members of the public should also be better informed of the entire lifecyle footprint of the products they buy.

In truth, we can confirm that technology is a positive force in making the world a greener place, notably by educating users through initiatives like Facebook's Climate Science Information Centre, progress in using AI to optimise energy consumption, but also by simply limiting the need to travel thanks to remote working solutions. As the European Commissioner for the Internal Market, Thierry Breton, said: "improved broadband connectivity [...] will allow us to connect more objects and process more data to understand better our energy consumption and cut emissions in other sectors by 15%".

Conclusion and Recommendations:

→ *The best way to reduce digital services' carbon footprint is to concentrate on the **main sources of pollution**: the production and recycling of devices.*

→ *There is no direct link between limiting the volumes of data and the development of more sustainable digital services.*

→ *On the contrary, digital services are an integral part of the **EU strategy** to reduce the global carbon footprint.*

104. 105. George Kamiya, AIE, "The Carbon footprint of streaming videos: fact-checking the headlines", 25 March 2020. https://www.iea.org/commentaries/the-carbon-footprint-of-streaming-video-fact-checking-the-headlines

106. As pointed out in this statement from Mr Cédric O, France's Secretary of State for the Digital Transition and Electronic Communications, regarding the digital transformation and environmental issues, on 8 October 2020: "We often focus on bandwidth consumption and its energy externalites. This overlooks the fact that 80% of digital technology's environmental footprint is due to the neverending replacement of devices and their impact nont only on rare earths and metals, but also the pollution they cause." https://www.vie-publique.fr/discours/276627-cdric-o-08102020-economie-numerique

FAMILLES RURALES[107]

"Sustainable digital tech above all means inclusive digital tech. We expect our government and public authorities to meet their commitment to provide everyone with a connection of at least 8 Mbps, as promised under the national broadband and superfast broadband scheme."

The Covid-19 crisis revealed just how much digital technology is at the heart of our everyday habits, our education system, the way we work, but also in creating and maintaining social ties. It also shed light on the scale of the **digital divide** and the resulting **inequalities.**

Even though a great many **rural areas** do not have efficient broadband access, and are still not eligible for fibre, 5G is being deployed, boasting of a tenfold increase in already available speeds.

Networks, content, uses and consumption are all bound to develop. Every digital sector player and stakeholder therefore has a tremendous responsibility to deliver sustainable digital solutions, that are mindful of people and of the environment, and capable of meeting the needs of a modern society.

It is in this context that Familles Rurales is alerting and calling on all of the sector's players to act responsibly:

Because sustainable digital tech above all means inclusive digital tech, we expect our government and public authorities to meet their commitment to provide everyone in the country with a connection of at least 8 Mbps, as promised under the national broadband and superfast broadband scheme. The Covid-19 crisis provided a painful reminder of the lack of high quality ADSL, depriving families from remote working, remote learning and even the ability to do their grocery shopping online during the lockdown.

This situation derives from having given operators the freedom to set 128kbits to 512kbits, at best, as the minimum threshold for broadband.

Familles Rurales is asking public policymakers:

→ To set a **legal or regulatory definition** for fixed broadband as a minimum 8 Mbps,

→ To implement a **carbon index** that enables consumers to become aware of their ecological footprint,

→ To introduce an **education plan on digital sobriety** and usage regulation that would be entrusted to approved consumer protection associations.

It is imperative that operators adopt fair and responsible processes and practices that are consistent with their CSR commitments.

5G rollouts are only just beginning, and it will take several years before most people have access to it. Despite which, there are already a growing number of adverts inviting consumers to subscribe to new 5G plans and replace their old devices, which can be misleading.

Here, we believe that transparency and honest information on actual coverage are vital to avoid misleading consumers, and in helping them make informed choices and be partners in digital sustainability.

Familles Rurales is asking operators and manufacturers:

→ **To inform** consumers on actual coverage, based on objective, measured data regarding connection speeds,

→ To implement every measure necessary to radically **extend the life** of digital equipment,

→ To ensure the **backwards compatibility** of the various equipment and standards,

→ To **finance** an education plan on digital sobriety and usage regulation.

Content publishers and providers, and advertisers also have a significant share of responsibility when it comes to digital technology's environmental impact.

Familles Rurales is asking content publishers and providers:

→ To use sober data **storage** technologies and practices,

→ To keep users **informed** by applying the carbon index to content,

→ To help finance digital sobriety awareness and education actions by paying a digital sustainability tax.

107. Familles rurale (Rural families) www.famillesrurales.org is a not for profit Association under the law of 1901, a recognised public-interest organisation, authorised and accredited in the following areas:
- Famillies
- Consumption - Education - Youth - Leisure
- Tourism - Community life - Training
- Health

FABRICE FLIPO

PHILOSOPHER, TEACHER AT IMT-BS AND RESARCHER AT LCSP UNIVERSITÉ DE PARIS.

"The real emergency concerns data sobriety then. [...] The idea of a carbon tax at the border has been mentioned: why not a tax on data?"

Digital sobriety = imperative

We must achieve **carboon neutrality** within 30 years (2050). Today's 20-year olds will be 50 by that time. It is widely acknowledged that digital technology is on the wrong trajectory: it is the sector whose emissions are increasing the fastest. Up until now, we had been betting that the phenomenal progress in energy efficiency would offset the **explosion in data traffic** – which drives all the rest: devices, networks, data centres etc. Once again, it appears that data is outpacing progress.

The real emergency concerns data, then. Despite which, the **Digital Agenda** is taking the opposite tack: everywhere, data is seen as the new "black gold", to be produced in ever increasing quantities (autonomous cars, 5G, 8K etc.). The issue is more that these deposits must remain underground, like some fossil fuel. And that the most data-hungry applications must never see the light of day. Of course, this poses a major economic problem, akin to disinvestment from fossil fuel. But herein lies the core issue of digital sobriety. It is too easily confused with win-win measures, generating both financial and energy savings. But these financial gains typically open the way for a reboud effect: added leeway used to consume more not less. So the ecological footprint is not reduced, but only shifts. That the most data-hungry applications never see the light of day also poses sovereignty issues that are not unsolvable.

The idea of a carbon tax at the border has been mentioned: why not a tax on data? 5G phones should thus be heavily taxed, unlike Nokia 2G ones; the same goes for OS that are unecessarily cumbersome or have options designed to increase consumption, or video (games) with ever increasing resolution.

Such a **law** would perhaps pave the way for more data-sober projects, such as those that use no digital data at all. Our work also suggests the importance of updating the architectures of choice.

Under the pretence of freedom, ill-informed and atomised consumers fall prey to the great seductive powers of the **promoters of product and services**, using well-honed techniques. A certain balance needs to be restored. We propose,for instance that products and services that are marketed on a large scale, such as 5G and 8K smartphones, be subject to a prior **forward-looking scenario** that would be made public: requiring the marketers to demonstrate the ways in which their sales strategy makes the world a better place, making their case to a panel of informed citizens or NGOs, in a fully transparent fashion.

FRANCE URBAINE

"As the architects of digital and green transitions, major cities and metropolitan areas have a powerful voice in responsible and sustainable technology discussions."

2020 had a clear leitmotif: "the **Covid-19 crisis** provided a powerful reminder of which activities are underpinned by digital technology". Forging relationships with users, maintaining and ensuring the continuity of public services, health, education, short circuits, supporting and providing visibility to local businesses: digital technology has never been more solicited. Even though it has been making deeper inroads into our daily lives over the past several years, the events of this past year have shown that digital technology has become a virtually essential part of our society.

Among its many attributes, digital technology involves strong environmental considerations, tied to the explosion of digital usage, the proliferation of digital equipment and the profusion of data. Here, vast areas of exploration are opening up, allowing us to work together on defining the engines of digital sustainability. Urban areas have a powerful voice in this process, backed by their expertise and responsibilities, but also by all of their existing digital uses and services. This avenue is one of the mainstays of local governments' roadmaps, as evidenced by large cities' and metropolitan areas' proactive stance and policies.

This thinking process also coincides with a core institutional through-line of **"territorialisation"** when implementing the recovery plan, and more broadly when drafting public policies. The creation of local digital governance will eventually enable fairer and more efficient regional penetration of digital technology which, in addition to the local authorities' voice, will federate the voices of the federal government, Europe, local businesses, representatives of civil society... As a tool to help in decision-making, it will be useful in steering priority actions, and identifying possible sources of financing, while alliances between territories and inter-territorial cooperation can be expressed through public digital policies. Above all, the measures and initiatives taken to achieve responsible and sustainable digital technology can be incorporated into sustainable development goals (SDG) and the different ecological plans and schemes implemented by local institutions.

By combining the application of **culture, ethics and digital sovereignty**, local authorities will have a fundamental role to play, especially in the area of digital sustainability and deciding the courses of action to take: awareness and adopting eco-friendly gestures with a view to creating a more skilled and knowledgeable civil society, promoting frugality, digital's energy consumption in relation to data storage, fostering the impulse to refurbish and recycle mobile devices and computer equipment, introduce environmental criteria in public procurement contracts... The list is long and the initiatives many, but there is already a real urgency in, together and quickly, bringing the cause of eco-friendly digital technology to the front burner.

FFTELECOMS

FRENCH TELECOMS FEDERATION

"Most of the increase in the digital sector's GHG emissions comes from emissions imported by connected equipment (starting with large screen devices such as TV, computers, etc.) and data centres."

"Most of the increase in the digtal sector's GHG emissions comes from the emissions imported by connected equipment (starting with large screen devices such as TVs, computers, etc.) and data centres."

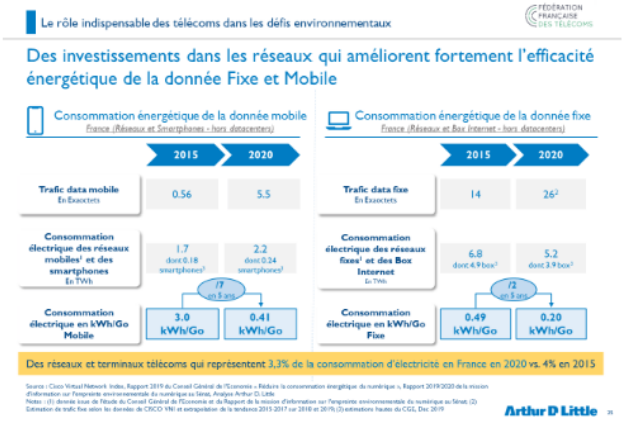
The French Telecoms Federation (FFTelecoms) would like to use these few lines to **make the** debate over the secondary environmental effects of the digital transition – an issue that has been amplified by the Covid crisis and debates over 5G – an **objective one.** A proven and shared methodology, hence agreed-upon figures, do not yet exist for assessing the impact of usage and evaluating the potential knock-on effects of the carbon impact of a physical use to a digital one.

One of the **top priorities for public policymakers** must be to resolve this lack of quantified information and a scientific evaluation methodology to obtain it, as we need to be able to measure digital technology's impact thoroughly and objectively before taking any new regulatory or policy steps to control it.

By making digital technology's – and telecoms' in particular – environmental impact the central issue of its 2020 economic study, FFTelecoms wanted to provide as yet unseen quantified elements, detailed here below, that demonstrate that telecoms are a key sector for tackling environmental issues[108].

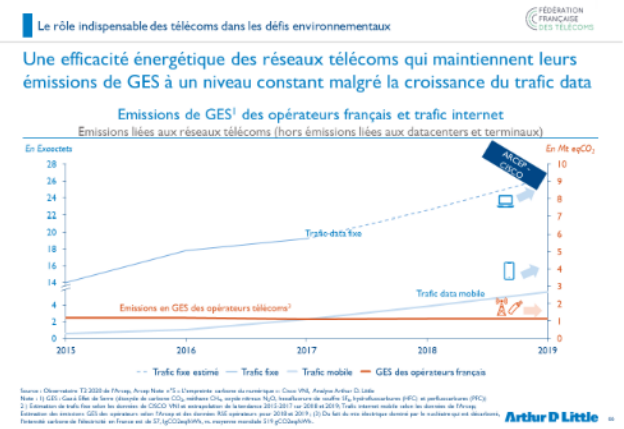
I/ The telecoms sector has made the most substantial efforts to control its environmental footprint:

→ in terms of energy efficiency



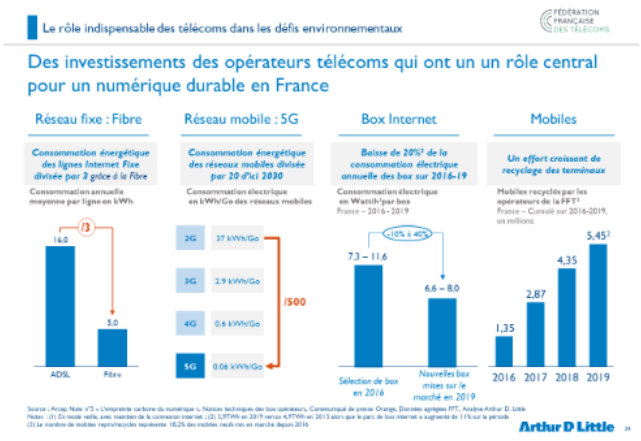
→ in terms of **greenhouse gas emissions**

Telecom networks represent only 0.4% of total GHG emissions in France.

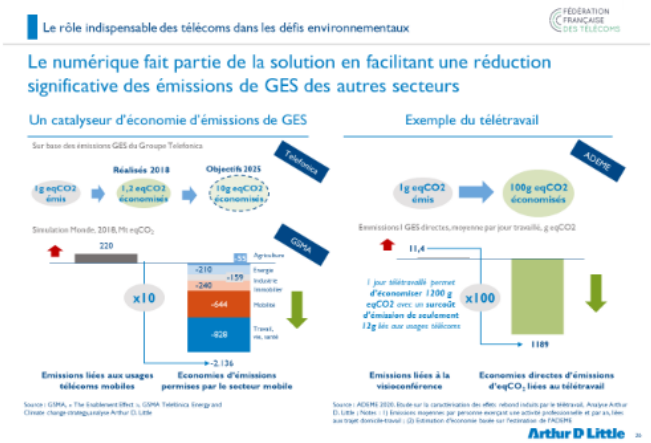


108. A study by consulting firm, Arthur. D. Little will be presented at FFTelecoms' year-end message/press conference on 15 December 2020

II/ This performance is the result of actions that telecoms operators have been taking for years now, involving both their networks and devices.

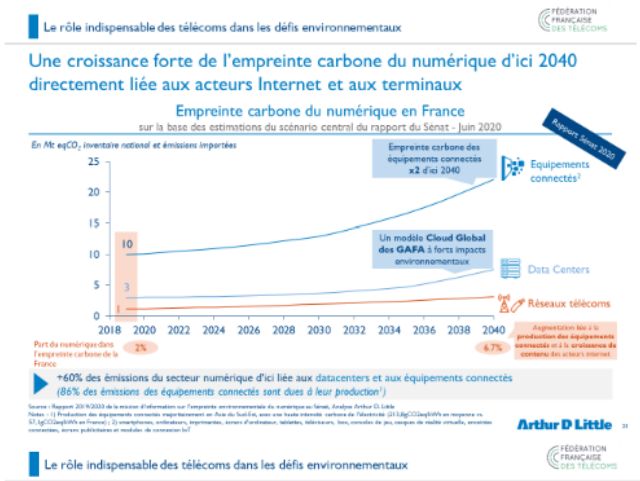


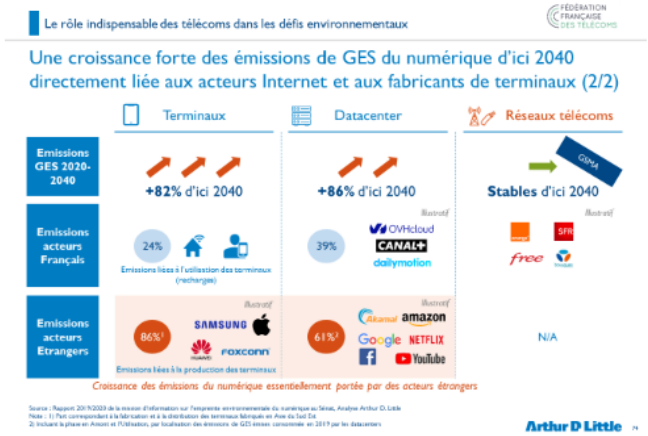
III/ Telecoms also have a crucial role in meeting environmental challenges by making a positive contribution to reducing other industrial sectors' greenhouse gas emissions.



CONCLUSION:

The telecoms industry's ongoing efforts must be completed by **new forms of leverage** from other digital ecosystem players.





The figures presented below confirm that most of the increase in the digital sector's GHG emissions come from emissions imported by connected equipment (starting with large screen equipment such as TVs, computers, etc.) and data centres, chiefly those operated by Big Tech companies. Hence the importance of having every digital industry player – including and especially **global heavyweights –** involved in creating more responsible tech.

Any new regulation must therefore be mindful of factoring in the relevant scale – European at minimum – so the burden does not lie solely on national players, and thereby create price squeeze and knock-on effects.

The current debate over **eco-costing** for data centres' electricity prices – but which could also apply to telecom networks equipment – illustrates the dangers of public policymakers' contradictory injunctions, between **digital sovereignty** and industry reshoring issues, and the issue of **making energy-hungry activities greener**.

FRANCE VILLE DURABLE

"Consider LCA for digital solutions as a way to increase regional and urban resilience, using a standardised (ISO 14040 and 14044) multicritera approach to assessing a product's life-cycle to obtain a clearer picture of the real relevance of its use, and especially of its impact."

Digital technology is unquestionably a tool that can be used to build sustainable cities: better management of action-related data, strengthening systemic approaches, greater mobilisation of stakeholders, etc.

More and more, however, it is often presented as THE only and obvious solution that every urban system needs to be geared towards, regardless of how it might affect the use of additional resources (particularly energy), its reliance on scarce resources and rare earth metals whose extraction is harmful to ecosystems, which are owned by other countries (starting with China), and which create **new, massive vulnerabilities** in terms of resilience to natural hazards or malicious behaviour that can shut down a city's power grid, for instance.

Digital technology enables digitalisation, data transfer and analyses. It is a key tool for **anticipating phenomena,** and a major issue in today's world. Using data, improving and optimising infrastructures and making a city's processes run more smoothly all help it become more resilient.

It also creates sizeable risks, however, including **cybersecurity** threats, its ecological footprint, the digital divide and public freedoms. Digital technology requires energy and polluting materials, and is itself vulnerable to emergencies (flooding, blackouts, etc.).

We can get some idea of digital technology's impact on ecosystems with just a few figures:

→ In 2019, close to 4% of global carbon emissions were due to the production and use of the digital system, or two times more than civil aviation, and they are increasing by 8% a year (The Shift Project).

→ Every year, 50 million tonnes of non or barely recyclable waste electrical and electronic equipment (WEEE) are produced. Or 5,000 Eiffel towers.

→ 70% of this waste are exported illegally overseas, primarily to Africa, India, Pakistan and Thailand.

Rare earth metals: the use of rare earths to produce digital tools is a major **geopolitical issue.** Today, 30% of the reserves of world's rare earth metals are located in China, even though that country supplies 90% of the industry's needs. The electronic waste recycling sector is complex and still only fledgling, and electronic waste requires new recycling techniques which are being studied. The scarcity of these minerals is not due to limited reserves, but rather their dispersion in the ground which requires specific and cumbersome extraction techniques.

Today, this production **outsources the pollution** generated by digital technology's production for now but can we guarantee sovereignty/autonomy over these raw materials in future? The mind boggling surge in demand (e.g. +2500% a year for neodymium, which is one the 17 rare earth metals) is making prices soar.

The immediate and dispersed impact of this form of extraction must be an integral part of any digital strategy discussions.

Digital technology LCA:

Consider performing life-cycle assessment (LCA) for digital solutions as a way to increase regional and urban resilience, using a standardised (ISO 14040 and 14044) multicriteria approach to analysing a product's life-cycle, to obtain a clear picture of the real relevance of its use and especially of its global environmental impact. Even approximate LCA are useful, and create the ability to involve both consumers and producers. In the case of cities in particular, they make it possible to compare the eco-friendliness of two systems with the same features.

The "always more" mantra of digital tech is **counterproductive** to the goals of a green transition and resilience: the always promised gains in energy efficiency are systematically erased by the development of new applications requiring more resources or, for instance, a doubling of screen sizes or the proliferation of connected objects.

GIMELEC[109]

PROFESSIONAL ORGANISATION OF ELECTRIC AND DIGITAL ENTERPRISES IN FRANCE

"Between 2010 and 2018, data centres' global consumption increased by only 6%, even though the number of servers rose by 550% during that time, which translates into a 20% improvement in energy intensity per annum."

Digital development represents a tremendous economic opportunity for France.

Promoting the deployment of data centres across the country is one of the keys to securing national independence in hosting data, and every businesses' **legal safety and security.**

Digital technology's ultra dynamic development is creating not only new possibilities, but also new responsibilities, particularly with regard to reducing one's environmental footprint. Efforts that data centres began to undertake more than 10 years ago have paid off, and the results were recently confirmed by Science magazine: between 2010 and 2018, data centres' global consumption increased by only 6%, even though the number of servers rose by 550% during that time, which translates into a 20% improvement in energy intensity per annuum[110].

Of course, this does not exonerate the sector from continuing to act. Digital technology has come under increased scrutiny of late, from a great many players in both France and across Europe, all with the same goal in mind: reducing their environmental impact. Because expectations are so high, there is a concern that we will confuse speed and precipitation to regulate, and so run the risk of introducing regulations that will miss their environmental mark, while also weakening France's and Europe's **digital autonomy.**

The first key to success is ensuring that decisions are based on **reliable information and data.** There is no getting around the fact that, today, when it comes to technical and scientific production, France and Europe continue to trail behind the United States and Asia. But nothing is set in stone, and GIMELEC is delighted to see a real awareness taking hold in this area.

The second key is ensuring that these data are **shared** and discussed by all of the stakeholders. Arcep's initiative to this end is helping to fill a need: namely for a platform that helps break down the silos and creates an open, wide-reaching dialogue.

Cybersecurity, digital sovereignty, green transition: digital technology's cross-cutting nature requires the adoption a holistic approach. Operating at the intersection of these different issues, GIMELEC members are ready to participate.

109. GIMELEC is a professional organisation of 200 member companies generating 15 billion euros from French exports and employing a workforce of 67,000 people in France. Our members design and deploy electric and digital technologies for safe, optimised energy and process management of infrastructures, industry, buildings, digital technology infrastructures and electromobility. At the intersection of electrons and bytes, GIMELEC's commitment to the circular economy is an integral part of our desire to foster the development of businessses in France and around the world.

110. https://science.sciencemag.org/content/367/6481/984.full

GOOGLE

"Google has set itself the target of using decarbonised energy 24/7 by 2030, in all of its data centres and offices around the world."

Energy and data centres

Google was the first major corporations to commit to carbon neutrality, and has been **carbon neutral since 2007**. Since 2017 Google has been the biggest purchaser of renewable energy in the world, enabling it to match 100% of its global electricity consumption.

Google has set itself the target of using **decarbonised energy 24/7 by 2030, in all of its data centres and offices around the world.**

Google data centres are twice as energy efficient as classic ones:

→ Compared to five years ago, today they can supply around seven times the computing power while using the same amount of electrical power.

→ By using Machine Learning, we were able to reduce the amount of energy needed to cool our data centres by 30%.

Google is committed to making **recycling** and the **circular economy** an integral part of its datacentre management: 19% of the components used in new hardware for upgrades are reused components, and 87% of the waste generated by Google data centres are reprocessed.

YouTube

To provide users with an optimal viewing experience, YouTube adjusts the **quality of the video stream** based on several criteria and parameters such as users' internet connection speed, the size of the video player/screen and the quality of the original video uploaded to the Web.

When a user watches a video, we suggest a list of additional videos they might like to watch using the autoplay feature[111]. To provide them with all of the tools they need to control their YouTube experience, they can turn off this feature at any time using the enable/disable option on the viewing page.

In their profile, every user can see their viewing stats[112], a 'take a break' reminder[113], and cap their viewing time using a timer. These tools are designed to help every user better understand how they use YouTube, to disconnect when necessary and set up healthy viewing habits for the whole family.

Devices

Google publishes **publicly available reports on the energy impact**[114] of every one of its products. These serve to reveal the product's environmental impact throughout its life-cycle, its energy efficiency, the resources used, etc.

Google reuses materials to reduce its products' environmental and social impact as much as possible:

→ Starting in 2022, 100% of 'Made by Google' products will contain recycled material and we plan on further developing the use of these materials whenever possible.

→ Google is committed to using recycled or renewable materials in at least 50% of the plastic used in its product line by 2025, using recycled* plastics as much as possible.

→ Google is committed to eliminating plastic from its packaging, and making it fully recyclable by 2025.

→ Google is committed to obtaining UL 2799 "zero waste to landfill" certification for all of its manufacturing sites by 2022.

To maximise the use of our products, a repair centre is available online[115].

Google allows users to give their old devices a **second life** by offering a free return by mail programmme[116] for **responsible recycling**, and is committed to continuing to expand our end of life management services. When purchasing a new device, users can return up to three used ones for free.

111. https://www.youtube.com/howyoutubeworks/user-settings/autoplay/
112. https://support.google.com/youtube/answer/9052667?hl=en&utm_source=wellbeing.google&utm_medium=referral&utm_campaign=wellbeing
113. https://support.google.com/youtube/answer/9012523?hl=fr&utm_source=wellbeing.google&utm_medium=referral&utm_campaign=wellbeing
114. https://sustainability.google/reports/
115. https://store.google.com/fr/repaircenter
116. https://store.google.com/fr/magazine/recycling

GreenIT.fr

AN EXPERTS COLLECTIVE

"Digital technology is a critical, non-renewable resource that is being exhausted too quickly. Let's save it."

Digital technology is a non-renewable resource; let's save it!

Digital technology is a critical, non-renewable resources that is being exhausted too quickly and inexorably. By deploying it on a very large scale, we have now become dependent on digital technology to **communicate** and **to impart our knowledge**; two needs that are vital to the perpetuation of our human civilisation.

This was the starting point that our longstanding experts collective adopted when forging its approach to digital sobriety and digital sustainability[117], some ten years ago. Simply put, we need to be economical in our use of digital resources whe we design, build and use them, while respecting life on the planet.

Digital sobriety is the cornerstone of more responsible digital technology, from both an environmental and social standpoint.

For more than 15 years, our studies examining issues on every scale – worldwide, in France[118], in businesses[119], in digital services[120] – have demonstrated that digital technology's[121] environmental impact is heavily concentrated in **the manufacturing of equipment**, and to a lesser degree in electricity production and at the end of that equipment's life. in other words, what we do with our smartphones and our computers once they are switched on has an only marginal impact. However, if we look only at networks and data centres, the opposite is true: the operation of their machines has a greater ecological impact than those machines' production (up two times as much for data centres).

Green design to produce less but better

To achieve this, we need to see **ecodesign** become ubiquitious for digital services and **to teach it** in schools. Ecodesign for equipment, massive reuse of hardware thanks to mechanisms such a European Directive, mandatory deposits and rethinking operators' contract renewal schemes, extending manufacturers' legal warantees, strengthening users' control over software updates and, of course, relying on existing international standards[122].

Digital that serves humanity and not the other way around

Having a more responsible digital network, which is one of Arcep's key areas of focus, enables everyone to have access to a decent connection (narrowing the digital divide) but with no added economic or technological cost, while respecting humans' privacy, access to digital services, ethics, neutrality, etc.

The number one priority is to ensure that everyone, without exception, has access to digital services that protect users and the planet. For this to happen, networks must be deployed in an intelligent and optimised fashion, based on needs that cannot otherwise be met. We also need to **quell our voracious appetites** to prevent a big crunch of the digital universe.

Respecting Life: the lodestar for innovation

Engaging in digital behaviour that respects LIFE is a powerful lodestar for innovation and value creation. It is also the only way to create an alternative and desirable digital future.

With more than 15 years of hindsight and daily practice in the field, we are also convinced that digital sobriety can give France a **competitive advantage,** and make it a trailblazer in this area.

Having good ideas is not enough, we need to put them into widespread action.

117. [SOBNUM 2019] "Sobriété numerique: les clés for agir", book, Frédéric Bordage, Buchet-Chastel, September 2019,
118. [EENM 2019] "Digital technology's global environmental footprint", study, GreenIT.fr, October 2019,
119. [iNUM 2020] "iNUM: digital technology's environmental impact in France", study, collective,, June 2020,
120. [WEGREENIT 2018] "What is the best GreenIT strategy for France's biggest corporations?", GreenIT.fr, WWF France, Club GreenIT.fr, February2020,
121. [GREENCONCEPT 2020] "Greenconcept White Paper", summary of the collective work performed, February2020,
122. ISO 14044/40 for life-cycle assessment and ISO Standard NF in IEC 62430 for the environmentally conscious design of digital prodcuts and services.

HADOPI

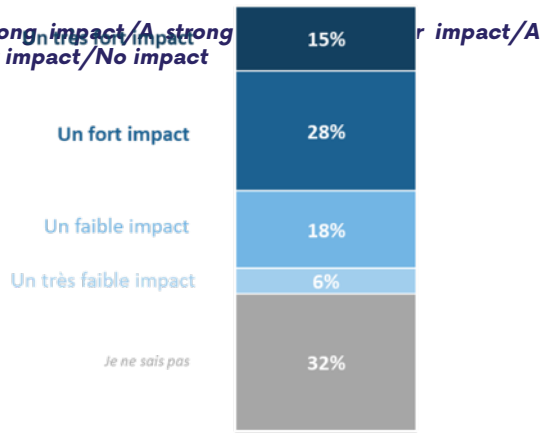
HIGH AUTHORITY FOR THE DISSEMINATION OF WORKS AND THE PROTECTION OF RIGHTS ON THE INTERNET

"66% of internet users say they could be convinced to consume less digitised cultural content given the tremendous amount of energy it consumes."

As part of the responsibilities assigned to it by law, to monitor the legal and illegal use of digitised cultural goods, Hadopi introduced a **barometer of the consumption of digitised cultural goods** back in 2011. The 2020 edition provided an opportunity to query internet users for the first time about how they perceive the environmental impact of their usage.

The first thing to emerge was that close to half of all internet users are aware of the environmental footprint of their consumption of cultural products online: **43% of those polled say that using the internet to consume cultural products has a strong impact on the environment, especially in terms of carbon footprint**. And the younger the users, the more prevalent these views are: 55% of those between the ages of 15 and 24 consider this impact to be strong or very strong, compared to 38% amongst internet users aged 40 and up.

Figure 1: Perception of the environmental impact of consuming cultural products online (base: internet users in France, ages 15 and up – 5,002 people)

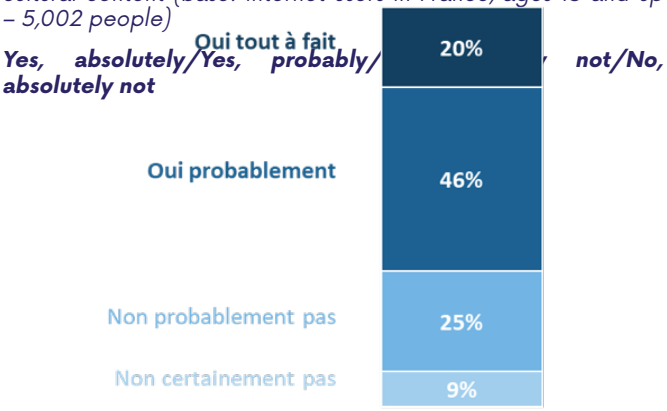


Answer to the question: How strong an impact do you think consuming cultural goods (films, TV series, music, software...) online has on the environment, especially in terms of carbon footprint (e.g. greenhouse gas emissions, such as CO2) ?

Source: Hadopi – 2020 Consumer barometer

In light of this perception, **two thirds (66%) of internet users say they could be convinced to consume less cultural content online, given the tremendous amount of energy it consumes.** This percentage of internet users willing to change their online behaviour reaches as high as three quarters (73%) among those who believe online consumption of cultural products has a strong impact on the environment – but only 69% amongst 15 to 24-year-olds, which is a statiscally comparable to the average.

Figure 2: Could you be convinced to consume less digitised cultural content (base: internet users in France, ages 15 and up – 5,002 people)



Answer to the question: consuming digital content, especially via streaming, uses a great deal of energy and emits a large quantity of greenhouse gases (e.g. using servers to store data requires a lot of electricity...). Could this fact encourage you to consume less digital content?

Source: Hadopi – 2020 Consumer barometer

While the issue of new technologies' environmental impact is gaining traction in the public discourse, as the many questions surrounding 5G testify, internet users seem to be increasingly aware of thes consequences of their own online practices.

It is nevertheless important that giving users the proper incentives to reduce their carbon footprint not translate into have less access to culture online. The vast dissemination of digitised cultural goods on the internet makes these works more accessible, especially to younger audiences. The solution should lie more in reducing the environmental impact of the products and services being made available to internet users.

HALTE À L'OBSOLESCENCE PROGRAMMEE

END PLANNED OBSOLESCENCE NOW

"Halte à l'obsolescence programmée is a clarion call to actively combat the planned obsolescence of digital devices, and to expand its definition to include the notion of software obsolescence."

The digital technology sector is responsible for around 4% of global greenhouse gas emissions[123], and this figure will continue to grow over time. Eighty percent of the impact that can be attributed to physical products occurs during the manufacturing stage[124]. Producing digital devices requires massive quantities of resources, and particularly rare earths and metals, which are a major source of supplier dependency since the reserves of these resources are concentrated in a small handful of countries. These raw materials are a major source of pollution, not only during their extraction but also further down the chain, since it is still impossilbe to recycle them. To achieve digital sustainability, it is therefore absolutely crucial to combat the obsolescence of digital devices and to prolong their life and their use.

Which is why **HOP (End planned obsolescence now) is a clarion call to actively combat the planned obsolescence of digital devices, and to expand the definition to include the notion of software obsolescence**. Digital devices are affected by two forms of obsolescence: hardware obsolescence because they are fragile and often cannot be repaired, and software obsolescence. The latter is rooted in software upgrades on devices, and is responsible for rendering still functional devices incompatible (i.e. obsolete). This encompasses several techniques: providing technical support for a shorter time than the device's lifespan, incompatibility of old and new versions of the software, and software updates that slow the devices.

Based on this knowledge, HOP is asking **for a separation of corrective updates and convenience updates.** Users must have the ability to peform only those updates that pertain to their device's security, and have the choice of not installing performance-related updates, whcih are often the most cumbersome and so the most likely to slow devices. The Law against waste and in support of a circular economy gives users the ability to refuse an update, but without this separation it could prove counterproductive. It is also important to make software upgrades reversible. it seems crucial to guarantee that consumers are given clear information that details how the update will affect the operation of their device and its applications. Greater **transparency** must be required on software's lifespan, devices' abilty to upgrade to new versions, and the expected evolution of basic features. HOP also wants to increase the length of the software guarantee introduced by the AGEC Act from 2 to 8 years. Regarding the progress enabled by this law, HOP underscores the importance of the upcoming Government report on software obsolescence, and supports the inclusion of a demanding criterion on software in the durability index that will be implemented in 2024.

Lastly, regarding the hardware obsolescence that affects a great many digital devices, it is vital to **require the environmentally conscious design and repairability of** digital devices. It is equally necessary to **foster the reuse and refurbishment** of this equipment. The development of a usage meter on some electronic products could also help stimulate a second-hand market, and provide consumers with more detailed information.

In conclusion, extending the life our of digital equipment is a crucial step towards achieving more sustainable digital technology, with the dual objective of protecting consumers and reducing our environmental impact.

123. Ademe (2018). "Modelling and assessing consumer goods' and devices' carbon footprint"
124. European Commission (2020). Circular Economy Action Plan

LES AUGURES[125]

THE OMENS

"Any rethink of a cultural innovation strategy must be through the prism of digital sustainability."

What does **cultural innovation mean** when the world is in the grips of an ecological crisis, with health, economic and social crises piled on top.

For the past 10 years, the world of culture has been projecting itself into the futre, through 3D renderings, virtual reality, unlimited freemium subscriptions. Massive amounts of money have been spent on digitising collections, developing video platforms and algorithms, designing interactive experiences, whose unbridled use has an **ecological cost** of which we are only just barely beginning to be aware, while **usage continues to surge.** At the same time, CSR has been virtually nil, due to a lack of means but especially to a lack of consideration for what is at stake, both socially and environmentallly.

Now that we are in a full blown climate emergency, the green transition is gradually inching its way onto the cultural sector's agenda. Awareness of the notion of digital sobriety is growing. One conclusion stands out: it is neither technology nor engineering that will enable the sector to come up with new resilient models, but rather the capacity to **experiment collectively** by making care for life on earth the central tenet of design and production. With this in mind, **any rethink of a cultural innovation strategy must be through the prism of digital sutainability.**

But cultural workers are feeling helpless: they have neither the means nor the skills to map out and implement a digital sobriety policy. They have been made more helpless still by the **Covid crisis**, forcing museums and theatres to remain closed, and so **driving cultural outlets even more towards digital technology** (cloud gaming, SVOD) and pushing them to develop online experiences, thereby increasing their ecological footprint.

How then can we implement **a responsible digital transformation**?

Les Augures (The Omens) are taking up the mantle of cultural sector ambassaor, and calling on public powers to commit to:

→ Developping a common tool for **measuring** and making visible the ecological footprint created by culture's use of digital technology

→ **Communicate** data on digital culture's footprint to the different audiences, to **regulate** practices

→ **Foster awareness** in management and train CTOs in digital sobriety

→ Make salvage solutions for digital devices an integral part of the culture to encourage their reuse

→ Enact a structural change in our digital **production** methods, both in terms of usage and for software.

125. Les Augures (https://lesaugures.com) is a collective that was creatd in spring 2020 to support and assist cutural actors – institutions, museums, arts centres, schools, cultural venues, artists – in their ecologiccal transition, and in their ability to innovate and adapt.

LILLE EUROPEAN METROPOLIS[126] (MEL)

MÉTROPOLE EUROPÉENNE DE LILLE

"MEL promotes all forms of network sharing to ensure reasonable and sustainable occupation of its territory."

First, MEL would like to salute the Authority's participatory approach to the work it is doing on "Achieving digital sustainability". Through its own new Territorial Climate Air Energy Plan, MEL has made environmental issues the centrepiece of its regional development projects, including the deployment of ICT networks.

MEL promotes all forms of **network sharing** to ensure reasonable and sustainable occupation of its territory. To this end, in 2013 it established a **relay antennae deployment charter** in concert with operators that encourages them to share their infrastructures.

At the same time, the successful rollout of a shared 4G network in Metropolitan Lille, thanks to the sharing of both equipment and frequencies, testifies to the relevance of **multi-operator projects**. MEL would like to see this model spread to other densely populated areas where infrastructure-based competition often makes no sense. Also worth noting is that the constraints on street furniture created by the use of the 26 GHz band make these sharing schemes unavoidable. MEL will work to harmonise and supervise access to street furniture across its territory, particuiarly with respect to energy supply lines and streetlamp management.

Regarding device sharing by end users, MEL regrets that in FTTH deployments, the optical network terminals (ONT) in apartment buildings do not contain a single active internet router that could serve each of the building's units.

MEL also supports the Digital Home proposal to "enable access to services, while recalling the existence of the national digital third places programme, designed to serve that purpose".

To devise an innovative response to the environmental challenges of waste management, MEL is **drafting a new framework document** that will be implemented by 2023. In practice, this sholud include **new preventive actions**, a reorganisation of **waste collection**, **recycling** and **reuse processes,** and closer ties with environmental organisations and digital device vendors.

MEL welcoms the introduction of **an environmental barometer for electronic communications**. It believes it is important to take have an objective assessment of the energy impact and cost of networks, services and usage, to be able to identify the most environmentally urgent actions to be taken as quickly as possible.

To achieve this, MEL believes that promoting decentralised network architectures to be closer to users needs to be weighed against geographical temperature conditions and data centres' cooling requirements.

It also believes that it could be more efficient and easier to switch off the legacy copper network, rather than older mobile networks that are still widely used. MEL is nevertheless in favour of **phasing out 2G and 3G technologies**, with trial switch-offs at the neighbourhood level as part of an overall transition process.

Lastly, to encourage vertical digital usage and eco-responsible behaviours, MEL is calling on the Government, through Arcep, to **design a national digital prevention plan** in the schools, to educate our children about electronic waste, and teach them how to sort and manage that waste.

126. Métropole Europenne de Lille/Lille European Metropolis (MEL) is a Public Establishment for Intercommunal Cooperation (EPCI). Serving its 95 component muncipalities, since early 2011, MEL has been managing the regional digital development aspect of network construction, and so shepherding operators' investments in fixed as well as mobile superfast network deployments.

NÉGAOCTET

"Using the standardised (ISO 14040-44) life-cycle assessment (LCA) method to quantify environmental effects is crucial to obtaining an holistic view of the digital sector's issues and challenges."

The impact of digital services in France and around the world is significant, and growing. Although able to make a beneficial contribution to our society, this unending development compromises **environmental commitments that have been made**, including the Paris Agreement, and our future ability to live on a habitable planet. As an adjuct, social and economic issues only shore up the conclusion that we must support reasonable digital development, which includes **mindful** and **controled** usage, appropriate means and optimised servies. To properly examine usage and means, digital technology must be looked at as a whole, through the services rendered to users (functional approach).

In addition, **ecodesign** must necessarily cover every element (physical and virtualised equipment) that makes up these digital services, starting with devices, networks and data centres, as well as the associated human resources (exhaustive approach).

The effects of digital services are multifarious, and influence the entire life-cycle, from the extraction of raw materials and production (exhaustion of resources, energy consumption and pollution) to end of life (waste management), by way of distribution (petrol consumption) and use (electricity consumption). Which is why we must take equipment's entire **life-cycle** into account (multi-stage approach).

Digital services are at the root of multiple environmental effects that need to be measured and monitored. A host of issues that have been identified, such as planetary limits, can be traced to digital services, such as global warming, water consumption, chemical pollution and other issues that are equally important, for humans, such as the consumption of natural resources. All of these issues must therefore be taken into account (multicriteria approach).

Using the standardised (ISO 14040-44) life-cycle assessment (LCA) method to quantify environmental effects is crucial to obtaining an holistic view of the digital sector's issues and challenges. This method has already become the norm in a number of sectors of activity, including construction, where strict regulation (RE2020) makes performing an LCA a key decision-making and authorisation criterion.

In addition, since 2010 France and Europe have established life-cycle assessment as a centrepiece of public awareness and communication campaigns on the environmental footprint of consumer goods. The PEF/OEF approach has also been applied to IT equipment and, in future, will probably be the preferred approach for characterising and benchmarking digital services' environmental footprint on a supranational scale. These are in fact the works that provide the framework for application for Article 13 of the AGEC Act in France.

From a more general perspective, we need to advance towards **harmonised** methods and data to achieve **homogeneity** in studies and **comparability** of their findings, using equivalent scope and indicators. In a sector that makes use of a range of materials, skills and locations, with applications in as many areas of society (energy, industry, entertainment, health...) as there are digital services, it is important to have precise and homogenous benchmarks (sector-specific reules) that help streamline the process of conducting environmental studies, and establishing realiable strategic guidelines.

Through the NégaOctet project, we propose to tackle these different issues by providing a method and data that comply with current international standards and benchmarks, established in concert with digital services sector players, based on the work of experts, to strengthen and facilitate the use of LCA and, in so doing, to create the ability to obtain a more complete and accurate measure of environmental effects.

NUMERISAT

"Satellite technologies are a vital supplement to regional superfast access deployments. They are by nature already part of a fair and eco-responsible stratagem."

Satellite superfast broadband solutions are already capable of supplying 30 to 50 Mb/s connections to white areas. They are part of the technology mix included in the national superfast access scheme in France, and already embody the three pillars of the circular economy:

1 - Target the service supply side for a better product-service system economy

2 - Target consumer behaviour by encouraging responsible consumption and longer product use

3 – Ensure equipment recycling.

These are the three pillars of Numerisat's actions. Below is a more detailed explanation of some of the principles we apply:

1- Plans tailored to customers' needs

→ Limiting unlimited plans and guaranteeing very good speeds for everyone

Unlimited plans consume a lot of energy. Satellite solutions create the ability to design plans with traffic caps, and with variable allowances. Users therefore pay based on their usage, and so have an incentive to optimise their consumption. Everyone has the same connection speeds regardless of their plan: all high-speed connections, which is important as they enable fast downloads and file transfers, and consume less energy per Mb relayed.

→ Time-limited plans tailored to seasonal activities and needs

Some internet access needs are tied to seasonal activities. This could be seasonal work or secondary residences. Satellite solutions are able to supply a high-speed connection for a set period of time. Which means a connection with zero consumption the rest of the year.

2- Optimised product use and paying speical attention to the length of their use

→ Decrease the consumption of connection devices (ISP routers and peripherals)

Some routers are designed to allow users to programme LED switch off for certain hours of the day. A satellite modem's consumption is also reduced when their is no traffic on the link. Incorporating smart energy management into these device's design should be a mandatory part of their specificaitons.

→ Length of equipment use

Satellite internet access equipment has a long lifespan; close to that of the satellite itself (15 years). The software that powers it can be updated to improve the hardware's performance, without having to replace it. We have been able to upgrade and keep the same equipment since 2012, while increasing connection speeds from 10 Mb/s to services running at 40 Mb/s in 2020.

3- Product management: recycling channels and short circuits

→ Recycling

As stated earlier, satellite connection equipment can be easily refurbised and reused, and has a very long lifespan. As a result, 40% of the equipment we supply are recycled by our departments, and offered to customers at special rates.

→ Short circuits courts and respecting the environment

Installing a satellite kit does not require the deployment of a complex infrastructure on the ground.

It is performed by a local installer or the customer herself. Using satellite technologies prevents the proliferation of powerlines and cell towers, and the polluting work needed to route high-power telecommuncations lines. Satellite connections can be set up in a matter of hours, anywhere on Earth, including remote, hard to access locations.

Satellite technologies are a vital supplement to regional superfast access deployments. They are by nature already part of the fair and eco-responsible approach that Numerisat supports: providing high-speed access everywhere, with solutions that are tailored to customers' needs and minimum rollout costs.

OVH CLOUD[127]

"The company has implemented a fully integrated industrial process, creating the abilty to satisfy customers' needs while reducing its environmental footprint."

For twenty years now, OVHcloud, a French cloud computing specialist has been providing virtualised IT resources at several levels: infrastructure (servers for computing capacity, network storage), as well as development environments and business applicaitons.

Cost-effectiveness and efficiency are the two bywords of a sustainable approach begun by OVHcloud more than 15 years ago.

The company has implemented a fully integrated industrial process, creating the ability to satisfy customers' needs while reducing its environmental footprint.

→ **Servers:**

o OVHcloud stands out from the competition by building its own servers, which gives it the ability to innovate continuously with quick turnaround, making new products available within a very short time between prototype and large-scale industrialisation.

→ **Data centres**:

o They operate within low-carbon networks using existing old buildings that have been refurbished to become data centres.

o OVHcloud does not use air conditioning to cool its servers. Starting in 2003, it was replaced by a watercooling system: water is injected directly on the processor to cool it, and so drastically reducing the need for electrical power.

o OVHcloud data centres have a PUE (Power Usage Efficiency indicator) of between 1.09 and 1.3 (the industry average being 2 points). OVHcloud has also reached an unmached score of 0.2 for its Water Usage Efficiency – the industry average being 1.8L/kWh.

→ **Circular economy**:

o Two dedicated server lines, to give them a second and third life.

o 100% of our components are incorporated into these processes (sorting, reuse and recycling).

OVHcloud's commitments

The company plans to move to the next level by making an ambitious short-term commitment: to be carbon neutral with a pure renewable energy mix by 2025, and plans on reaching its net-zero emissions target by 2030.

To achieve this, OVHcloud will be concentrating its efforts around five priorities: monitoring and analysing the cloud computing industry's global environmental impact, infrastructure design, use of renewable sources of energy, promoting the circular economy and mobilising its stakeholders.

An ambitious collective approach

The indusry has deployed massive efforts to develop more eco-friendly servers and data centres. A study from the International Energy Agency (IAE) published in 2020 revealed that, despite an exponential increase in data traffic (x12 in 10 years), data centres' electricity consumption worldwide has not increase proportionately, if not remained unchanged.

This global stabilisation in the amount of energy being consumed can be attributed to the improvements that have been made, but also to the growing adoption of cloud solutions. They make it possible to share and absorb the impact of this massive increase in usage.

Optimising infrastructures is therefore an indispensable step but will only solve part of the problem. In addition to that work, the entire impact chain needs to be assessed, looking at the upper layers, applications, analyse coding and determine each one's impact in terms of energy consumption.

It was in this spirit that OVHcloud initiated a partnership with Inria (France's National Institute for Research in Digital Science and Technology) to provide its customers with information on the impact of their own use of cloud services, and optimise their usage.

127. OVHcloud, European leader in cloud computing, with a staff of more than 450 people, and operating more than 400,000 servers in 31 data centres on four continents, with very strong presence across France

QARNOT [128]

"The ecological costs of construction, energy costs of food, energy wasted on cooling, heat given off by computers lost: data centres' energy equation is not a balanced one..."

Digital technology: the virtual illusion

As has been pointed out elsewhere, while attempts were made to pass digital technology off as virtual, intangible, it does in fact has a very physical side to it. What not longer exists next to us, still exists somewhere else, and this somewhere else is often **data-centers**. So intead of dematerialisation, we sholud be talking about **"rematerialisation"**.

Qarnot: an eco-friendly alternative to data centres

Data centres are part of digital technology's ecological problem. These digital factories, where thousands of computers operate 24/7, comandeer land, artificialise nature, mobilise colossal electricity networks, materials for their production... Once built, data centres are powered by energy to run their servers, but also to be ventilated and/or cooled. A computer that's operating is a computer that's generating heat – so goes the basic premise of the Joule effect.

The ecological costs of construction, energy costs of food, energy wasted on cooling, heat given of by computers lost: data centres' energy equation is a not balanced one...

Qarnot offers an ecological alternative to data centres by distributing computing capacity directly **where heat is needed.** Qarnot thus makes use of IT's unavoidable heat to heat buildings and water, thanks to two main products that use microprocessors as sources of heat: a radiator-computer and a digital furnace. It is data that are flowing over the optical fibre and not the heat that is being transmitted. The more heat the user needs, the greater the demand for computing they receive in their furnace or radiator, driving up the microprocessors' frequency and so emitting heat.

Qarnot has thus dimished computing's carbon footprint (-89%) and energy spending (fourfold). Qarnot technologies are **digital circular economy solutions**: one person's waste (a computer's heat) is another one's precious resource (heat in a building).

The limitation of PUE

Power Usage Effectiveness (PUE) has clear limitations. If it is a fairly accurate indicator of the distribution of a data centre's energy consumption, it does not factor in the question of the heat that IT hardware invariably gives off.

A data center with a very low PUE can continue to do nothing with the heat emitted by its computer hardware.

Here, Energy Reuse Effectiveness seems a more complete indicator, and reveals more obvious energy assets. Of course, limiting a data centre's energy consumption is a positive step, but it is even better to make use of the heat given off by the servers.

A distributed approach

Qarnot's distributed approach is enabled by a distibuted computing platform: Q.Ware, which assigns computing tasks based on the heating instructions from users' furnaces and radiators. in addition to its clear ecological dimension, this edge computing approach has major environmental advantages, as well as guarantees.

Smart buildings, smart cities: where's the brain?

Smart cities and smart buildings are not often looked at enough in terms of security, sovereignty and independance. What makes a city or a building today smart? Computing, of course, and especially processors that process and analyse the data. Typically, these data are sent to data centers, which are the ones that make the city smart. So a genuine **question of security, and sovereignty arises** when the city or the building its not master of the data being processed. Qarnot's approach, which aims to distribute computing capacity directly in buildings and cities, has the added advantage of putting the city closer to its brain, and even putting that brain right inside it.

The frenetic pace of IoT development, of data capture in cities, the acceleration of big data, artificial intelligence and machine learning technologies, should all be forcing us to ask the following question: **so where's the brain?**

128. https://qarnot.com/a-propos/

GAUTHIER ROUSSILHE

RESEARCHER AND ENVIRONMENTALLY CONSCIOUS DIGITAL DESIGN SPECIALIST

"The specific model being challenged is the digital data trade [...] based on three functions: maximise user engagement, capture data, sell ad space and/or equipment."

"Digital" is an umbrella term that encompasses many realities and many different sectors. No-one is challenging the use of digital technology as an infrastructure for research, for instance (computing power for fundamental research, climate models, etc.). **The specific model being challenged is the digital data trade,** powered by the United States and **based on three functions: maximise user engagement, capture data, sell ad space and/or equipment.** In termes of technical infrastructures, this specific business model is based on replacement of consumer devices (smartphones, tablets, etc), the massive deployment of sensors and connected objects, etc. Wikipedia, for instance, does not have the same business model and does not trade in data. So the digital experience that Wikipedia provides is radically different. The business models is one of the keystones for reorientating the digital mindset.

As in any other sector, Big Tech (GAFA, BATU, etc.) will need to transform itself to align with the requirements set out in the Paris Agreement, among others. The digital sector is complex as it can constitute a sector unto itself, in addition to being an integral part of most other sectors.

As it stands today, the digital sector (ICT + Big Tech) represents only a small percentage of greenhouse gas emissions (GHG) in terms of absolute value, compared to transport, agriculture, energy production, etc. However, it is also the sector which allegedly has amongst **the highest annual growth rates in terms of energy consumption, GHG emissions, and in waste electrical and electronic equipment production (WEEE)**.

The research needed to understand digital technology's environmental footprint is being done, but has not yet settled on a method or the scale and scope of the system to be analysed. There is a dire lack of data that could drive things forward: a lack of data from manufacturers and industry players to obtain more accurate of life-cycle assessments. **One vital step** to a better understanding of the **sector's environmental effect is making manufacturers' LCA data available as open datasets.** These are **pubilc interest** data.

Some "techno-optimist" institutions like the World Economic Forum say that "digital" enables other sectors to reduce their GHG emissions by 15% thanks to the increased efficiency and optimisation that digital technology enables. These figures are based on several questionable technical and economic hypotheses. An analysis needs to be conducted to compare these projections with reality, and to understand how to separate the wheat from the chaff in these assertions. In any event, this statement does not specify by how much GHG emissions are increasing in terms of absolute value. Today, **the goal** is to **decarbonise every sector, not to decarbonise each one's growth.**

Training the sector's professionals (designers, developers, engineers, etc.) is imperative. Environmentally conscious digital design of services must be the norm for every government and local authority procurement contract, which will eventually force the private sector to fall in line. From an operational standpoint, there are two strands to ecodesign: reduce digital technology's environmental footprint and provide an efficient response to the needs expressed (while also questioning them). It is fuelled by six principles:

→ Increase equipment's lifespan

→ Promote a decrease in global consumption of non-renewable resources and a reduction in electronic waste

→ Increase the life of services as such (relevance and maintenance)

→ Optimise for the most difficult usage conditions

→ Be a gateway for incorporating other best practices from the web (accessibility, security, governance, open data)

→ Raise awareness of the need for sobriety.

One of the biggest questions that will inform public policymaking is the following: **what does a digital ecosystem (infrastructures + services) look like in and for a world stabilised at +2°C?** This is the political horizon that needs to shape our digital choices, a question to be explored and answered thanks to better data, more research and better training of our industry practitioners.

SNCF

FRENCH NATIONAL RAILWAY COMPANY

"People have lost faith -- which is something that is intrinsically bound up with our ability to tackle what lies ahead. We – Businesses – must work to regain that trust."

How does our current view of digital technology differ from the one we had 30 years ago? When did we shift from believing in its benefits to questioning them? Is this an irreversible trend?

Digital technology enabled us to **create new services**, accelerate earlier ones, to allow more and more people to enjoy new oppportunities. It is an undeniable purveyor of progress. Then, it got ahead of us. We set ourselves on a frantic path of relentless innnovation: digital technology has become a service/experience rather than hardware/a device, it has become the heart of the matter, where once it was only a tool.

In 2020, according to human rights protection advocates, digital technology has become the number one source of **exclusion**.

Now that we know this, what can we do? Digital technology in the workplace can only be sustainable if it serves a responsible strategy. The first step, then, is to reframe the debate, **putting environmental** (and societal) **considerations at the heart of corporate** (Government?) **strategy**[129].

But this is not, or rather, no longer enough. People have lost faith – which is something that is intrinsically bound up with our ability to tackle what lies ahead. We – Businesses – must work to regain that trust. This will be accomplished in three stages:

→ **Lead by example**. Reconsider a product/service's entire lifecyle before making a decision. Look to best practices (digital worplace, migration to the cloud, enterprise network, waste management and the circular economy...). Work on optimising our own use of digital technology, in line with our actual needs.

"More than 50% of the demands developed as part of digital products serve no, or little, purpose[130]*."*

→ **Collaborate**. Two player profiles seem key to transforming digital technology.

o Because the sector is heavily outsourced[131], it is crucial to include partners/suppliers in our considerations. But a single corporation alone cannot change an industry's practices. We need to ally our strengths, our objectives, our visions to stand up to the titans. We need to have the courage of our convictions.

o By the same token, it is vital to work in tandem with the Government to map out tomorrow's digital careers, and create the sectors accordingly. We need to alter digital tech's very DNA by factoring environmental (GreenIT.fr) and societal (inclusion and accessibilitu) considerations into school curriculums: "Sustainable by design".

→ **Innovate**. Our major corporations also have a duty to believe in the future, and to build a better tomorrow. Let us be responsible, aware, ethical, and continue to imagine solutions for what lies ahead.

Acting to achieve digital sustainability above all means **regaining people's trust**, proving that science can rhyme with conscience.

129. In 2018, SNCF changed its corporate mission to "give everyone the freedom to travel easily, while protecting the planet," and has continued its transformation with the TOUS SNCF project, making territorial, societal and environmental committments one of the six pillars of its strategie (on by with security)
130. The Standish group – Chaos report 2009
131. While Gartner cites 25% (2017 figures) for the transport sector, our ratio is twice that.

TELECOOP

"Act as a counterweight to telcos' business models."

Digital technology is neither good nor bad. It is what we do with it that counts. TeleCoop believes that telecom operators' **business models**, which are a gateway to ICT, are not sufficiently conscious of environmental and social issues: encouraging users to replace their old equipment and overconsume data, the unchecked deployment of 5G, impatient management of human resources and their clientele, the digital exclusion of certain members of the public, blinders on their social footprint in the countries where they extract their metals, etc.

The first step to addressing these transgressions is transparency. First, **semantic**: there is no agreed-upon definition of the terms "sustainable" or "responsible"; everyone has their own. TeleCoop members and clients expect to see the terms "sustainable" and "responsible" be associated with compliance with the **Paris Agreement** on climate change, and its quantified objectives for reducing greenhouse gas emissions, to keep the average increase in temperature below 1.5° Celcius.

Second, we must use **data** to shed light on the counterproductivity of telcos' business models. TeleCoop notes that the **percentage of mobile phones sold by operators in France** is not publicly available information. A napkin calculation by TeleCoop estimates this share at 50%, including 25% through plans with contractual commitments.

Were this information to be made public, people would be better informed, for instance, about operators' interest in deploying 5G to consumers as quickly as possible. We can deduce the share of these sales in operators' revenue. This is why we are asking for these data to be exposed on Arcep's website.

These data are all the more crucial knowing that Arcep has established that the vast majority of digital technology's negative effects on the environment can be attrributed to **devices**. It would thus be appropriate that Arcep have the power to penalise operators who:

→ reward their customers' loyalty by offering to **subsidise the purchase of a new device** (with no commitment)

→ **give customers and incentive to replace their old device via a plan** with a less than three-year commitment.

Regarding **data consumption**, to put an end to this illusion of endless abundance, the legislator should penalise:

→ **operators** who offer their customers unlimited – or very high volume – flat rate plans, and do not encourage them to consume responsibly (using Wi-Fi at home)

→ **operators** that do not adjust any part of thier plans to actual consumption

→ public or private sector **enterprises** with a staff of more than 500, whose website is not ecodesigned based on standardised system like the one that exists for people with disabilities (RGAA in France)

→ online video **platforms** that do not adapt the resolution of their content to the size of the device

→ **manufacturers** whose telephones cannot connect systematically to a predefined Wifi network, rather than the phone network.

Lastly, regarding 5G, TeleCoop was astonished by the statement by the Secretary of State, Ms Agnès Pannier-Runacher on 30.06.20: "We have met our health and environmental responsibilties, we have relied on agencies Anses, Arcep (telecoms regulator), ANFR (national frequency agency) for guidance".

We suggest amending Arcep's responsibilities under French Law, so that no Government can avail themselves of the telecoms regulatory authority for any electronic communications development project that is likely to increase its ecological footprint on a natoinal scale, and this without a prior **impact study**.

TeleCoop, its members and its clients welcome the new chapter that Arcep is opening, putting the telecoms sector on the path to digital sustainability. We want you to know that we will be by your side, working to make French digital technology an enlightened third way between Silicon Valley and Chinese tech, guided by environmental excellence.

THE SHIFT PROJECT

"It is indispensable to both prioritise making digital behaviours climate positive, and to limit digital technology's direct environmental impact, and so to enact a real split from what have become entrenched habits amongst suppliers and consumers over the past 15 years."

The Shift Project thanks ARCEP for having joined the digital sustainability debate. Indeed, we believe it is urgent for public authorities to move beyond shared conclusions, and take vital measures to ensure that digital technology is more of an asset than a liability in the battle against climate change.

We are aware of its potential contributions to diminishing certain sectors' production of greenhouse gases, including mobility, housing and construction, farming, energy production, etc. But it would be oblivious and irresponsible to believe that this technology has an inherently positive environmental impact, as some public policymakers would have us believe. It is imperative that we inject **environmental rationality** into the digital transition that is currenlty underway, by conducting forecast impact studies, in particular to measure the percentage of "grey" energy that any new project will produce, both prior to operation and at the end of its life, as well as all of its quantifiable emissions, including scope 3 ones.

ARCEP's role as regulator is currently confined to electronic communications networks. But they represent only a portion of digital technology's energy consumption. However, the lever effect that networks have on devices and usage means that any decisions regarding them will have industrial and especially political consequences for the future of our society. Deploying a technology without regulating the usage resulting from the inexorable rebound effect is no longer acceptable in light of our current climate emergency.

Among the workshops and discussions that ARCEP has facilitated over the past six months, we would like to underscore the measures that can lead to a pro-sobriety attitude and foster systemic resilience:

→ We must promote measures that create an incentive to keep devices as long as possible:

o Prevent hardware and software **obsolescence**

o Diminish the impact of **advertising** and especially price **incentives** to a contiuous cycle of replacement

o Promote **responsibly designed** and so repairable devices.

→ We must guarantee **greater complementarity** between the different network technologies by ensuring that customers can use the most energy-efficient technology for the requested service, and penalise the most energy-wasting ones (4K video on a mobile in the subway)

→ We must **banish unlimited plans** from operators' line-up. The feeling of unchecked abundance elicited by these plans is an illusion that must be dismantled.

→ We must **discourage abusive practices** by platforms using attention marketing, which lead to uncontrolled inflation of digital traffic, as well as a loss of free will, which is entirely antithetical to the internet's original goals.

To preserve digital technology's capacity to help create lifestyles that are compatible with a low-carbon use, **it is indispensable to both prioritise making digital behaviours climate positive, and to limit digital technology's direct environmental impact, and so enact a real split from what have become entrenched habits amongst suppliers and consumers over the past 15 years or so**; this cannot happen without a proactive commitment from regulators.

TIBCO

"Digital well being. Guaranteeing a sustainable digital world by caring for the economy, humankind and the planet."

Tibco's aim is to become the first ecoresponsible digital services company.

So taking part in ARCEP's "Achieving digital sustainability" collaboration platform seems like a natural fit. Tibco was founded 36 years ago, specialising in repairing circuit boards. Already driven by the need not to waste.

Today, we are involved in digital services in a broader sense, as much on the user and usage side as the network and operator side of the equation. These professional and technological skillsets alone cannot be a goal unto themselves. Aware that we must be part of sustainable business models, we have adopted eco-responsibilty as a strategic driving force for our company's sustainable development. And one that will come to fruition through our current 2020 – 2023 transformation, which encompasses multiple green initiatives.

Tibco's strategy is: **Digital well being. Guaranteeing a sustainable diigtal world by caring for the economy, humankind and the planet.**

How to reconcile these three elements:

The economy: We cannot overlook the fact that the goal of any company is to be **profitable**. So let's be profitable by doing business in an ecoresponsible way, offering competitive prices, by being technologically innovative, by outperforming the competition, while respecting the environment. We therefore rolled out our first **eco-friendly** solution using recycled materials. And new ones are on the way, as our working tools and methods evolve.

Humankind: People who work at Tibco are all called Tibs, and we are deeply mindful of managing their skills and monitoring their psycho-social health. Everyone will be part of the transformation, and we believe it is important to protect **human capital**.

The planet: Opting for solutions that improve the carbon footprint of our products' and our customers' usage, those that limit **rare earth metals and oil extractions, promote soft mobility, energy sobriety, repair, reuse, collection and recycling**.

Services with a positive effect, to promote responsible digital behaviours

We offer our customers dedicated **eco-friendly** solutions whose aim is to have a positive effect on our production processes, and on our customers' digital usage.

Noteworthy among our actions: switching our vehicle fleet to electric (140 electric light vehicles to date), digitising contractual documents, building our Tibs' awareness of responsible use of digital tech, selective sorting and processing of our waste, transition to green energy contracts on our main sites in France, introduction of remote working on a voluntary basis, using ecologically recycled hardware, testing triple bottom line accounting...

A systemic and partner-centric vision

We believe in keeping a systemic global view of things, to be able to deliver the best eco-friendly solutions: **Life-cycle assessment of uses and resulting effects.**

We have three main challenges before us:

→ To take **relevant** eco-friendly measures (total CO2 emissions, quantity of minerais, RoI)

→ Galvanise all of the **stakeholders** (publc policymakers, technical players, users)

→ Work **together** with all of the players to achieve digital sustainability.

These transformations will take time. We know that we cannot change the world singlehandedly, but we are committed to doing everything we can, with great humility. You can count on us to work like the mighty hummingbird, and do our part.

UFC QUE CHOISIR

"Downstream data-driven regulation of consumer subscriptions would only be acceptable if paired with 'upstream' regulation of corporate practices."

The prospect of 5G's commercial rollout brought to light the issue of digital technology's environmental footprint to an entirely unprecedented degree. This was when UFC-Que Choisir, which is dedicated to promoting responsible consumption[132], was able to put forth one demand, during the discussions that took place as part of the work done on the "Achieving digital sustainability" platform: **transparency on the concrete environmental impact of digital technology**.

The recent bill that seeks to reduce digital technology's environmental footprint in France[133] served to highlight this need for transparency (which could be fostered thorugh the creation of the Observatory stipulated in its Article 3) since its Article 15 proposes a form of regulation of mobile data consumption, by having **consumers pay for the actual mobile data traffic they generate**, and no longer giving them a contractually stipulated monthly data allowance.

Such a measure would have a clear effect on consumers. For instance, if consumers can manage the number of text messages they send or how many calling minutes they use, it is much harder when it comes to mobile data, since it is difficult if not impossible to know how much mobile data is generated when using this or that internet service. Added to which, it is worth noting that capping mobile data could redraw the current landscape by further segmenting available plans, and could deprive consumers of more limited means from using the mobile internet, which is an essential tool for many if not most.

This type of approach was further expanded upon by the National Digital Council which incorporating the data used on the fixed internet into the scope of the data cap regulation. Such an approach could be especially problematic, dismantling a framework that today has been fully integrated into consumers' daily lives, and which enabled the emergence of new services, and abundance in terms of usable data traffic on fixed networks.

particulièrement problématique, in rompant with un cadre qui a aujourd'hui pleinement intégré le quotidien des consommateurs and permis émergence de new services, à savoir abondance in terms of data utilisables via les networks fixed.

Yet, any measure that can have a concrete effct on consumers' use of digital technology, and whose stated goal is to reduce that technology's environmental footprint will only be accepted if the condition attached to reducing that environmental footprint is that it be truly effective.

UFC-Que Choisir would also like to draw attention to the data consumption imposed on consumers. For instance, data-hungry advertisements are being foisted on consumers more and more, notably on video streaming sites and applications. **'Downstream"' data-driven regulation of consumer subscriptions would only be acceptable if paired with 'upstream' regulation of corporate practices.**

132. https://www.quechoisir.org/action-ufc-que-choisir-pour-le-monde-d-apres-construisons-ensemble-la-loi-pour-une-consumption-responsable-n80671/
133. https://www.senat.fr/leg/ppl20-027.html.

VODAFONE[134]

"Technology and connectivity can change the future in a positive way, and ensure that this change does not come about at the expense of our planet."

We support the European Commission's ambitions for a resilient, green and digital Europe.

Our motto is "connecting for a better future" and we are optimistic about the way in which **technology and connectivity can change the future in a positive way, and ensure that this change does not come about at the expense of our planet**.

The major challenges facing our sector are energy consumption, carbon emissions and the production of electronic waste. We are adopting a global approach, setting ambitious targets in each of our markets: our European operations, for instance, will be 100% renewable by i July 2021, and our operations in Africa by 2025. This represents a tremendous challenge in certain markets, but also the best opportunity to bring about change on a large scale.

We are committed to reducing our carbon footprint by being more energy efficient, using renewable energy sources, reducing the waste produced by our network, and by imposing new environmental criteria when choosing our suppliers.

Vodafone remains determined to improve the energy efficiency of its data centres, which together account for 95% of the company's total energy consumption.

In 2019, Vodafone invested 77 million euros in energy efficiency and renewable energy projects, which enabled it achieve annual energy savings of 186 GWh[135].

From a more concrete pespective, last year, despite the ongoing increase in data traffic, Vodafone was **able to reduce the total quantity of GHG emissions per PB of mobile data by 38.5%**, to reach an average of 230 tonnes of CO2 equivalent per PB[136].

In July 2020, Vodafone also announced a new target, to help its customers reduce their own carbon emissions **by a combined total of 350 million tonnes over 10 years, between 2020 and 2030**.

The IoT applications that help customers reduce their emissions include, among other things[137]:

→ Smart energy meters that give enterprises, municipal authorities and households the ability to monitor, manage and reduce their energy consumption. Vodafone has more than 12 million smart meter connections worldwide using its IoT technology, saving around 1.6 million tonnes of CO2e a year.

→ Smart cities - intelligent networking to make energy-hungry services more efficient, such as public transport, public road and public lighting networks. In the city of Guadalajara, in Spain, for instance, 13,500 LED lights were connected to a central management system, reducing the energy consumed by the town's public lighting system by 68%.

→ Smart logistics - Built-in IoT technologies in vehicles for optimised management of their travel routes and vehicle maintenance, helping to reduce petrol consumption by up to 30% and saving an estimated 4.8 million tonnes of CO2e.

134. Vodafone is one of the largest telecommunications operators in Europe and in Africa (with joint ventures in India and in Australia).
135. https://www.vodafone.com/perspectives/blog/building-a-sustainable-future
136. https://www.vodafone.com/news-and-media/vodafone-group-releases/news/vodafone-european-network-to-go-100-percent-green
137. https://www.vodafone.com/news-and-media/vodafone-group-releases/news/vodafone-european-network-to-go-100-percent-green

WIFIRST [138]

PROFESSIONAL WIFE NETWORK OPERATOR

"Future recommendations for establishing action plans to minimise networks' carbon footprint must factor in the protocols available on devices."

Examining the carbon footprint generated by data traffic:

It is not because our core business is to provide a service tied to data consumption that we cannot also be concerned about the effects of that service. Wifirst believes **that future recommendations for establishing action plans to minimise networks' carbon footprint must factor in the protocols available on devices**:

→ In absolute terms "1 Gb relayed over fibre consumes less energy than 1 Gb relayed over an electrical conductor" and "1 Gb relayed over WiFi consumes les energy than 1 Gb relayed over a cellular network". However, a device that is unable to connect via fibre or wireline Ethernet only has a choice between cellular and WiFi. So connecting it via wireline would require additional access equipment, which would create a bigger carbon footprint.

→ A computer connected in RJ45 will transmit a Gb with a smaller carbon footprint than a mobile phone, but it will consume much more energy than a cellphone. Another way of looking at it: one hour of videoconferencing on a wired computer probably causes more pollution than on a mobile device, because of the two devices' very different levels of electricity consumption.

It is worth exploring the introduction of the **Merit Order**[139] principle. When a choice is available (which it is in the vast majority of cases) the least polluting channels must be programmed to be used first. Wifirst has undertaken a broad research and development initative on this issue, seeking:

→ To **quantify,** on all of the infrastructures on which we operate, the weight of the different phases of the equipment's life-cycle: production, transport, upstream, downstream, installation, operation (energy consumption), removal, recycling

→ To **evaluate** the impact of the frequency at which equipment is replaced on the networks' carbon footprint

→ To **identify** the levers for reducing the carbon footprint of its telecom operator business.

This initiative, which is currently underway, and being carried out in partnership with leading outside experts, is scheduled to be completed by Q1 or Q2 2021 at the latest.

If the intelligence of our networks must create the ability to control their energy consumption, the process of deploying ever more eco-friendly digital solutions also requires users to be aware of the impact of their usage. This is part of a drive to achieve global awareness by, why not, showcasing green solutions. When will we have a "nutri-score" type system for telecoms operators?

138. Wifirst is a B2B telecom operator specialised in providing WiFi as-a-service. We deploy and operate WiFi networks for a wide variety of businesses: retail chains, hotels, student residences and the armed forces. Our motto: enable businesses to improve their productivity thanks to connectivity, and to generate savings thanks to sustainable multiservice WiFi. It is because we have put carbon footprint at the heart of our strategy that we deploy sustainable networks on our customers' premises.

139. Transposing a principle that already exists for electricty networks to the telecoms industry

PART 3

[act]

MAKE CONCRETE PROPOSALS AND TAKE ACTION

As part of its work, Arcep wanted to map out concrete courses of action to achieve digital sustainability. Among the regularly proposed courses of action, some pertain to standardisation and taxation. For its part, and with its regulator's background, Arcep wanted to examine the mechanisms that could strengthen the incentives for economic agents – suppliers and users – to reduce digital technology's environmental impact, through three strands.

First, Arcep's analysis, which is set out in Part 1, underscores the need for more and better data to achieve a more detailed definition of digital technology's environmental footprint, for every component in its ecosystem, to move beyond the stage of awareness and so be able to take appropriate measures. This is a need that was also expressed in most of the Workshops and Big discussions that the Authority has facilitated over the past several months. It has highlighted the need to give public authorities the power to collect information from digital sector players, to be able to monitor their footprint and measure the effects of their practices (3.1).

Second, during these moments of discussion, several forms of leverage and possible courses of direct action on the networks were identified, giving Arcep an opportunity to draft a preliminary list of actions to take to incorporate environmental imperatives into its regulatory actions (3.2).

Finally, the discussions also underscored how important it is to increase incentives for economic stakeholders and users, which begins by fostering a committment from all of the sector's players to act in an eco-responsible way (3.3).

Before detailling these different proposals, Arcep wanted to present an initial analysis (for which the players can suggest changes), positioning the digital sector's different stakeholders and describing their impact on digital infrastructures from an environmental perspective. Arcep will then use this description to finalise its proposals. Other cross-cutting issues could help enrich this analysis over time, such as the link between cyberthreats and environmental threats, which was recently addressed in a Workshop co-hosted by ANSSI and Arcep and summarised in Part 2.1.9.

Networks are deployed and managed by electronic communications operators. Their environmental footprint therefore depends above all on operators' deployment strategies and management processes. But other factors also come into play. First, the properties of the devices sold by suppliers, which affect energy consumption among other things. Second, how users employ their devices, which influences both how networks are scaled and how much of their installed capacity is occupied. This usage affects networks' environmental footprint in two ways: how the services are designed (encoding optimisation...) by content and application providers (CAP), and user consumption (volume, type of services consumed, etc.) itself.

Beyond that, one also has to examine – as is regularly pointed out – the ways in which the features of ISPs' (internet service providers, which here also include electronic communications operators) plans influence network traffic and, albeit in a different way, CAPs' plans as well (subscriptions to video on demand services or music streaming services, for instance). An expensive plan that includes traffic-based billing would, for example, potentially rein in a subscribers' usage levels.

Electronic communications operators
Users
Content and application providers
Devices
Network equipment
NETWORKS

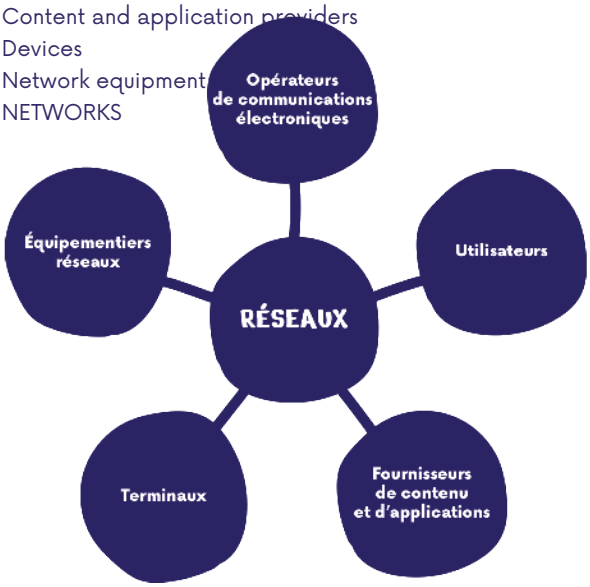


Figure 13: Players who shape the "Networks" building block

Regarding **devices,** it is their production stage that accounts for the bulk of their environmental footprint (86% of the GHG emissions tied to devices occur during their productionn[140]). This equipment is produced by manufacturers that determine both the resources that will be employed upstream, how easy or hard they are to repair, and their operating features when being used. Their distribution (new, used, rental), which can affect these devices' environmental footprint (see Workshop 1), can take place either in a

Distributo
Users
Content a
Repair, re
Manufactu
DEVICES

Figu

140. Citizing, *Digital technology's carbon footprint in France: are public policies enough to handle the rise in usage?*, June 2020.

brick and mortar shop or online. A growing number of players are becoming involved in distribution, including manufacturers selling their own products themselves, alongside traditional vendors (authorised retailers/resellers, specialised retail chains, generalist retail outlets, etc.) and electronic communications operators.

Repair, refurbishment and recycling mechanisms have been developed and are expanding. They are managed either by the abovementioned vendors, or by new players.

In addition to which these devices, which are what give users the ability to consume the content and applications offered by CAP, affect network operations for several reasons:

• first, because of the energy resources that OS and applications use to deliver access to their content and services, to data centres, networks and devices;
• second, because of their replacement, as equipment may be prematurely scrapped or discarded. To give an example, when an old version of an OS is no longer maintained or when applications are no longer compatible with a device, users may feel pushed to replace their old device to be able to have access to the latest services and features.

Data centres (which account for 14% of digital technology's carbon emissions in France[3]), meanwhile, are usually managed by CAP themselves, or by data centre or CDN (content delivery network[4]) operators when the CAP employs a third party. Network operators may also control a portion of these data centres (notably those linked to their core network). Data centres' environmental footprint stems from the equipment they house, supplied by manufacturers, the strategies used to install this equipment and how it is employed, all of which shape the data centres' scaling and provisioning strategy (which is also determined by the level of demand from users, as well as the type of services and volume of data produced and stored by service providers). To be accessible to users, the content and applications on offer are necessarily stored in data centres.

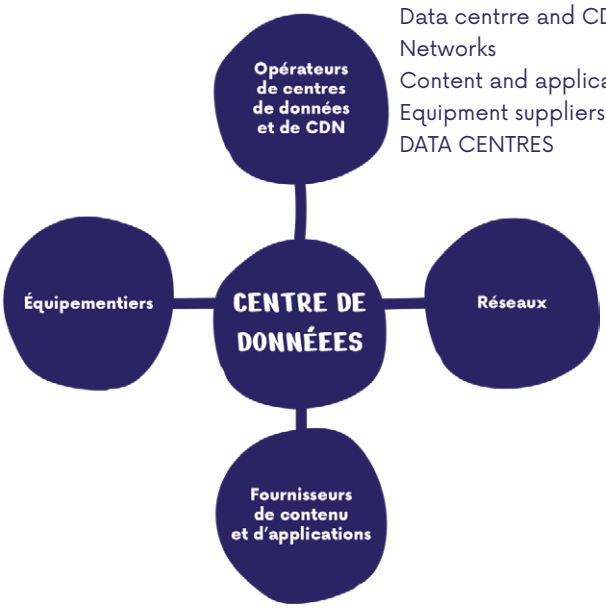
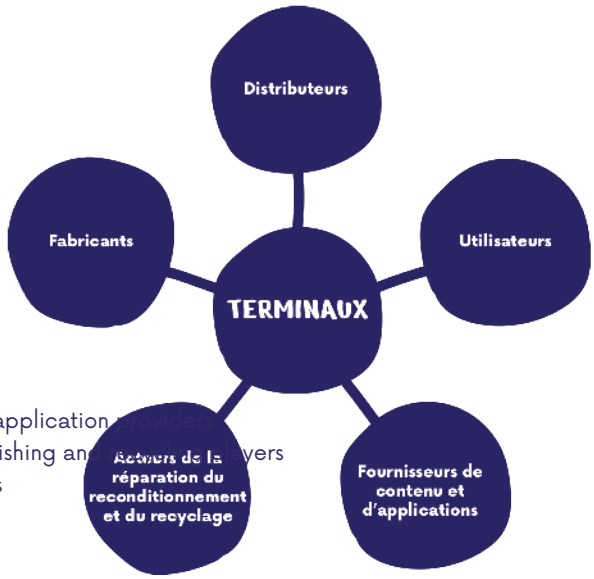


Figure 15: Players who shape the '"Data centres" building block



rs
nd application
furbishing an yers
urers

ure 14: Players who shape the '"Devices" building block

3. Citizing, *Digital technology's carbon footprint in France: are public policies enough to handle the rise in usage?*, June 2020.
4. *Content delivery networks* are platforms that content and applications providers use to be closer to end users, and thereby improve both their own quality of service and the quality of the user experience, while enjoying global connectivity and reducing traffic routing costs. Reducing the distance between customers and servers helps reduce latency, increase performance and reduce costs. See Glossary.

3.1 Measure to ensure better oversight by public authorities

3.1.1 Data-driven regulation, transparency and more

In a situation of permanent innovation, the sector's regulators rely more and more on the collection, utilisation and publication of data, as part of a "data-driven" approach to regulation, which comes to complete the regulator's traditional toolbox and enables it to expand its capacity to take action, particularly as part of a process of monitoring and detecting weak signals, and to help users make informed choices and so better steer the market in the right direction.

Instead of ordering economic stakeholders to adopt certain behaviours, the goal is to deliver a **massive "dose of transparency"** to reduce information asymmetries and leverage the impact of regulatory action by galvanising users. Making data available to as many people and entities as possible, and giving players opportunities to utilise them, to discuss them, to give them value and produce relevant decision-making tools for users all contribute to **creating a platform-like system of public action** where incentives to take action are not coming solely from the regulator.

Data-driven regulation also opens the way for **greater involvement from all of the player**s, strengthens the regulator's analytical capacity and helps keep users and civil society better informed.

This seems like an advisable approach to take to environmental issues as, in addition to the benefits listed above, it would also generate data to fuel the work being done by experts, helping to advance their efforts to obtain an accurate assessment of digital technology's environmental footprint, and to foster the emergence of tools for users, to inform the environmental aspects of the choices they make and actions they take in the digital universe.

The first step in this process is to ensure the **collection of the data** that will provide public authorities with the information they need to **define and implement appropriate action**s (3.1.2). To this end, we need to establish which are the relevant data to collect to **implement control indicators** (3.1.3). Data collection must also be designed to power the tools made available to the public, to better inform users and enable them to make good choices. This latter mechanism is explored in more detail further on (3.3.5).

3.1.2 Improve measurement to be able to better identify issues and enable an efficient mobilisation of public powers

In 2019, France's Competition Authority, along with fellow regulatory authorities, AMF, Arafer, Arcep, CNIL, CRE and CSA drafted a memo[141], as part of a joint work project[142] to formalise their discussions and investigations, and to provide an account of their progress in data-driven regulation. This work helped to highlight two core

141. Arcep, Competition Authority, AMF, Arafer, CNIL, CRE, CSA, *New regulatory methods –Data-driven regulation*, July 2019.

142. An informal group that has been meeting twice a year since 2017, including the chairs of several independent administrative or public authorities, as defined by the Law of 20 January 2017, along with their directors and General secretaries, to discuss cross-cutting issues and manage joint work and investigations. This group now includes eight institutions.

objectives associated with data-driven regulation, namely: to amplify the regulator's capacity to take action and to empower users to make informed choices. The joint memo also underscored the implications of data-driven regulation, including **the need to gather information from regulated players**, but also the need to **expand the scope of the data being collected**, to develop crowdsourcing tools, and to acquire new skills and instruments.

In the bid to achieve digital sustainability, data gathering could **help deliver a massive dose of transparency** on digital applications' environmental footprint, and provide information on the environmental responsibilities of certain types of player or service. This information will be vital to drafting and implementing appropriate action plans for achieving sustainability for the digital sector.,
For this to happen**, a regulator, in the broadest sense of the word, must be given the power to specify what format environmental data gathering will have, and the players concerned must have a legally binding obligation to provide that regulator with this information.**

Arcep, which has already lent itself to this exercise on other matters, is ready to support this process. **The Authority has already taken steps in this direction**, within the limits of the powers it has been assigned, by **adding – in April 2020 – an environmental dimension to its system for gathering information**[7] from electronic communications operators. The thus collected indicators pertain to the main electronic communications operators' greenhouse gas emissions, along with a breakdown by scope (i.e. scopes 1, 2 and 3 emissions as defined by the ISO 14064-1 standard[8]) between 2015 and 2019, and on the electricity consumption of the router and set-top boxes used by their customers.

Under the hypothesis that **Arcep would be asked to expand its actions to all of the sector's players, notably to include data centres, and to devices, in addition to increasing its personnel and possibly financial means, this would require the adoption of legal foundations that give it the power to address these players**.

3.1.3 Identifying indicators that can apply to the entire ecosystem

The process of gathering environmental data begins with identifying and implementing indicators that pertain to the entire digital ecosystem.

In this section, Arcep offers a first draft of the indicators that may be useful to collect. This proposal is based, first, on work that has already been done or is currently underway and, second, on Arcep's current understanding of data needs, following its discussions with stakeholders via its " Achieving digital sustainability " collaboration platform.

The proposals listed here below constitute a preliminary proposal on which **players are invited to give feedback.** In certain cases, it may be appropriate for indicators to be gathered on a European if not international scale.

This is a rich set of proposals that may be complex to collect, to utilise and for users to fully understand. Which is why deployment needs to be gradual, and why additional studies, including joint work between the players, will be needed to achieve an increasingly relevant and operational system of data gathering.

To construct certain indicators and collect certain data, it seems advisable to review this list with the players, **to identify which information can be easily gathered and which cannot**. For hard to gather information, stakeholders could **explore possible solutions and establish approximations**, for instance through supplementary indicators, which do not supply perfect information but rather orders of magnitude and trajectories that align sufficiently with reality. In addition, **some of the proposed indicators could be given higher priority than others, which would be collected**

143. Arcep Dcision No. 2020-0305 of 26 March 2020 on implementing surveys in the electronic communications sector

144. The ISO 14064-1 2006 standard specifies principles and requirements at the organisation level for quantification and reporting of greenhouse gas (GHG) emissions and removals. It includes requirements for the design, development, management, reporting and verification of an organization's GHG inventory. It differentiates direct greenhouse gas emissions (scope 1), indirect emissions associted with energy (scope 2) and other indirect emissions (scope 3).

during a subsequent stage of the process, according to each indicator's importance and stakeholders' technical ability to collect them.

In any event, all of these data and indicators cannot be collected immediately, in one fell swoop. Here again, it must be **part of a gradual approach** that involves **developing an initial, small scale information gathering campaign that can then be steadily expanded** to obtain more granular data and more streamlined indicators, ultimately to have a detailed and accurate picture of different digital players' environmental footprint (beyond their carbon footprint) and its progression over time.

For the sake of clarity, below is a preliminary list of proposals, for each type of player involved in the information gathering. A summary of the indicators that Arcep believes should be the initial priorities is also included at the end of this section.

> Collecting data from electronic communications operators

Why gather information from these players?

> Five percent[145] of digital technology's environmental footprint can be attributed to networks, and there is still too little information available to be able to clearly break down this impact and identify the levers for action.

To begin with, and using the process employed by Arcep for its first information gathering campaign with electronic communications operators[146], it would seem essential to obtain data from operators[147]on their **direct and indirect GHG emissions**[148] **and their electricity consumption in kWh**[149]**.** These two indicators, which may seem quite similar, are nevertheless complementary. While the aim of the Paris Climate Agreement is to reduce greenhouse gas emissions, which can be achieved by decarbonising the energy being used, also monitoring electricity consumption offers a way to know whether or not the measures being taken are containing or reducing networks' energy consumption.

Regarding **internet routers and set-top boxes** in particular, the **energy consumption of each of the models marketed** by operators, whether in sleep or normal operating mode, the average electricity consumption of all of the boxes and STBs **used by each operators' customers** as well as the current **composition of operators' equipment base** do appear to be relevant information.

All of these data could serve to supplement those that ADEME has already collected under the stipulations of Article 13 of the **AGEC Act**[150], to provide a snapshot of the environmental footprint generated by subscribers' data traffic on fixed and mobile networks.

145. French Senate, Task Force report - Achieving a green digital transition June 2020.
146. Arcep Decision No. 2020-0305 of 26 March 2020 on implementing surveys in the electronic communications sector
147. To obtain aggregate sectoral data, it will be essential to remove any tallying issues that would result in double counting (e.g. service provision between electronic communications operators).
148. GHG emissions of scope 1, 2 and 3 of as defined by ISO 14064-1 standard
149. Consumption in kWh makes it possible to analyse a player's energy consumption without considering their carbon footprint. It therefore does not factor in energy mix decarbonisation strategies that might be adopted by the players (also captured by GHG emissions) and which could result in transferring effects to other critieria (consumption of abiotic resource, artificialisation of land, etc.). The purpose of measuring consumption in KWh is to gauge energy efficiency and sobriety strategies, while factoring in possible rebound effects (without identifying them specifically) and could serve as an effective proxy for other effects.

Second, it would be useful to collect information on operators' **GHG emissions** and electricity consumption on the **different network segments** (access, backhaul, core network) depending on the underlying, notably **access technology** (3G, 4G, 5G, FttH, ADSL, etc.). This would provide a more detailed understanding and hence more relevant analysis of the forms of leverage and actions to undertake.

Finally, since electronic communications operators also sell the devices their customers use, it would seem relevant to collect certain information from them regarding the **business models used and the life cycle of the equipment they sell**. This information could, for instance, include the **volume of subsidised, new and refurbished device sales,** along with the number of used devices collected by operators and their destination (refurbishment, recycling, etc.).

> Collecting data from equipment and device manufacturers

Why gather information from these players?

As indicated above, the vast majority of devices' environmental footprint is generated during their production (86% of the GHG emissions[151] tied to devices in 2019 were generated during the production stage). Setting up data gathering on device-makers' GHG emissions would make it possible to correctly identify the sources of the emission during these production processes, and track their evolution, to inform consumers and to shine a light on manufacturers with the greenest production processes.

The AGEC Act already requires equipment and device manufacturers to provide **data that will help establish repairability[152] and durability[153]** indexes, starting in January 2021 and January 2024[154], respectively.

Beyond that, it seems advisable to collect data on their **direct and indirect GHG emissions** and their electricity consumption in kWh (cf. above).

Furthermore, in addition to repairability and durability indexes, a recyclability index could also be considered[155].

It may also be useful to supplement these indicators with **other environmental ones,** for instance regarding the consumption of finite resources (abiotic resources, rare earth metals, etc.) to obtain a more exhaustive picture of these players' environmental footprint.

Other information regarding **operating systems' maintenance processes** installed on devices (which may influence their obsolescence), the life cycle of each product (at the very least in terms of the main parameters of their production stage, using a multicriteria approach), **equipment's actual energy consumption when in operating or sleep mode, and the volume of new and refurbished products sold** (when manufacturers distribute some of the devices they produce) could also warrant collection.

> Collecting data from content and application providers and particularly operating systems suppliers

Why gather information from these players?

Content and application providers (CAP) develop services that become user applications. They are the managers of most of the services consumed on the internet, and have a direct influence on data centres', networks' and devices' own consumption. A small handful of CAP supply the lion's share of services and applications.

150. These data must be sufficiently detailed to represent a reliable and useful source of information, without being too complex for operators to collect. This mechanism must also be sufficiently secured to ensure that it does not violate operators' trade secrets or consumers' privacy.
151. Citizing, Digital technology's carbon footprint in France: are public policies enough to handle the rise in usage? June 2020.
152. For instance: availability of documentation, ease of disassembly and reassembly, whether required tools exist and are available, potential commitment on how long spare parts will be available, shipping time, ratio between the price of the part and the price of the product, existence of a competitors to the manufacturer.
153. For instance: average time between the repair and the next breakdown, frequency and results of quality and wear tests, component hardware's robustness and estimated lifespan, existence of after sales service and technical support.
154. Work of the National Assembly – Sustainable development and regional development committee, on the bill passed into law, on combatting waste and in support of the circular economy, and the work done on putting an end to planned obsolescence (Halte à l'Obsolescence Programmée) will be useful to more precisely determine the indicators to collect. - Halte à l'Obsolescence Programmée, White Papter – 50 measures for sustainable consumption and production, February 2019. - National Assembly, Report on behalf of the Sustainable development and regional development committee, on the bill on combatting waste and in support of the circular economy (No. 2274), November 2019. Also: Ministry for the Green and Inclusive Transition, "Public consultation on a draft Conseil d'Etat decree, and associated orders, regarding a mandatory repairability index for electrical and electronic products", August 2020.
155. For instance: rate of old equipment collection, rate of recycling by type of hardware and equipment, etc.

The operating systems (OS) installed on devices typically service a very large number of users, and play a very particular role since they set the access conditions, as well as some of the terms and conditions for developing the services and applications on the devices. They generate both direct (energy resources solicited by OS) and indirect (tied to the replacement and sometimes premature scrapping of equipment due to software-generated obsolescencet)[156] environmental effects.

Implementing a process for gathering information on the effects induced by operating system suppliers' and CAPs' practices would result in a better understanding of digital services' environmental footprint, and of the scale of the impact of device obsolescence. This information gathering could also provide an opportunity to showcase ecodesign best practices.

What issues are raised by services' and devices' marketing and distribution models? Service providers, operators, device distributors, users... What role does each stakeholder play in defining business practices? What are the varying effects of device purchasing, rental and sharing models? What advertising strategies and incentives would lead to more mindful consumption?

The topic was addressed in two parts. The first asked the question: "Achieving digital sustainability, which tech company practices should be promoted, improved or changed, and above all why?" Participants answered that they believed certain business practices resulted chiefly in reducing the life of devices (around 23 months in France for smartphones) and increased the number of devices (IoT etc.) in circulation. Participants underscored the need to supervise business practices such as promotional or customer loyalty campaigns that decorrelate the price of the device from its market value. Depending on the sensibilites, proposals ranged from banning these practices to introducing incentive mechanisms for device vendors (compiling best practices, for instance). Transparency and improving the information provided to users were also suggested as additional tools to enable them to maintain a critical eye regarding business practices, and to make informed choices.

Regarding content and application providers, here again it could be useful to begin by collecting data on their **direct and indirect GHG emissions** and energy consumption in kWh (cf. above) to be able to track the evolution of the carbon footprint and of the energy consumption of the largest among them.

At a later stage, it could be useful to fine tune this **information gathering to a more granular level (breaking down the above-mentioned** information by scope and by digital service) and possibly to encourage CAPs to provide consumers with **individualised information** on the environmental footprint created by their consumption of digital content and services. This in the same spirit as the obligation that the AGEC Act imposes on electronic communication operators.

Indicators that create the ability to deliver information on the **data volume required to supply existing digital services** could represent another useful piece of information. Initially, average data consumption to use a service (Gb/minute of consumption for instance) might be one piece of information to be made transparent. Further down the road, it could be interesting **to be able to distinguish,** from amongst these data required to supply the service, the **volume of data** that is mobilised to run the service but **does not serve users' direct requests** (e.g. the amount of data mobilised for cookies, video adverts, etc.).

Lastly, because these services can be a source of premature scrapping of user devices, indicators pertaining to **operating system suppliers and content and application providers' practice**s could also be worthwhile. For instance, initially, regarding OS suppliers: the average hourly electricity consumption that the OS needs to run, how long each of the main OS in circulation is maintained, the number and type of pushed updates, and the device models compatible with the latest versions of the still maintained OS would all be useful information.
Lastly, regarding content and application providers, potentially relevant indicators could include the number of OS each service supports, whether the service is maintained on each of these different OS and in their updates. These indicators would provide a clearer picture of the reality of software and hardware obsolescence.

156. The notions of direct and indirect environmental effects as defined here are only intended to illustrate the statements made in this report, and are not a definition recognised beyond that. To the Authority's knowledge, no specific terminology exists that covers the effects described here.

Later on, it could be useful to have a **life cycle assessment for each service.**

> Collect data from data centre managers and operators

Why gather information from these players?

> Data centres represent 14% of digital technology's environmental footprint in France. While a substantial body of existing work on indicators makes it possible to assess the environmental impact data centres[157], more detailed work would prove use to fully understanding their impact and the actions to take.

As with other players, it seems relevant, initially to collect data on **direct and indirect GHG emissions and consumption** in kWh (cf. above) to be able to track the evolution of the carbon footprint and energy consumption of the largest data centres and data centre operators.

The European Commission launched an in-depth study in autumn 2020 which aimed, among other things, to define data centres, collect information on current practicesn assess their life cycle and improve how their energy efficiency and resource efficiency is measured[158]. The findings of the study will probably create the ability to fine tune the list of indicators that it would be useful to collect from these players.

A data centre's energy consumption is distributed between its computer equipment (servers, storage, network) and its other installations (air conditioning, ventilation, power distribution systems, etc.). The first data to collect, then, could pertain to the **IT equipment's energy consumption**: in the same vein as ITEE (IT equipment energy efficiency) reports that measure the actual energy consumption of a data centre's computer equipment. ITEE corresponds to IT equipment's rated capacity divided by its rated power consumption. ITEU (IT equipment utilisation) is another indicator used to measure the efficiency of IT equipment's energy use.

Information on the **energy consumption of a data centre's other installations** (air conditioning system, ventilation, power distribution) could also be gathered. The aforementioned **PUE** (Power Usage Effectiveness) measures a data centre's energy efficiency.

In addition obtaining data that **enables a complete multicriteria analysis,** in the form of a life-cycle assessment of a data centre's installations, would make it possible to have a full accounting of data centres' environmental impact. It could be useful to begin to obtaining information such as **WUE** (Water usage effectiveness), i.e. the quantity of water used annually, along with information on the **reuse of the waste heat**[159] produced by the data centre. Subsequently, information such as the **rate at which a data centre's components are recovered** for recycling and repair, the **rate of hardware reuse** (whether in a data centre or for another application), the existence of a **second hand** data centre hardware market, and their **management of "zombie" servers**[160] could all be equally worthwhile to obtain.

157. Dinesh Reddy V, Setz B., Rao G. V., Gangadharan G. R., and Aiello M., Metrics for Sustainable Data centres, IEEE Transactions on sustainable computing, vol.2, No. 3, p.299, July-Sept.2017. and notably the following definition: "A green data centre is a system in which the mechanical, lighting, electrical and IT equipment are designed for maximum energy efficiency and minimum environmental impact". Murugesan and G. R. Gangadharan, Eds., GreenIT.fr: An over-view, in Harnessing GreenIT. fr: Principles and Practices. Hoboken, NJ, USA: Wiley, ch. 1, pp. 1–21, 2013. R. Basmadjian, and al., Green data centres, in Large-Scale Distributed Systems and Energy Efficiency: A Holistic View. Hoboken, NJ, USA: Wiley, pp. 159–196, 2015.

158. European Commission, Study on greening cloud computing and electronic communications services and networks: toward climate neutrality by 2050, 2020.

159. According to the definition used by the Multiannual Energy Plan : "heat generated by a process which is not its primary purpose, and is not recovered".

160. "Zombie" or "comatose" servers are physical servers that function and so consume electricity, but that do not communicate and generate no processing resource. In other words, they are turned on but not used at all. The definition by Koomey and Taylor considers a server to be comatose after six months of no network activity, user activity, connections or CPU activity. Cf. Koomey J. and Taylor J., New data supports finding that 30 percent of servers are 'Comatose', indicating that nearly a third of capital in enterprise data centres is wasted, Oakland, CA: Anthesis Group, 2015. According to this study, 30% of all physical servers are comatose. If virtualisation seems to enable more optimal used of these servers, a broader 2017 study, including half of all data centres, concluded that 30% of virtual machines and 10% of virtualised servers are zombies.

Summary of indicators mentioned

The proposals listed here are not final, and players are invited to provide feedback on them.

In addition, some of the proposed indicators could be considered top priority, and others collected later on.

To Arcep's knowledge, some of the indicators mentionned here are already available or work on them is underway. It would be useful in future to be able to determine how far along these works are, and their ability to make the data they produced publicly available.

Network indicators
to be collected from operators

→ GHG emissions
- Step one: by scope
- Step two: by network segment (core, backhaul, access) and by underlying access technology (2G, 3G, 4G, ADSL, Fibre, Cable etc.)

→ Electricity consumption (KWh)
- Step one: for the entire network
- Step two: by network segment (core, backhaul, access) and by underlying access technology (2G, 3G, 4G, ADSL, Fibre, Cable etc.)

→ Routers/STBs' annual electricity consumption
- Step one: by device model
- Step two: other environmental footprint factors

Device indicators,
to be collected from leading manufacturers, distributors, operators and players involved in refurbishing devices, depending on the indicator

Carbon footprint and Electricity consumption

→ GHG emissions
- Step one: by scope
- Step two: by device model available in the marketplace

→ Electricity consumption (KWh)
- Step one: during the production phase
- Step two: by available device model, in operating and sleep mode

Other environmental effects

- Step one: volume of devices sold by catgory new/refurbished and subsidised/ SIM-free)

- Step one: collection/recycling volume
  - Volume of devices collected by players, including the number actually refurbished, number recycled and volume of unprocessed waste (discarded)
  - Volume of recycled matter

→ Indicators that will make it possible to construct repairability and durability indexes, made mandatory in 2021 and 2024, respectively, by the AGEC Act
- Step two: other environmental footprint considerations

OS indicators for content and applications,
to be collected from the biggest suppliers

Other environmental effects

→ **Data volume**
- Step one: total volume of data stored and transmitted
- Step two: total volume of data by service – including volume of primary data and volume of data not solicited by users (cookies, adverts, etc.)

→ **CAP practices:**
- Step one: number of compatible OS per digital service
- Number of updates proposed (including number of performance upgrades and number of corrective maintenance updates) per digital service

→ **OS providers' practices:**
- Step one: length of maintenance support for the main OS in circulation by company
- Number of updates proposed (including number of upgrades and number of corrective maintenance updates) per player
- Step two**: Life-cycle assessment by service**

Carbon footprint and electricity consumption

→ **GHG emissions**
- Step one: overall
- Step two: by scope and by digital service

→ **Electricity consumption (KWh)**
- Step one: by supplier
- Step two: by digital service

Data centre indicators, to be collected from the largest operators and data centre managers

Energy consumption

→ **GHG emissions**
- Step one: in France and by scope

→ **Electricity consumption (KWh)**
- Step one: in France

→ **ITEE**
- Step one: in France on average by company

→ **PUE**
- Step one: in France on average by company

Other environmental effects

- **Step one:**
  - Quantity of water consumed: WUE *(Water usage effectiveness)*
  - Reuse of waste heat produced by the data centre
- **Step two:**
  - Rate of collection for the data centres' components for recycling, repair and refurbishment.
  - Rate of hardware reuse, for a data centre or another application
  - Comatose server management

3.2 Better incorporate environmental considerations into the actions that Arcep takes in its role of "architect of communication networks as a common good"

To ensure that communication networks continue to develop as a "common good", today the Authority wants to incorporate environmental considerations more extensively into its day-to-day actions, and thereby open a new chapter in its regulation.

To achieve this, Arcep wants to obtain an **objective comparison** of the technologies' performances, for which there are still no clear answers (3.2.1) and to **encourage the transition** from fixed networks, and the legacy copper network in particular, to fibre, the new and far more energy efficient infrastructure of reference (3.2.2). **Several issues still need to be clarified** regarding mobile systems in particular. (3.2.3). Lastly, and as was mentioned in Part one, the digital and green transitions both extend beyond national borders, and therefore require **action at the European and international level** (3.2.4).

3.2.1 Obtain an objective comparison of the different technologies' performancess

As mentioned in Section 1.1.2, comparative assessments have already been made of the different fixed and mobile technologies' energy performance. The **most recently deployed technologies are considered to be more energy efficient than their predecessor**s: fibre consumes less than ADSL in the access network; similarly, 5G is designed to enable mobile networks to consume less power per Gb transmitted than 4G, 4G less than 3G and 3G less than 2G. In addition, **wireline networks are considered more energy efficient than mobile ones**.

There is no consensus, however, on absolute energy consumption assessments for each technology
Different analyses may indeed reach different conclusions depending on their methods: an approach that takes a given technology's total energy consumption divided by the amount of data traffic it is relaying, will not necessarily factor in that the technology has an irreducible consumption even when there is zero traffic, and that energy consumption is therefore not directly proportionate to the volume of data consumed.

This is why an exact **comparison of the different technologies' energy performances is no simple matter, and requires a detailed approach,** which takes into account whether or not it depends on traffic, or control over the "paths" taken by the data depending on use cases.

Added to which, assessing energy performances in "silos", technology by technology, has its limitations. It does not take into account the history of the different technologies' deployment on fixed or mobile networks, specific associated use cases, the degrees of substitutability between the technologies, or the status of the market associated with each technology and particularly compatible installed equipment.

These individual assessments therefore need to be completed by a global approach to the technologies and the networks, to develop the means to achieve an interplay of connectivity, resilience and sobriety by playing on their complementary and competing features.

3.2.2 Encourager fixed networks' transition to fibre

> Choosing our networks

On the fixed network front, it was in the 1970s that France equipped itself with a copper network that spanned the entire country, initially used for telephone services and later broadband internet and television. Ten years ago, operators decided to deploy Fibre to the Home (FttH) networks that would provide users with superfast internet connections, and satisfy other wireline service demands (television and landline calling).

Fibre has a smaller environmental impact than the copper network (ADSL or PSTN[161]) in terms of the infrastructure's energy consumption: a fibre line is estimated to consume three to four time less than a copper one[162]. This increased efficiency applies only to the network portion, and could be nuanced by the power consumed by the devices (ISP customers' routers) connected to the fibre system. This consumption may indeed exceed that of equipment connected to the copper[163] network due to the larger number of built-in features, as well as the higher speeds and increased data consumption.

Over time, the transition to fibre should result in a reduced environmental footprint for fixed networks, but special attention will also need to be given to ensuring that it not go hand in hand with excessive device obsolescence and energy consumption.

It was in this context that Arcep observed an acceleration in the pace of fibre network deployments, and in the increase of fibre subscribers, which comes to confirm the wisdom of the Authority's definition of a framework that would undergird this overall trend, and **lay the groundwork for a now credible passing of the torch from copper to fibre, the new fixed infrastructure of reference.**

Not only is the coexistence of two nationwide fixed networks not economically viable, but it also represents excessive consumption of both energy and resources. In its new round of regulation (2021-2023), and in keeping with its national and European regulatory objectives, Arcep plans on supporting and helping to shepherd this transition, which rests on the initiative of 'Orange[164], owner of the legacy copper network. It encourages operators to switch over to fibre wherever it is available, for instance while remaining vigilant about ensuring that this transition does not undermine competition, and leaves no user aside.

If it is inevitable that this period of transition between copper and fibre will include the temporary coexistence of two wireline networks, the Authority believes that **Orange's plan**, which it welcomes and whose principle it salutes, **nevertheless leaves a number of unanswered question, which is inevtable for an undertaking of this scale**. To prevent this situation from lasting too long, it is vital to ensure that Orange can stick to the timetable that it has set for itself, namely the gradual technical switch-off of its network starting in 2023 and to be complete in 2030.

161. The Public Switched Telephone Network (PSTN) is the legacy landline telephone network (where the phone is plugged into the wall jack). Orange has decided to stop marketing and operating this technology, because it is obsolete. It is becoming more and more difficult to maintain as suppliers no longer (or will soon no longer) produce the equipment needed for the network's operation. See Glossary.
162. Arcep, Future Networks - Digital technology's carbon footprint, p.4, October 2019.
163. Lambert S. and al., Worldwide electricity consumption of communication networks, December 2012, citied in the report: France Stratégie, Controlling digital technology's consumption: technological progress will not suffice, October 2020.
164. Regarding the copper network, Orange has announced the gradual technical switch-off of its network starting in 2023.

> Optimising the networks

In addition to the problems surrounding the coexistence of two networks based on different technologies, which is explored above, is the **question, for any single technology (e.g.: copper or fibre), of optimising its use by several players.**

In its fixed network regulation, Arcep has also worked to encourage, whenever possible, the **adoption of sharing strategies between players and the reuse of existing infrastructures.** This approach makes for more efficient deployments, not only from an economic standpoint but also an environmental one since it avoids the duplication of footprints between operators, who do not need to each build an entire network to provide services to their users. Regarding copper and fibre networks, Arcep regulation requires operators to share last drop (i.e. the section of the network closest to end users, which is the longest part of the network in terms of total kilometres) of copper and fibre networks.

Some of the platform's participants also specifically underscored that is important for the sector to better identify **the weight that civil engineering infrastructures have** in the environmental footprint. The vast majority of these infrastructures (overhead lines, underground ducts, etc.) belong to Orange, and have historically been used for the copper network's deployment. The essential and non-replicable nature of these assets has led Arcep to regulate access to Orange civil engineering infrastructures since 2008. The access obligations imposed on Orange thus ensure that operators deploying networks have effective access to the 560,000 km of underground ducting, and more than 13 million poles that have been installed. This avoids the duplication of an infrastructure which already has a very densely meshed footprint across the country. For new deployments, Arcep plans on remaining attentive to the development of innovative techniques, such as micro-trenching under roadways, which should curtail the environmental footprint of civil engineering deployment

When appropriate, it could be addressed by the Expert committee on the fibre local loop[165].

Other initiatives and issues were raised during certain discussions:

• Anticipating future civil engineering work, to pool repairs and installations to be performed, to avoid having to regularly open up the trenches due to a lack of communication between the players. This solution is especially relevant for special locations or those where it is hard to obtain permission to do the work (e.g. a lot of government red tape involved).

• Better management of consumables and packaging during connection work performed by operators and sub-contractors, notably to reduce the amount of waste produced, and to ensure it is recycled.

Arcep proposes **addressing these practices with operators, notably within the working groups that it facilitates on issues surrounding access to civil engineering and network operations, to determine whether rules of conduct cannot be established.**

Finally, in these working groups with operators – and to echo the concerns that were voiced on several occasions during the "Achieving digital sustainability" platform workshops – Arcep also proposes to tackled the question of whether there is an opportunity to implement automatic sleep mechanisms on operators' subscriber devices at certain times of the day, or when they are not being used for extended periods of time.

165. The Expert Committee on the optical local loop is responsible for issuing opinions on the technical rules that must be followed when deploying FttH networks, as well as their deployment and utilisation procedures. Arcep, "Fibre Expert Committee work programme," updated on September 2020. https://www.arcep.fr/la-regulation/grands-dossiers-reseaux-fixed/la-fibre/les-travaux-du-comite-dexperts-fibre.html.

3.2.3 Clarifying mobile network issues

>Shutting down 2G and/or 3G networks: a complicated solution whose impact needs to be better evaluated

The rising consumption of mobile data and growing capacity needs are creating a heavy load on mobile networks. The older technologies (2G and 3G) are unable to support these high-speed applications, but remain in service alongside new generation networks (4G and 5G). These new technologies are more energy efficient, i.e. they consume less power for the same amount of traffic. The direction that network development is taking will no doubt result in the eventual shutdown of 2G and/or 3G technologies, but the question of timetable remains unanswered.

The answer is complicated, as reflected in the range of arguments traded by Workshop 3 "Choosing our networks to achieve digital sustainability" participants. **In particular, a certain number of prerequisites need to be in place before any shut down can occur, otherwise penalising a number of applications.**

Older generation networks continue to satisfy a still significant number of needs. In consumer and business markets, a quarter of all mobile customers still connect using only 2G or 3G, and **2G-only devices continue to be sold** in the marketplace as they satisfy certain specific needs (telephones with no data connectivity, simple uses...). Added to which, **a substantial percentage of calling traffic still transits over 2G and 3G networks** (in 2019, around 80% of all calling minutes were relayed over 2G or 3G networks – 14 points less than in 2018[166]), largely because of the fact that a great many of the 4G devices in circulation today are not compatible with VoLTE (Voice over LTE) technology, which provides the ability to route calls on 4G networks.

In the **M2M** (machine-to-machine) market, which represents 20 million connected objects with minor connectivity needs, the **bulk of SIM cards are attached to 2G and 3G networks for texting, limited data exchanges and voice calls** (devices in cars for emergency calls, payment devices, sensors and control modules, phones in lifts, etc.). So tens of millions of devices today still operate only in 2G and 3G, and the situation is changing very slowly. **Shutting down 2G or 3G networks in the very near future would therefore mean replacing tens of millions of devices, which would have an environmental cost that would need to be carefully weighed.**

Furthermore if, on a micro level, a shut down appeals in terms of reducing networks' overall environmental footprint, at the macro level, this impact still needs to be qualified.

It should be said that 2G and 3G traffic has gradually diminished with the development of 4G, and operators' drive to scale back their use (close to 90% of data traffic on mobile networks is in 4G). These technologies have been switched off on several frequency bands: only one in six bands is still being used for 2G and 3G. So these technologies consume relatively few resources compared to the rest of the network and this consumption continues to drop.

Two other ideas warrant consideration:

- First, the equivalent of the remaining traffic on 2G and 3G should still be relayed by another technology (the traffic would not disappear but rather be converted);

- Next, examples of shutdowns in other countries reveal a reallocation of liberated spectrum resources to more recent technologies, to provide better indoor coverage and coverage in rural areas. In any event, a lot of the network equipment that currently consumes the most power is multi-technology compatible, in other words shutting down older networks would only marginally affect their operation and so – until this equipment is replaced – the associated energy bill as well.

166. Data collected by Arcep from mobile operators

The environmental impact of switching off a technology is therefore hard to measure. In light of these elements, then, shutting down 2G and 3G technologies must remain on the books, but its scale needs to be put into perspective and the difficulty of executing it taken into account. To explore this matter further, Arcep wants in particular:

• **to obtain a more detailed analysis of the positive and negative effects of such a shutdown, and the operational impediments to carrying it out,** the matter of European eCall regulation for cars also warrants close examination, working in concert with the Government;

• **remove possible barriers and ensure that the right incentives are put into place.**

> Adding an environmental dimension to how mobile networks' performance is characterised from a consumer perspective

Today, mobile network deployments are largely guided by coverage (rural areas, indoor coverage, etc.) and user quality of service objectives. Operators will scale their networks in accordance with these objectives, which in turn structures the networks' environmental impact to a large extent. **A balance is also sought between environmental impact and quality of service/coverage –** all of which reflects the challenging trade-offs we face as a society (e.g.: achieving increasingly vast coverage vs. reducing our environmental footprint).

The information provided to users currently pertains chiefly to the coverage and quality of service that operators provide. A number of players publish coverage and quality of service scorecards. Arcep also conducts a quality of service audit every year to test the performance of operators' networks in the different types of area in France (high density, medium density and rural areas). This measurement campaign includes speed and quality tests for different applications, such as web browsing, streaming and voice calling.

The results of these tests are very important to operators to the extent that they can influence consumers' choices. Operators therefore have an incentive to deploy and configure their network to obtain the highest "scores" on the indicators generated by these measurements. If it does not provide users with complete information, this type of approach will not incentivise operators to take the initiative to reduce networks' environmental impact (e.g. putting networks to sleep during off-peak hours).

This requires rethinking the information provided to users, putting operators' quality of service performances side by side with environmental impact indicators. These scorecards would enable users to also choose their network based on operators' pro-environmental efforts.

For its part, Arcep proposes examining the addition of an environmental dimension to its annual quality of service audits of mobile networks in 2021, in concert with operators and players involved in network measuring and testing.

> Optimising mobile networks

In addition to questions of a trade-off between coverage/quality of service and environmental impact mentioned above, **Arcep proposes to work with stakeholders on exploring solutions for optimising mobile networks' environmental impact in the medium to long term.**

It suggests beginning with an examination of network sharing issues and making the best possible use of the frequencies that appear to be the most promising in helping to reduce networks' footprint.

Increased sharing of mobile networks (at different levels in the network) could help reduce their environmental footprint, particularly in rural areas where the traffic load is lighter. If, over the past several years, Arcep has worked to promote network sharing, the topic can be explored in greater depth, by assessing potential ecological gains, while also factoring in the need to sustain an equilibrium that fosters competition between operators. New questions on opportunities for sharing will also arise with the future development of edge computing[167] (i.e. the deployment of computing and data storage resources closer and closer to users).

Optimising frequency use could potentially be another major lever. The access network represents close to 80% of networks' total energy consumption[168] and 70% of this consumption can be attributed to mobile access networks[169]. This impact depends in part on how frequencies are allocated between operators: for instance, using the same amount of spectrum, awarding contiguous frequencies could be more eco-friendly than allocation fragmented frequencies in different bands. This issue is especially worth examining as it could provide a way to respond to both environmental imperatives and the drive to improve QoS.

This study could be steadily expanded to include the main solutions that could serve as levers for reducing the environmental footprint. If appropriate, the Authority could use its existing regulatory tools to promote their proper application or utilisation.

From a concrete perspective, a range of solutions were suggested during the "Achieving digital sustainability" platform workshops:

• physical levers tied to infrastructure and hardware aspects to shape networks' architecture ;

• procedural levers tied to networks' operating methods to optimise their operation and efficiency.

The physical levers mentioned include:

• structural developments such as edge computing or cloud-RAN[170], creating a choice between a distributed or centralised network architecture;
• the use of small cells which, in some cases, can produce more environmentally efficient network architectures (e.g.: providing indoor coverage with a small cell rather than a high-power outdoor cell);
• increased network sharing between operators.

The procedural levers mentioned include:

• sleep mechanisms for network equipment;
• network automation, optimisation and auto-reconfiguration using artificial intelligence and machine learning;
• network virtualisation, softwarisation and, further down the road, their cloudification.

As it stands today, all of these relatively novel topics require more detailed study to quantify their ability to reduce the environmental footprint, their maturity/capacity to be controlled by the players involved (starting with network operators) and their limitations.

Moreover, as they are all by nature intrinsically linked to the networks' deployment and smooth operation, any analysis of these levers must also be part of an overall view that includes a technical and economic dimension.

One important idea to bear in mind is that it is often not the proposed solution itself that helps reduce the environmental footprint, but rather how it is applied. Here, the analysis could also prove useful by assessing the best implementation procedures and, from there, the right incentives to put into place.

167. See Glossary
168. Arcep, Future Networks - Digital technology's carbon footprint, October 2019.
169. France Stratégie, Controlling digital technology's consumption: technological progress will not suffice, October 2020
170. Cloud-RAN or C-RAN (Cloud Radio Access Network) is a centralised radio network architecture, based on virtualisation and cloud technologies, enabling efficient large-scale and collaborative deployment of radio technologies and their virtualisation. Several standardisation initiatives are currently underway. See Glossary.

> Optimise work done on the networks during deployments to reduce the environmental impact?

Other initiatives and issues were raised during some of the discussions, and add to the concerns expressed about fixed networks, in particular on the matter of anticipating civil engineering work, to be able to coordinate and share any work that needs to be done, to avoid having to dig up roadways too often. This issue also applies to mobile networks when deploying backhaul networks. In a similar vein, it was also suggested that landscape considerations could also be better taken into account. **Arcep proposes addressing these topics in working groups with operators.**

3.2.4 Take action at the European and international level

The digital and green transitions are two major transformations that extend beyond national borders, and require international and national consistency in the benchmark standards used and the initiatives taken.

For instance, every internet ecosystem player – most of which are transnational companies – must be involved in taking environmental issues into account. Regulation of electronic communications networks has traditionally relied on coordination and harmonisation at the international and European level. **It therefore seems essential that all of these different rungs be involved in devising common methods and indicators, and implementing a global strategy to which every player is committed.**

At the international level, ITU began work within the Q9 Study Group of Working Party 5: "Climate change and assessment of information and communication technology (ICT) in the framework of the Sustainable Development Goals (SDGs)". The purpose of this work is to produce recommendations for establishing robust and common methodology frameworks for measuring the digital technology sector's environmental impact, which are to be incorporated into work done on a national scale.

Meanwhile, the OECD published its "Digital economy outlook" in late November 2020 in which it recognised that digital technology is at once a source of opportunities, but also challenges from an environmental perspective. While digital technologies can often support the growth of green solutions (smart cities and infrastructures, etc.) they can also have negative effects on the environment, starting with the steady demand for raw materials, energy and the proliferation of electronic waste. Work on these matters could be undertaken as part of upcoming OECD work programmes, notably within the Working Party on groups on communication infrastructures and service policies (WPCISP).

As to dedicated UN initiatives on digital technology, we can point to the latest Internet Governance Forum (IGF-2020) where the environment was the central topic for the first time, alongside other themes such as data and inclusion. The diversity of the players who take part in this forum make it a privileged venue for discussing and promoting environmental best practices.

At the European level, the degree of harmonisation of environmental and digital policies requires strong coordination between Member States and their regulators. It was European texts that set forth the first environmental requirements of the sector and notably the current regulation on ecodesign[171], energy efficiency[172] and handling waste electrical and electronic equipment (WEEEE)[173]. More recently, the European Commission identified tackling digital technology's environmental impact as a vital to achieving the environmental objectives of the Green Deal[174]. European lawmakers announced the launch of several initiatives designed to strengthen the current framework, notably by expanding the application of ecodesign objectives to include devices, to expand efforts to increase the durability and repairability of equipment and to improve the collection and processing of waste electrical and electronic equipment (WEEE) by promoting the reuse of mobile devices and chargers. New environmental standards for greener public procurement contracts were also being drafted as of this writing and, on 25 November 2020, the European Parliament adopted a resolution[175] calling on the Commission to take measures to improve value chains' circularity. The res-

171. Framework Directive 2009/125/EC on ecodesign https://eur-le.g.europa.eu/legal-content/FR/ALL/?uri=CELEX%3A32009L0125
172. Directive 2002/91/EC on energy efficiency https://eur-le.g.europa.eu/legal-content/FR/ALL/?uri=celex:32002L0091
173. Directive 2012/19/EU on WEEE https://eur-le.g.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2012:197:0038:0071:fr:PDF
174. European Commission Communication "A new circular economy action plan", March 2020.

olution contains three strategy proposals: combatting obsolescence and providing users with better information, to further the shift to more sustainable production and consumption modes, a device repair strategy, the deployment of an overall strategy towards an economy of repair and reuse. Particular attention is given to goods with a digital dimension, stressing software's responsibility in this area (point 7 of the resolution).

The prerequisites needed to create a true single market underscore the wisdom of a harmonised approach.

Current discussions about the environmental impact of electronic communications place the Body of European Regulators for Electronic Communications (BEREC) as the natural hub for dialogue and coordination, to ensure the establishment of best practices that reflect the sector's reality, and an implementation in line with the EU's environmental ambitions and targets. The Commission has already indicated that it would assess the need to increase the transparency of the electronic communications sector's environmental data, to enable users to make more informed choices[176] and for a toolbox to promote connectivity, incorporating environmental criteria for the first time[177]. The regular discussions within BEREC and its members' discussions with operators, along with national regulators' strong involvement in its governance are all major assets underpinning these preliminary initiatives.

175. European Parliament Resolution of 25 November 2020 Towards a more sustainable single market for business and consumers (2020/2021(INI)).

176. European Commission Communication "European Green Deal", December 2019.

177. On 21 September 2020, the European Commission published a Recommendation calling on Member States to boost investment in high speed networks, and proposing a toolbox for reducing deployment costs. In point 3. (16) Member States are encouraged to develop criteria for assessing the environmental impact of future networks and provide incentives to operators to deploy environmentally sustainable networks.

3.3 Strengthen incentives for economic stakeholders and users

Beyond just the networks themselves, it is important that the entire ecosystem take environmental imperatives into account. So the first essential step is to strengthen the incentives, as much for economic stakeholders as users, to take these issues on board, using new incentivising mechanisms in particular.

Naturally, this approach must address the matter of devices whose frequent replacement is generating the sector's most significant environmental footprint (3.3.1). Digital service providers whose business is intrinsically bound up with networks' and data centres' infrastructures also need to be encouraged to adopt more environmentally conscious practices (3.3.2). A better understanding is also required of data centre operators – which have worked to contain their energy consumption as it began to rise significantly over the past several years – to obtain more detailed knowledge of their environmental footprint and identify the best levers to sustain these efforts (3.3.3).

The information gathering detailed earlier (3.1) must provide fuel for data-driven regulation tools, to better inform users, give them the means to make informed choices as consumers, and thereby deliver the right incentives (3.3.4).

3.3.1 Champion less frequent device replacement

As indicated earlier, **devices play a very prominent role in digital technology's environmental footprint**[178]. Smartphones, for instance, have an average estimated life of 23 months[179]. At a time when Europe has announced its desire to expand the Ecodesign Directive to include new types of devices[180] and recycling remains a last resort and not terribly efficient solution[181], **working to limit the frequency of device replacement, and so to prolong their life and use emerges as an important course of action.**

During the work done as part of the "Achieving digital sustainability" platform, **three types of obsolescence were the focus of specific discussions (notably during Workshop 2 "Combatting obsolescence to achieve digital sustainability"):**

- hardware obsolescence, caused by wear, breakage and often the impossibility of repair;
- software obsolescence, caused by having no support for the software used by the device or by the new versions of the software or operating systems being incompatible with the phone's capacities;
- cultural obsolescence, playing on users' behaviour, so that they replace their devices more often than necessary, out of habit, a desire to keep up with trends, or because of sales or advertising practices that give them an incentive to replace their phone very frequently.

178. Devices account for 80% of digital technology's carbon footprint in France. Citizing, *Digital technology's carbon footprint in France: are public policies enough to handle increasing usage?* June 2020.
179. *Ibid.*
180. The European Directive of 2009 on ecodesign applies for now to "energy-related products" and includes computers and televisions but not smartphones or STBS or ISPs' routers. The Commission has nevertheless voiced its desire to expand the scope of the Directive's application, as part of its 2020-2024 work programme.
181. France Stratégie, *Digital technology's metal consuption: a far from digitalised sector*, June 2020. *"Virtually all of the rare metals, and notably rare earth metals, are almost never recycled. But the digital sector uses a number of rare metals for its high-tech functions."*

To make this lever truly effective, what remains now is to determine how to active it, so that it has a complementary effect on economic stakeholders' practices and consumer behaviour.

> Encourage manufacturers and OS providers to increase the durability of the devices launched into the marketplace

Regarding hardware obsolescence, the AGEC Act will require enterprises[182] to publish repairability and durability indexes for consumers.

On 25 November 2020, the European Parliament adopted a resolution that calls on the European Commission to establish a consumers' "right to repair". The resolution also calls for products that are durable by design, the need to improve labelling and information regarding durability, along with comments on the positive role the digital sector can play, and the need to reduce the sector's ecological footprint. Beyond that, manufacturers could adopt repairability methodologies, notably for commonly occurring problems, starting with the device's lifespan, such as battery life. These initiatives could be completed by shining a light on best practices and eco-friendly devices. For instance, **a product's design affects its environmental footprint as it influences how easy it is to repair and by extending its durability** (avoiding having capacitators close to heat sources, using standardised components, etc.). This is especially critical as devices include more and more features, and are replaced as soon as one of those features fails to keep up. **Repairability can therefore be a crucial to curbing the pace of device replacement.** Using modular devices, i.e. whose components can be replaced one by one, also reduces early replacement. **These arguments apply to all devices, and so consideration must also be given to connected objects which are becoming increasingly diverse** (smart watches, speakers, home appliances, home automation devices, cars, street furniture...) and are being produced by a growing array of companies.

If this progress marks a step in the right direction, Arcep is unable to gauge whether they will suffice. Up until now, some of the leading manufacturers have been very reticent on this front. Which means that enshrining an actual **right to repair** in law will no doubt be required.

Taking action to rein in software obsolescence mechanisms is a parallel and equally important path to giving devices a longer life. An update to any service or application can cause an entire device's software obsolescence. If the device's owner is especially attached to a given service or application (photo editing, messaging, social media...) being no longer able to access it could be reason enough to change their device. **To this end, ecodesign for services and applications can be promoted** by the most prominent players on these issues (public authorities, think tanks, associations...) with a view to their adoption by every service and application provider. **These ecodesign measures could also be the subject of charters or codes of conduct, notably for the largest, most influential providers (aka the "digital gatekeepers").**

Workshop discussions helped to identify the need to **tackle operating systems (OS) issues separately.** Devices deliver an increasingly vast array of functions (TV, STB, routers, connected objects, etc.), all of which are powered by an operating system. These OS have a fundamental role in determining how the devices function, since they are the sole interface managing a user's access to the different services installed on the device, but also to the device's features. It is therefore crucial to target OS to ensure a device's durability of the whole[183].

This is all the more imperative given the small number of players operating in this layer that dominates the most popular kinds of devices[184] – to the extent that any effects on the environment are even more heavily dependent on how these players are positioned, and given the slim likelihood that any potentially greener alternatives will emerge in the medium

182. Art. L. 541-9-2.-I. of the Environmental Code "Producers, importers, distributors or other entities releasing electrical and electronic equipment into the marketplace will provide (...)] the repairability index of this equipment [(...)]".

183. To give an example, Let's Encrypt estimates that a third of Android smartphones may no longer accept certificates in 2021, which will have a dramatic impact on the selection of online content these users are able to access. Hoffman-Andrews, J. "Standing on Our Own Two Feet", Let's Encrypt, 6 November 2020. https:/letsencrypt.org/2020/11/06/own-two-feet.html

term. A key objective, then, is to improve the life of existing players' operating systems. There are several relevant courses of action here, including **guaranteeing longer support for software from the players and improving transparency to facilitate maintenance by third parties. Better API (programming interface)[185] interoperability thanks to the use of standards, for instance, would also prevent existing applications, services and products from becoming obsolete.**

Another oft-mentioned measure pertaining to OS would be to **separate corrective updates, that need to be installed systematically for security reasons, from performance upgrade updates that users should be able to choose to install or not.** While these upgrades deliver new features they can also slow the device, and so give its owner a reason to want to replace it.

From a broader perspective, this issue echoes questions surrounding the way in which these OS and devices have the ability to restrict users' ability to access the online content and services of their choice and, as a result, to access greener players and solutions. Arcep has already had occasion to underscore this issue several times over, including in the publication in February 2018 of its report "Devices: the weak link in achieving an open internet[186] and in December 2019 in a brief on influential online platforms, providing discussion points regarding their characterisation"[187]. **Arcep's 2018 proposal to enshrine device neutrality is more relevant than ever before as we strive to achieve a more eco-friendly digital world.**

In any event, it will be necessary to organise (3.1) a procedure for gathering information from OS providers to gain a deeper understanding of these players' practices and their impact on the environment. **It seems advisable that, in time, these players commit, through a code of conduct, to reducing devices' environmental footprint by adopting ecodesign practices that extend their lifespan.**

> Develop used device collection and reuse channeles

One corollary to expanding devices' lifespan "by design" is to **create instruments for giving them a second and even third life, through refurbishment then recycling channels.**

Recycling is largely seen as a last resort solution since the recycling processes also consumes resources whose efficiency remains limited[188]. Recycling channels can nevertheless be further enhanced and developed, as every device reaches the end of its life at some point. Here again, **anticipating this recycling during devices' design and production phases can help make them even more efficient.**

One of the avenues identified during the workshops was to work on steering both players and users towards a mindset of device reuse. This is still a very marginal, if growing, practice in the digital sector. Several initiatives that could foster the emergence of these solutions were put forth during the workshops, including **increasing the exposure given and facilitating access to refurbishing channels, along with the mechanisms for building users' trust in these channelss.** This applies as much to a user who is getting rid of their old device, and wants to be reassured, for example, that their data, files, messages, etc. will not fall into the hands of the company refurbishing the device or the device's next owner. And to the person buying the refurbished device, who wants assurance over its future durability and, for instance, that no malware has been installed on it. The products' durability, i.e. their ability to continue to function

184. For smartphones in Europe, Android (Google) and iOS (Apple) account for 67.8% and 31.8% (99.6% combined) of all sales in October 2020. StatCounter– GlobalStats, "Mobile Operating System Market Share in Europe", November 2020.https://gs.statcounter.com/os-market-share/mobile/europe. For tablets in Europe, iOS (Apple) and Android (Google) account for 55.7% and 44.2% (99.9% combined) of total market share in October 2020. StatCounter – GlobalStats, "Tablet Operating System Market Share in Europe", November 2020. https://gs.statcounter.com/os-market-share/tablet/europe.

185. *Application Programming Interface* is a standardised set of classifications, methods, functions and constants that provides a façade through which software can provide services to other software.

186. Arcep, *Smartphones, tablets, voice assistants – Devices, the weak link in achieving an open internet*, February2018.

187. Arcep, Digital Gatekeeper platforms – *Discussion points regarding their characterisation*, December 2019.

188. France Stratégie, *Digital technology's metal consumption: a far from digitalised sector*, June 2020. *"Virtually all of the rare metals, and notably rare earth metals, are almost never recycled. But the digital sector uses a number of rare metals for its high-tech functions."*

without requiring maintenance or repair, is the solution of choice for increasing their lifespan.

> Encourage a change in distribution models to reduce incentives to replace old devices

Devices' traditional distribution models, as well as certain advertising tactics (encouraging innovation, the quest for the new...) were identified by some of the workshops' participants as contributing to the phenomenon of devices' cultural obsolescence, but also as signals that do not take refurbishment issues properly into account. **To extend the life of every device, one of the paths that could be explored would be to support distribution models that reduce incentives to replace devices that still work perfectly well.**

One workstream to this end would be to supervise distribution practices for the sale of new devices. The systematic purchase of new devices is a major contributor to increasing digital technology's environmental footprint. A number of participants pointed to **the special deals** offered by every device vendor (manufacturers, retail chains, appliance shops, operators, etc.) as sources for accelerating the rate of device replacement, along with **operators' device subsidy practices.** These practices threaten to dull users' perception of the devices' environmental cost.

Regarding operators' device subsidy practices: they concerned only 22% of consumer subscriptions in 2019, compared to 99.9% in 2010[189]. This is a positive development, and the challenge now is to move towards a ubiquitous trend of separating device sales from subscriptions. Here, Arcep believes that it could help develop a better understanding of these practices, and of the users who subscribe to these plans. It has already include questions on this topic in the survey that will be conducted for the next edition of its Digital Market Barometer. **Should it be given the responsibility to do so, the Authority could develop more detailed monitoring of operators' practices in this area, and of their effects.**

A second workstream could be to facilitate the emergence of new models that are not based on the sale of new devices. Initiatives in support of **the product-service economy, device rental and developing a second-hand device market** were all cited by participants as avenues to encourage. These participants also underscored the fact that no single model was virtuous in and of itself, and that particular attention would need to be paid to the process of developing these offerings in the marketplace. A device rental model, for instance, is only environmentally friendly if its goal is to extend the life of devices, and so does not go hand in hand with a model for encouraging users to replace their old devices, but rather promoting their repair and refurbishment.

Without sufficient hindsight, it seems advisable at this stage to **ensure the coexistence of several of these models.** Nevertheless, as the **number of connected objects is increasing exponentially with the development of the Internet of Things, this issue warrants particularly close attention.**

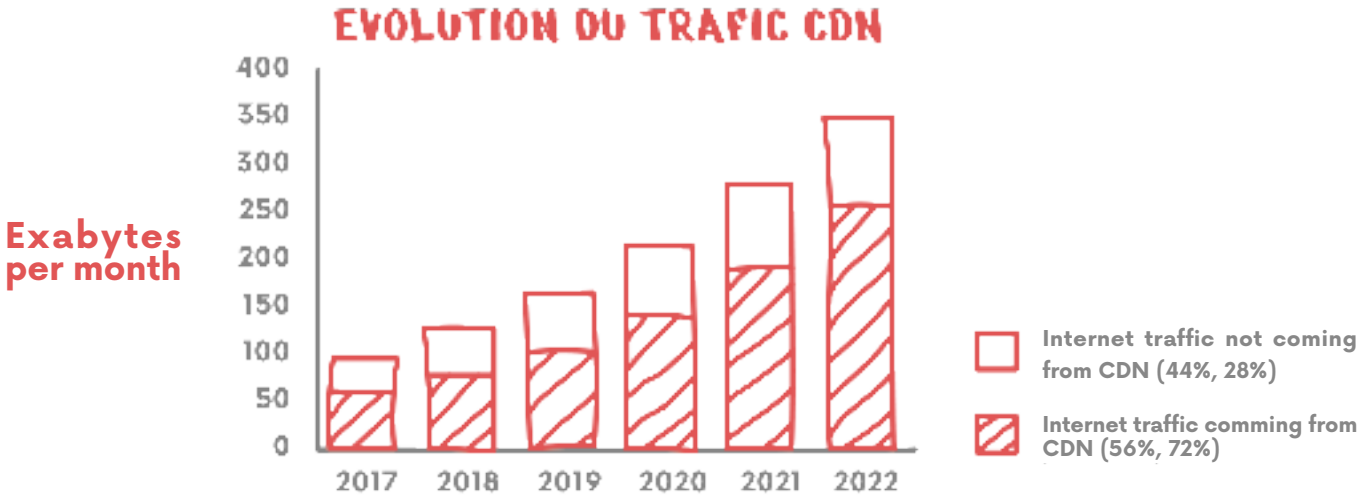
189. Arcep - Observatory, *Fixed and mobile services price index, June 2020.*

3.3.2 Encourage more responsible practices from providers of the most bandwidth-hungry service

According to the Cisco Observatory[190], annual global internet traffic in 2017 totalled 1.5 Zettabytes (Zb)[191], and is forecast to reach 4.8 Zb a year in 2022. **Cisco estimates that internet traffic worldwide will increase by an average of 26% a year between 2017 and 2022.**

Today, this traffic is concentrated around a small handful of heavyweight players whose content and applications consume a great deal of bandwidth, such as Netflix, Google, Amazon and Facebook[192]. This can be attributed to both the size of these companies and to the type of services they provide. Video is one of the most bandwidth-hungry uses, but it is not alone (websites, online gaming, etc).

Also noteworthy is that, according to Cisco, traffic from CDN will rise to reach 72% of total internet traffic in 2022. Some CDN are able to incorporate the distribution of content from several CAPs: cases in point include commercial CDN such as Akamai, Limelight, Cloudflare, etc. Moreover, to keep pace with the swift rise in internet traffic, certain ISPs also now have their own CDN. Lastly, some of the top content and application providers, like Netflix and Google, are building their own content delivery networks to distribute their services. Because of their increasing size and influence, particular attention needs to be given to the environmental impact of CDN over the coming years.



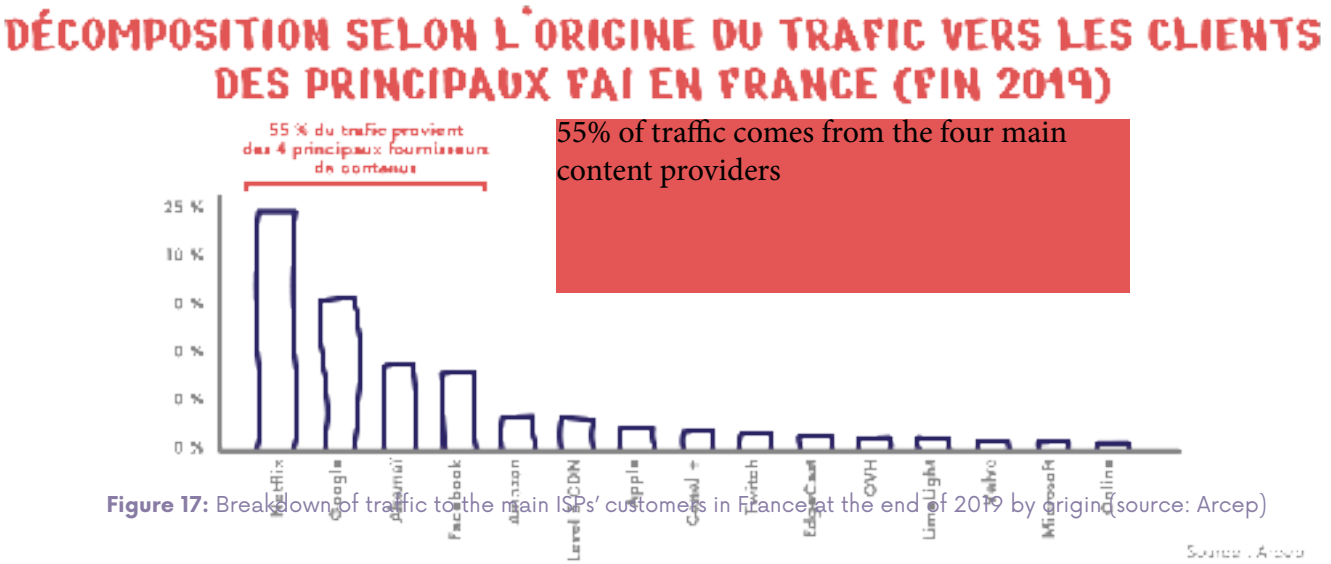
The graph depicts traffic between 2017 and 2022

Source : Cisco VNI Global IP Traffic Forecast, 2017-2022

Figure 16: Progression of CDN traffic (source Cisco)

190. Cisco, *Visual Networking Index: forecast and trends, 2018-2023.*
191. 1 Zettabtye = 10^{21} bytes
192. Sandvine, *The Global Internet Phenomena Report*, 2018.

France is no exception to this global trend. Inbound interconnection traffic to the top ISPs in France has increased steadily, to reach 18.4 Tbit/s at the end of 2019, which marks a 29% increase from the end of 2018. Added to which, half of all traffic (55%) to the top ISPs' customers in France comes from just four providers: Netflix, Google, Akamai and Facebook. This suggests a clearly increasing concentration of traffic in the hands of a small number of players who are enjoying increasingly powerful positions in the content market.



55% of traffic comes from the four main content providers

Figure 17: Breakdown of traffic to the main ISPs' customers in France at the end of 2019 by origin (source: Arcep)

Because of the amount of internet traffic they generate, suppliers who consume the most bandwidth can help reduce the environmental impact of digital usage.

Several actions can be taken to address the distribution of the most bandwidth-hungry video content. Again, according to Cisco[193], 75% of the global IP traffic transiting over electronic communications networks in 2017 was video traffic, a percentage that is forecast to climb to 82% in 2022. Best practices for video could, for instance, include disabling autoplay, adapting videos' resolution to screen size, etc.

During the first lockdown in France, from mid-March to early May 2020, some players such as Netflix and YouTube installed mechanisms for optimising their services' streams by adapting video resolution and quality to prevent congestion on already heavily taxed networks. This served to highlight the **ability to employ mechanisms for reducing services' bandwidth (and so their environmental impact) without significantly diminishing the quality of the user experience.**

One particular case worth considering is that of the large CDN that aggregate several CAPs' content. Although these CDN do not handle their customers' content, and their role is to guarantee the availability and quality of this content, their customers' combined traffic is massive, one prime example being Akamai in France.

It is the Authority's view that the main service providers have very little incentive to reduce their environmental impact, even though they have clear leeway to do so.

193. Cisco, *Visual Networking Index: forecast and trends, 2018-2023.*

The public authority could, first, seek assent from these players through a process of collective commitment, to get them out of the "prisoner's dilemma" mentality, which for them means running the risk of being viewed by users as delivering lesser quality than the competition should they take unilateral action. If such a mechanism proves insufficient, more incentivising tools would need to be considered. In any event, **an approach that targets the biggest players** seems the most appropriate, to avoid imposing constraints on the smaller players that are disproportionate to the overall expected gains generated by these measures.

A code of conduct for the CAP and CDN that are the heaviest bandwidth consumers could therefore be introduced, in which these players would commit to adopting a certain number of practices that would reduce their environmental footprint. This code of conduct could include best practices for storage strategies based on data localisation and the equipment used.

Under this hypothesis, as it already performs this work for the purposes of its annual report on the State of the internet in France[194], **Arcep could be tasked with identifying the main service providers, and even with monitoring their practices.** In concrete terms, for Arcep this would involve identifying the five to ten biggest players (CAP and CDN) every year, which are the heaviest consumers of bandwidth in France.

Other parallel initiatives could also be considered, such as supervising or regulating video advertising. A guide could also be developed for all CAPs to assist them with sustainable website design.

All of these processes should be consistent with the more general work being done on other internet applications, notably sustainable web design, optimising programming of the different network and applications functions using more energy-efficient programming languages, etc.

Although, on its own, an ordinary website does not appear to generate much of an environmental footprint, the spread of sustainable design practices to the millions of websites created each year[195] could have a sizeable cumulative effect.

Regarding the most bandwidth-hungry services, it should also be pointed out that several other solutions to encourage them to scale back their traffic have been raised in public debates. Among these proposals, imposing a tax or fee on the biggest generators of online traffic is regularly put forth. As it was during the "Achieving digital sustainability" platform workshops, and directly cited in proposal No. 16 of the Senate report published in June 2020 which states that a "tax could be create to incentivise the heaviest producers to reduce the data injected into the network to a more reasonable level. Only those enterprises transmitting a certain quantity of data – in practice the largest video streaming providers – would be subject to this tax. The thus collected revenue could be channelled into the Digital Solidarity Fund (FSN), and thereby help finance regional digital development and provide people in remote areas with ICT training. It could also help financing public initiative network maintenance".

Leading ISPs could also introduce data interconnection fees that produce a similar effect. In both cases, it involves **sending a price signal** to the main service providers so that they better optimise their traffic. As mentioned above, this is a hypothesis to be considered if an accountability-based approach, such as Code of conduct, fails. Whatever approach is ultimately taken, its feasibility would naturally need to be qualified.

194. Arcep, *Annual report, State of the internet in France,* June 2020.
195. the livestats.com wesbsite provides several estimates of internet use, some of which pertain to the number of active websites

3.3.3 Develop a deeper knowledge of data centres' practices and their environmental impact

According to a 2014 IDC study[196], data centres would represent an energy demand of around 50 GW in 2017.

Several data centres are currently installing mechanisms to enable them to control their environmental impact. This impact naturally varies depending on their size, the servers and equipment used and the data centre's cooling system.

To reduce a data centre's environmental impact, it is possible to use a traditional cooling system and **recover the heat it produces to heat neighbouring buildings or produce hot water.**

Today, it is possible to reduce a data centre's energy consumption while maintaining a steady indoor temperature (between 22°C and 30°C), regardless of the outdoor temperature and the amount of heat that the servers are giving off. Traditionally, data centres used air conditioning enclosures located near the servers, which sucked the hot air from the room and blew cold air into the raised floor. The heat is transported by a closed water circuit to the CRAC unit. **Free cooling** creates the ability to save energy by using the outdoor temperature to cool the data centre. There are several types of free cooling that can help a data centre reduce its environmental impact:

- **Indirect free cooling.** It is not the outdoor air that cools the servers, but air that cools the closed water circuit, which will help to limit the power absorbed by the CRAC unit's compressors. There are several types of indirect free cooling, some of which use an adiabatic cooling system (cf. below)..

- **Direct free cooling** with a CRAC unit. Here, outdoor air enters the data centre to cool the servers directly when, for instance, the outside temperature is below 30°C. When it rises above that temperature, the data centre switches to a more traditional system, using CRAC units to cool the premises.

- **Direct free cooling using an adiabatic cooling process.** This is currently the solution that reduces a data centre's environmental impact the most. Under this configuration, CRAC units are no longer required. Once the outside temperature exceeds the set threshold, adiabatic cooling is triggered. The air is cooled based on water evaporation: dry hot air passes through an evaporative heat exchanger. The energy needed for the water to evaporate is extracted from the air that cools by dispelling its heat. With automated systems, it is possible to obtain a steady temperature year-round without requiring air conditioning units. It is worth noting that an adiabatic cooling system cannot be used when the hot air is very humid, but this is rarely the case in France.

Another path to reducing data centres' environmental impact is to reduce the temperature at which data centres maintain their cool aisle (currently between 22°C and 30°C). **The growing ubiquity of servers that are compatible with cool aisle temperature of 40°C,** year round, would significantly reduce the energy footprint of data centres that are cooled by free cooling.

To monitor data centres' energy efficiency, some of the sector's players use and publish their **PUE** (Power Usage Effectiveness) indicator. This indicator was developed in 2007 by The Green Grid consortium to measure a data centre's efficiency, and was standardised in 2016[197].

It corresponds to the ratio between the total energy used by the data centre's building and the energy used to power the servers. The sector's current practices appear to put PUE values at around 1.5 for traditional cooling and 1.15[198] for free adiabatic cooling with no CRAC unit. Other indicators pertaining to a data centre's energy efficiency could also be relevant, such as the degree of reuse of the heat produced by the data centre, the percentage of renewable energy used, CO2 emissions compared to electricity consumption, etc.

196. France Stratégie, *Controlling digital technology's consumption: technological progress will not suffice,* October 2020.
197. ISO/IEC 30134-2:2016 Standard

The best practices identified for data centres seem to indicate that the way in which they are designed will have a decisive impact on their environmental footprint. This is a topic that Arcep still needs to have verified.

Introducing data-driven regulation, including at the national level, could be a good first step to better understanding the current situation, and the main issues and challenge that digital ecosystem players are facing. This approach would make is possible to confirm or disprove the assumption that data centres' design stage is when significant ecological commitments can be made, and have a sizeable impact.

Collecting this information could pave the way for the introduction of a **code of best practices** for data centres. **Arcep could draft this code of conduct in concert with stakeholders, and be in charge of the subsequent monitoring of their practices.**

In any event, given this sector's specificities and the nature of the activity, if implementing a mechanism that allows data centres to make legally binding commitments, or which aims to impose environmental obligations on data centres were to be considered, it seems crucial that this be **undertaken at the European level. Should this come to pass, Arcep would be capable of monitoring French players' compliance with these obligations or commitments, if it is assigned the responsibility to do so.**

3.3.4 To give the Code of Conduct's stipulations their full impact: legally binding commitments to record the pledges that economic stakeholders have made to the Government

Several of the proposals listed above shed light on how useful it would be for all of the players (operators, manufacturers, distributors, data centres operators, service providers, etc.) to commit to certain practices, via Codes of best practices

Monitoring ongoing compliance with these commitments could be achieved through information gathering campaigns, as described above.

The public authority could also decide to take things one step further, by asking that **these commitments be legally binding.** This type of system already exists in the telecoms sector, for coverage targets in the most sparsely populated parts of the country, pursuant to Article L.33-13 of the French Postal and Electronic Communications Code (CPCE), whereby operators can make commitments, after having referred to Arcep for an opinion, the latter being responsible for monitoring compliance and, if required, imposing penalties for failures to comply.

3.3.5 Give consumers the power to reduce their environmental footprint by making informed choices: a Green Barometer + measurement and comparison tools

In addition to direct appeals to economic stakeholders, it also seems essential **to step up initiatives aimed at users.** This approach cannot be the only aim of public action, but is a crucial link in the entire chain of levers to employ. The idea here is not to implement strategies to impose restrictions on users, be they legal or economic, but rather to work on

198. Scaleway press release "Ultimate Performance: Scaleway and Lenovo deliver a solution for extreme use with the Bare Metal server, the most powerfu on the market", 19 November 2020.
https://www.scaleway.com/fr/pressroom/ultimate-performance-scaleway-et-lenovo-repondent-aux-usages-extremes-avec-le-server-bare-metal-le-plus-puissant-du-marche/

accelerating the pace of building users' awareness of environmental issues tied to their use of digital technology and, at the same time, **improve and expand the information provided to users', and so their empowerment** by enabling them to make informed choices, that align with their needs and behaviour, and thereby influence the market.

In addition to **gathering information detailed in Section 3.1,** data-driven regulation also means **delivering accurate and relevant data, whether through the dissemination of raw data, making dedicated online tools available or the deployment of third-party tools,** to better reflect reality and the effect of the different uses, but also to make it easier for users to access this information.

Transmitting this information to users, in a way that aligns with their needs, and with the goal of further empowering them, is a crucial step in the process. Several examples of tools used to this end can be cited: **in the food and cosmetics sectors, Openfoodfacts[199] and applications such as Yuka[200] provide users with clear and accurate information**, along with elements that enable them to choose products based on their needs. Regarding network coverage and quality of service, the "Mon réseau mobile[201]" and "Ma connexion internet[202]" map-based websites developed by Arcep give users the ability to see the fixed and mobile electronic communications coverage that is available in their area (at home, at work, etc.). An ecosystem of QoS measuring tools comes to complete the information provided by these maps, thanks to speed tests performed "in the field" by users. **Further initiatives from associations, and the public and private sector, also exist, and prove how valuable efforts to provide users with data can be.**

These observations all show that the public authority's role will not necessarily be to concentrate data and action, but rather to **create a framework of trust and coordination, as part of a process to develop initiatives to foster user accountability.** Here, two forms of public involvement would seem to be required: first to **ensure that the necessary data are made availables** (defining that data, ensuring their availability as open data, the legal certainty on the transmission of these data, ease of reuse, etc.) and, second, to work on **making these tools reliable,** and guaranteeing a framework of trust between these tools and users.

Regarding digital technology's environmental impact, the same process should be undertaken, by supporting the deployment of existing tools and enabling the development of new ones. Several positive initiatives can already be cited (in a non exhaustive fashion), including the creation of repairability and durability indexes by the AGEC Act, along with the mechanism requiring electronic communications operators to inform users of the GHG emissions associated with their online data consumption. The "Carbonalyser " application from the Shift Project[203], the "ifixit"[204] initiative that offers detailed tutorials on how to fix different equipment, etc.

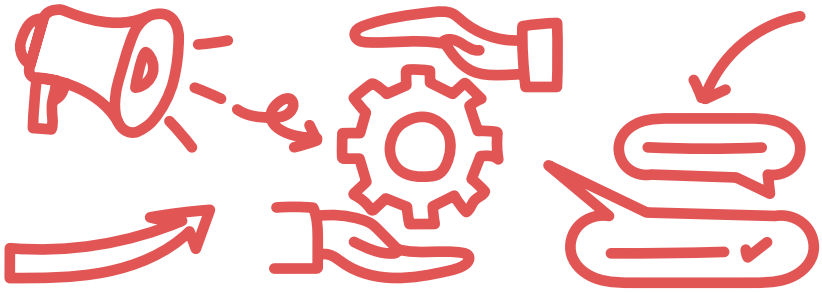
The Government could also consider a call for proposals to stimulate the emergence of eco-friendliness comparison engines and **decision-making assistance tools** for consumers.

Other tools could also emerge if public action in this area is stepped up. To this end, Arcep proposes the **creation of a "Green Barometer"** whose purpose would be to shine a light on the most proactive playerse, taking a "name and shine" approach and, if appropriate, to highlight problematic practices. This Green Barometer would be developed based on data collected by every public sector player, and notably as part of the indicators that Arcep is submitting to stakeholders for discussion, and listed in Section 3.1.2.

One essential component of this system is the involvement of public authorities who, should there be a lack of initiative from third parties, could also issue a call for proposals for the design and creation of environment-centric data-driven regulation tools.

199. https://fr.openfoodfacts.org/
200. https://yuka.io/en/
201. https://www.monreseaumobile.fr/
202. https://maconnexioninternet.arcep.fr
203. https://theshiftproject.org/carbonalyser-extension-navigateur/
204. https://fr.ifixit.com/

CONCLUSION



Summary of Arcep's proposals

The discussions with stakeholders enabled Arcep to forge a better understanding of digital technology's environmental footprint and of the work that needs to be done.

The Authority is of the opinion that digital technology can and must do its part to further the low-carbon strategy, but without companies having to forego any technology-driven business or innovation opportunities. The purpose is **not to deliver a blanket condemnation of technology per se –** as it encompasses such as a vast array of uses, some of which in fact contribute directly to reducing greenhouse gas emissions, such as telecommuting – nor to rein in or restrict its use out of hand. But **nor should digital technology be seen as a sector exempt from doing its part** to comply with the Paris Climate Agreement and its new targets. **The goal, then, is to successfully combine the ongoing increase in the use of digital tech and reducing its environmental footprint.**

To this end, Arcep wanted to mapout **a middle path between the two pitfalls of laissez-faire and administered economy.** Galvanising the instrument of regulation to act as the bridge between market initiative and imperative for the greater good.

Among the driving forces in this direction is the significant mobilisation of a large body of players who are tending to commit to being more environmentally responsible. Whether through voluntary carbon-neutrality programmes, sector-specific initiatives that promote ecodesign, or the growing awareness amongst our fellow citizens over the impact that their use of digital technology has on the planet: **there is no doubt about a widespread awareness**, which testifies to a certain incentive for economic agents – both vendors and users – to modify their behaviours.

This mobilisation is the starting point for Arcep's proposals, the goal being to amplify it and ensure that it actually creates the ability to **steer it past the stage of mere good intentions and onto a concrete, ambitious path for reducing the environmental footprint.**

Not excluding anything out of hand, nor outsized faith in the outcomes of proactive accountability. This is the common thread running thorugh Arcep's "mission statement," whose lodestar is "networks as a common good" which must now be addressed from an environmental perspective. Although networks represent only a fraction of digital technology's ecological issues, a green approach needs to become more systematic, particularly when it comes to **devices, data centres and service providers.**

Introducing environmental regulation for digital technology is, first, **a public policy decision**. It is up to the Government to define the scale of the ambition and especially **the trajectory it wants to set the for digital sector, so that it can be a full-fledged participant in the low-carbon strategy.** It is also up to public policymakers to enshrine in law the tools of transparency, incentive and, if necessary, restriction, that will give shape to this regulation, and to the institutions tasked with enforcing them.

Arcep's proposals can be seen as a three-step process: (i) better understand and monitor the ecological footprint of the different links and players in the digital chain, by equipping the public authority with solid and shared supervisory instruments, (ii) regarding the scope of telecoms regulation, to incorporate environmental imperatives into regulatory choices pertaining to both fixed and mobile networks, (iii) increase the incentives for economic agents – suppliers and users. On this last point, Arcep is aware of the range of potential instruments, notably in the area of taxation, but wanted to confine itself here to public policy levers rooted in the philosophy of regulation.

STRAND 1: STRENGTHEN PUBLIC POLICYMAKERS' CAPACITY TO STEER DIGITAL TECHNOLOGY'S ENVIRONMENTAL FOOTPRINT

1. Entrust a public entity with the power to collect useful information from the entire digital ecosystem (content and application providers, operating system developers, device manufacturers and datacentre operators, in addition to electronic communications operators for which this type of mechanism already exists) to be able to obtain granular and reliable data that is crucial to assessing and monitoring the sector's environmental footprint, and the measures that have been implemented.

2. As part of its initiatives with ADEME, participate in the creation of a common frame of reference for measurement: Improve measurement to better identify the issues, compile data to keep users informed and foster a virtuous dynamic in the sector.

STRAND 2: INCORPORATE ENVIRONMENTAL ISSUES INTO ARCEP'S REGULATORY ACTIONS

→ **For fixed access**

3. Facilitate the transition from copper to fibre.

4. Encourage network optimisation by promoting civil engineering infrastructure and fibre infrastructure last drop (access network) sharing schemes.

5. Encourage initiatives designed to implement automatic sleep mechanisms in ISP customers' routers and STBs at certain times of the day or when not being used for long stretches of time.

→ **For mobile access**

6. Achieve more detailed analysis of the positive and negative impact of switching off 2G and 3G networks, to lift potential barriers and ensure that the right incentives are put into place.
European regulation on in-vehicle emergency calls (e-call) in particular warrants in-depth examination, working in tandem with the Government.

7. Examine network performance indicators in 2021 to incorporate environmental issues in consumer choice parameters.

8. Work with interested stakeholders to explore solutions for optimising mobile networks' medium and long-term environmental impact, focusing in priority on sharing issues and making the best possible use of frequencies.

9. Develop, if appropriate, **more detailed monitoring of operators' handset subsidy practices** and their effects.

STRAND 3: INCREASE INCENTIVES FOR ECONOMIC STAKEHOLDERS, PRIVATE AND PUBLIC SECTOR STAKEHOLDERS AND CONSUMERS

10. Work with interested stakeholders to draft Codes of conduct/charters to buttress ecodesign, and which are **capable of leading to the adoption of legally-binding commitments**, akin to electronic communications operators' regional digital development commitments, and commitments to cover the country's sparsely populated areas with electronic communications' networks (Art. L.33_13 of the French Postal and Electronic Communications Code (CPCE)). Notably:

- **content and application providers,** particularly heavyweight digital "gatekeepers" (e.g. over best practices such as adapting content resolution to the device's screen, or limiting autoplay);

- **operating system developers,** particularly the largest, most influential ones (e.g. over best practices such as maintaining older versions of their OS, or taking better account of obsolescence issues in updates);

- **data centre operators** (e.g. over best practices such as data centres' architecture, optimising cooling systems, or managing storage equipment...).

Other proposals in line with this incentive-based approach are regularly put forth, such as introducing mechanisms designed to convey price signals that heavily affect content and application providers, e.g. regarding bandwidth use. This type of solution could be useful if codes of conduct fail and, in any event, warrant closer analysis.

Compliance with codes of conduct must be monitored by a public entity with supervisory and, if warranted, sanctioning powers.

11. Increase users' accountability and their ability to take action through a data-driven approach to regulation, fostering the emergence of **tools for aiding consumers** in making informed choices, and understanding their impact on the environment. Publish a "Green Barometer" to help shine a light on best practices from across the digital ecosystem.

ANNEXES

Bibliography

REPORTS

ADEME, ***Modélisation et évaluation des impacts environnementaux de produits de consommation et biens d'équipement,*** September 2018.

https://www.ademe.fr/modelisation-evaluation-impacts-environnementaux-produits-consommation-biens-dequipement

Assemblée Nationale, ***Rapport au nom de la commission du développement durable et de l'aménagement du territoire sur le projet de loi relatif à la lutte contre le gaspillage et à l'économie circulaire (n° 2274)***, novembre 2019.

http://www.assemblee-nationale.fr/dyn/15/rapports/cion-dvp/l15b2454-t1_rapport-fond#

CGE, ***Making digital technology more energy efficient*** December 2019.

https://www.economie.gouv.fr/files/files/directions_services/cge/consumption-energique-numerique.pdf.

Cisco, ***Visual Networking Index: forecast and trends,*** 2018-2023.

Cisco, ***VNI Global IP Traffic Forecast,*** **2017-2022**, 2018.

Empreinte carbone du numérique en France: des politiques publiques suffisantes pour faire face à l'accroissement des usages**?**, June 2020.

http://www.senat.fr/rap/r19-555/r19-5551.pdf

European Commission, ***Energy-efficient Cloud Computing Technologies and Policies for an Eco-friendly Cloud Market***, 2020

https://ec.europa.eu/digital-single-market/en/news/energy-efficient-cloud-computing-technologies-and-policies-eco-friendly-cloud-market

European Commission, ***Study on greening cloud computing and electronic communications services and networks: toward climate neutrality by 2050***, 2020.

Convention citoyenne pour le climat, Les proposition de la Convention Citoyenne pour le Climat, June 2020.

https://propositions.conventioncitoyennepourleclimat.fr/pdf/ccc-rapport-final.pdf

France Strategie, ***La consommation de métaux du numérique : un secteur loin d'être dématérialisé,*** June 2020. https://www.strategie.gouv.fr/sites/strategie.gouv.fr/files/atoms/files/fs-2020-dt-consommation-metaux-du-numerique-June.pdf

France Strategie, ***Maîtriser la consommation du numérique : le progrès technologique n'y suffira pas***, October 2020.

https://www.strategie.gouv.fr/sites/strategie.gouv.fr/files/atoms/files/fs-2020-dt-empreinte-numerique-October.pdf

GreenIT.fr, ***Empreinte environnementale du numérique mondiale***, September 2019.

https://www.greenit.fr/wp-content/uploads/2019/10/2019-10-GREENIT-etude_EENM-rapport-accessible.VF_.pdf

Halte à l'Obsolescence Programmée, Livre Blanc – ***50 measures pour une consommation et une production durables***, February 2019. https://www.halteobsolescence.org/wp-content/uploads/2019/03/Livre-Blanc.pdf.

Hootsuite & We Are Social, ***Digital 2020 Global digital overview***, 2020.

https://wearesocial-net.s3-eu-west-1.amazonaws.com/wp-content/uploads/common/reports/digital-2020/digital-2020-global.pdf

Iddri, FING, WWF France, GreenIT.fr, ***Livre Blanc – Numérique et environnement, Faire de la transition numérique un accélérateur de la transition écologique***, 2018

https://www.iddri.org/sites/default/files/PDF/Publications/Catalogue%20Iddri/Rapport/livre%20blanc%20num%C3%A9rique%20%C3%A9cologie.pdf

Sandvine, ***The Global Internet Phenomena Report***, 2018.

https://www.sandvine.com/hubfs/downloads/phenomena/2018-phenomena-report.pdf

Sénat, Rapport d'information – ***Pour une transition numérique écologique***, June 2020

https://www.senat.fr/rap/r19-555/r19-5551.pdf

The Shift Project, ***Climat: L'insoutenable usage de la vidéo en ligne***, July 2019

https://theshiftproject.org/wp-content/uploads/2019/07/2019-01.pdf

The Shift Project, Lean ICT: ***Pour une sobriété numérique***, October 2018

https://theshiftproject.org/wp-content/uploads/2018/11/Rapport-final-v8-WEB.pdf.

EUROPEAN TEXTS

Communication from the European Commission: "A New Circular Economy Action Plan", March 2020.

https://eur-le.g.europa.eu/legal-content/FR/TXT/HTML/?uri=CELEX:52020DC0098&from=EN

Communication from the European Commission, "The European Green Deal", December 2019.

https://eur-le.g.europa.eu/legal-content/FR/TXT/HTML/?uri=CELEX:52019DC0640&from=EN

European Commission Recommendation ***"On a common Union toolbox for reducing the cost of deploying very high capacity networks and ensuring timely and investment-friendly access to 5G radio spectrum"***, 18 September 2020.

https://ec.europa.eu/digital-single-market/en/news/commission-recommendation-common-union-toolbox-reducing-cost-deploying-very-high-capacity

Europea Parliament Resolution: "Towards a more sustainable single market for business and consumers", 25 November 2020 (2020/2021(INI))

https://www.europarl.europa.eu/doceo/document/TA-9-2020-0318_FR.html

SCIENTIFIC ARTICLES

Dinesh Reddy V, Setz B., Rao G. V., Gangadharan G. R., and Aiello M., ***Metrics for Sustainable Data centres, IEEE Transactions on sustainable computing***, vol.2, No. 3, July-sept.2017.

https://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=7921551

Koomey J. and Taylor J., ***New data supports finding that 30 percent of servers are 'Comatose', indicating that nearly a third of capital in enterprise data centres is wasted***, Oakland, CA: Anthesis Group, 2015.

Lambert S. and al., ***Worldwide electricity consumption of communication networks,*** December 2012.

https://www.osapublishing.org/oe/fulltext.cfm?uri=oe-20-26-B513&id=246736

Masanet E., Shehabi A., Lei N., Smith S., Koomey J., ***Recalibrating global data center energy-use estimates.*** Science. 367. 984-986, 2020.

https://science.sciencemag.org/content/367/6481/984/tab-article-info

Murugesan S. and Gangadharan G. R., Eds., GreenIT.fr: An over-view, in Harnessing ***GreenIT.fr: Principles and Practices.*** Hoboken, NJ, USA: Wiley, ch. 1, pp. 1–21, 2013.

http://www.vandemataramcollege.com/app/webroot/files/NOTES_sem246/Green_IT-FYCS-Sem2.pdf

Basmadjian R., and al., ***Green data centres, in Large-Scale Distributed Systems and Energy Efficiency*****: A Holistic View.** Hoboken, NJ, USA: Wiley, pp. 159–196, 2015.

Williams E., The 1.7 ***Kilogram Microchip: Energy and Material Use in the Production of Semiconductor Devices***, United Nations University, 2002.

https://pubs.acs.org/doi/10.1021/es025643o

ARCEP DOCUMENTS AND REPORTS

Arcep - Observatory, *Fixed and mobile services price index*, June 2020.

https://www.arcep.fr/fileadmin/cru-1606137251/reprise/Observatory/indices-prix-fixed-mobile/evolution-prix-services-CE-2019_160620.pdf

Arcep, *The Digital Market Barometer*, 2019.

https://www.arcep.fr/uploads/tx_gspublication/report-barometre-num-2019.pdf

Arcep, Work of the Fibre Experts Committee, updated on 18 September 2020.

https://www.arcep.fr/la-regulation/grands-dossiers-reseaux-fixed/la-fibre/les-travaux-du-comite-dexperts-fibre.html.

Arcep, Competition Authority, AMF, Arafer, CNIL, CRE, CSA, *Nouvelles modalités de régulation – La régulation by la donnée* July 2019.

https://www.arcep.fr/fileadmin/cru-1606998432/user_upload/grands_dossiers/La_regulation_par_la_data/note-aai-regulation-par-la-data-juil2019.pdf

Arcep, *Plateformes numériques structurantes – Eléments de réflexion relatifs à leur caractérisation*, December 2019.

https://www.arcep.fr/uploads/tx_gspublication/platforms-numeriques-structurantes-caracterisation_reflexion_dec2019.pdf

Arcep, Annual Report on the State of the Internet in France, June 2020.

https://www.arcep.fr/uploads/tx_gspublication/report-etat-internet_edition-2020_250620.pdf

Arcep, *Future Networks - Digital technology's carbon footprint*, October 2019.

https://www.arcep.fr/uploads/tx_gspublication/reseaux-du-futur-footprint-carbone-numerique-July2019.pdf

Arcep, *Smartphones, tablets, voice, assistants – Devices, the weak link in achieving an open internet,* February2018.

https://www.arcep.fr/uploads/tx_gspublication/report-devices-fev2018.pdf

WEBSITES, etc.

Hoffman-Andrews, J. *"Standing on Our Own Two Feet",* Let's Encrypt, 6 November 2020.

https://letsencrypt.org/2020/11/06/own-two-feet.html

ITU-T, "Recommendations L.1400, L1015 and L.1470 on the general principles of methodologies for assessing the environmental impact of information and communication technologies, and on the criteria to be used for evaluation of the environmental impact of mobile phones"

https://www.itu.int/ITU-T/recommendations/rec.aspx?rec=11015

https://www.itu.int/ITU-T/recommendations/rec.aspx?rec=13719 ; https://www.itu.int/rec/T-REC-L.1470/en

Ministère de la transition écologique et solidaire, "Consultation publique sur un projet de décret en Conseil d'Etat et arrêtés afférents, concernant l'indice de réparabilité obligatoire pour les produits électriques et electronic", August2020.

http://www.consultations-publiques.developpement-durable.gouv.fr/indice-de-reparabilite-pour-les-produits-a2178.html

Scaleway - Press release. "Ultimate Performance : Scaleway and Lenovo répondent aux usages extrêmmes with le server Bare Metal le plus puissant du marché", 19 November 2020.

https://www.scaleway.com/fr/pressroom/ultimate-performance-scaleway-et-lenovo-repondent-aux-usages-extremes-avec-le-server-bare-metal-le-plus-puissant-du-marche/

StatCounter – GlobalStats, "Mobile/Tablet Operating System Market Share in Europe", November 2020.

https://gs.statcounter.com/os-market-share/mobile/europe; https://gs.statcounter.com/os-market-share/tablet/europe

Glossary

Abiotic resources: abiotic is an adjective meaning "non-living". Abiotic resources are elements such as water, rare earth metals, fossil fuels such as oil, and any other resource that generally exists in limited quantities.

Access network: The access network refers to all of the resorces used to connect telecommunication devices to an infrastructure network switch. For a fixed network, it typically refers to the local loop, or the section of the network located between the subscriber and the optical connection node, for fibre, and the subscriber connection point for copper.

ADSL: ADSL (Asymmetric digital subscriber line) is a technology based (in France) on the Orange legacy copper network.

Backbone network (or core network): The core network is the main part of an infrastructure network, characterised by very high speeds, which concentrates the signals coming from other parts of the network and enables them to interconnect by transporting them between each other or to other networks.

Backhaul network: The backhaul network is the portion of an infrastructure network, upstream from the access network and whose purpose is to transport signals between the backbone network and access networks

Carbon footprint: carbon footprint covers both direct and indirect emissions at the national level, as well as emissions abroad but which are vital to the activity, the product or service whose footprint is being calculated.

Carbon intensity: According to INSEE, carbon intensity is the ratio of an organisation's CO2 emissions to its production.

Cloud-RAN: Cloud-RAN ou C-RAN (Cloud Radio Access Network) is a decentralised radio network architecture based on cloud and virtualisation technologies. It enables efficient large-scale and collaborative deployment of radio technologies, and their virtualisation. Several standardisation initiatives are currently underway.

Content and application provider (CAP): A company that supplies multimedia content or software and IT services to its users over a network (typically the internet).

Content Delivery Network (CDN): Content Delivery Networks are platforms used by content and application providers to bring content closer to end users, and so to improve quality of service (QoS) and customers' quality of experience (QoE), while having global connectivity and reducing traffic relay costs. Reducing the distance between customers and servers creates the ability, by and large, to shorten latency, increase performance and reduce costs.

Digital technology's environmental impact: Impact is the effect that something, in this case digital technology, has on the environment. For the purposes of this report, the term "environmental impact" does not refer to a notion as specific as "carbon footprint" or "GHG emissions" but simply to digital technology's influence on the environment.

Ecodesign: aka Green design, aka environmentally conscious design. The concepts of ecodesign were set forth at the international level in 2002, with the release of the ISO/TR 14062 standard. It describes concepts and current practices relating to the integration of environmental aspects into product design and development. France defined the first section of documentation on this topic in 1998, in a now withdrawn standards callled FD X 30-310. ADEME was a major contributor, and later represented France at the international level, in addition to being the secretary of the committee that drafted the ISO 14062 standard. In 2009, Directive 2009/125/EC, establishing a framework for the setting of ecodesign requirements for energy-related products defines ecodesign as "the integration of environmental aspects into product design with the aim of improving the environmental performance of the product throughout its whole life cycle"'. The ADEME website provides more detailled information (in French): https://www.ademe.fr/entreprises-monde-agricole/organiser-demarche-environmentale/dossier/ecoconcevoir-products/enjeux-lecoconception-benefices-lentreprise-leconomie-lenvironment

Eco-responsibility: or environmental responsibility is a global approach that involves incorporating sustainable development considerations into every daily activity. For the purposes of this report, its aim is to hold digital ecosystem players accounatable, so that they factor these issues into their decision-making processes.

Edge computing: Edge/fog computing appiles to both fixed and mobiele uses. It consists of replacing large centralised data centres with "mini" data centres that process information closer to users (e.g. a the cell site level). As they are more local, they handle smaller quantities of information.

Encoding: encoding refers to the action taken to change a video's format using a codec (program) that handles the process of transforming a source file into a new file. The development of increasingly efficient codecs (hence encoding methods) helps save the quantity of data needed to disseminate the file with an identical quality.

Environmental footprint: the environmental footprint is calculated in the same way as the carbon footprint, but covers several indicators in addition to just greenhouse gases. It may, for instance, include the consumption of abiotic resources, artificialisation of nature, water pollution, etc.

Greenhouse gases (GHG): These are gaseous components that contribute to the greenhouse effect, and are one of the causes of global warming. GHG therefore include several gases, including steam from water, carbon dioxide and methane. For the sake of simplification, GHG and "carbon" (a shorthand for carbon dioxide or CO2) are often used interchangeably, to the extent that the carbon dioxide that is present in the atmosphere and of anthropogenic origin is responsible for the majority of the anthropogenic greenhouse effect and, according to GIEC, is responsible for for 78% of GHG emissions worldwide between 1970 and 2010. (Cf. GIEC, Rapport de synthèse - Changements climatiques, 2014). This report employs the same shorthand, and may therefore use the tersm "GHG" and "carbon" interchangeably, even though the term carbon covers a much more limited scope than the the term GHG.

Greenhouse gas emissions: GHG emissions are broken down into direct emeissions (during the period of use of the product in question) and indirect emissions (i.e. during the stages prior to and after the product's useful life, such as production and recycling). At the national level, the notion of emissions does not factor in sources located abroad (unlike the carbon footprint). However, when analysing direct and indirect emissions at the global level, emissions and footprint are synonymous. The ISO 14064-1 standard of 2006 sets forth the principles and requirements for organisations, for quantifying and publishing reports on greenhouse gas emissions and their eradication. They include requirements regarding design, fine tuning, management, drafting reports and verifying an organisation's GHG inventory. They make a distinction between direct greenhouse gas emissions from owned or controlled sources (scope 1), indirect emissions from the energy purchased and used by the organisation (scope 2) and all other indirect emissions (scope 3). ADEME provides a very thorough definition of these scopes (in French): https://www.bilans-ges.ademe.fr/fr/accueil/contenu/index/page/bilan%2Bges%2Borganisation/siGras/1

→ Direct GHG emissions (SCOPE 1): direct emissions from fixed or mobile installations located within the organisation's perimeter, i.e. emissions from company-owned and controlled resources, such as combustion of fixed and mobile sources, industrial processes other than combustion, ruminant emissions, biogas from landfills, refrigerant leaks, nitrogeneous fertilising, biomass...

→ Indirect energy emissions (SCOPE 2): Indirect emissions from the production of electricity, heat or steam purchased or imported for the organisation's activiites.

→ Other indirect emissions (SCOPE 3): The other emissions produced indirectly by the organisation's activities, that are not included in Scope 2 but are linked to the full value chain, such as: the purchase of raw materials, services or other products, staff travel, upsteam and downstream transport of merchandise, management of the waste generated by the organisation's activities, use and end of life of the products and services sold, capital goods and production equipment...

Internet of Things (IoT): From a conceptual standpoint, the Internet of Things means connected physical objects that have their own digital identity and are capable of "talking" to each other. From a technical standpoint, this consists of direct and standardised (IP address, smtp, http etc.) digital identification of a physical object thanks to a wireless communication systems that can be an RFID chip, Bluetooth or Wi-Fi.

Last drop of a network: in the case of a fibre to the home (FttH) infrastructure, the last drop or last mile of the network is the very last section of the acces network, and is located at the shared access point. In terms of total number of kilometres, it represents the longest portion of the network, and in France is fully shared between electronic communications operators.

Life-cycle assessment (LCA): A life-cycle assessment (LCA) inventories and quantifies the physical material and energy flows associated with and environmental impact caused by human activity throughout a product's life. For a more detailed defintion, see the work done by ADEME (in French): https://www.ademe.fr/expertises/consommer-autrement/passer-a-laction/dossier/lanalyse-cycle-vie/quest-lLCA.

Net neutrality: Internet or network neutrality is a principle that guarantees equal treatment to every data traffic stream on the internet. It prohibits, for instance, any positive or negatve discrimination based on the source, the destination or the content of the information being relayed over the network.

Operating system (OS): An operating system is a set of programs that makes it possible to direct a computer terminal's resources. It also has a user interface that enables the user to interact with their computing device. Simply put, it is a set of programs that provide the ability to run and control a computing device.

PCR (Product category rules): These are documents that specify predetermined rules for performing a life-cycle assessment on a category of products, and determine the format for developing Environmental Product Declarations (EPD). They are indispensable for assessing different environmental effects.

Primary energy: Primary energy (PE) is the "potential" energy contained in raw natural resources (such as wood, oil, etc.) before being subjected to any transformation process. It is distinguished from "final energy" since the resource's production, transport and transformation processes generally induce losses.

Public Switched Telephone Network (PSTN): The PSTN is the legacy fixed telephone service technology, used by landline phones plugged directly into the wall jack.

PUE (Power usage effectiveness): PUE is the metric used to evaluate a data centre's energy efficiency. It is the ratio between the total energy used and the energy needed to power the computer equipment housed in the data centre.

Rebound effect: The rebound effect refers to a situation wherein a technological innovation makes it possible to improve the energy efficency of a particular use or application which, in theory, should result in an overall decrease in that use's energy impact but, in fact, that increased efficiency drives up usage so that any expected gains are depleted if not cancelled out by the resulting overall increase in usage. This effect was laid out for the first time by W. Stanley Jevons ("The Jevons Paradox" cf. W. Stanley Jevons, *The Coal Question; An Inquiry Concerning the Progress of the Nation, and the Probable Exhaustion of Our Coal Mines*, 1865.) and later updated by economists Daniel Khazzoom and Leonard Brookes ("The Khazzoom-Brookes postulate" cf. Saunders, Harry D, *The Khazzoom-Brookes postulate and neoclassical growth. The Energy Journal.* 13 (4): 131–148, 1992). The paradox lies in the fact that any development of an application or a technology that improves an activity's energy efficiency must, a priori, involve a reduction of this activity's overall energy impact. However, as Jevons observed in 1865, that overall coal consumption increased in England after the introduction of the steam engine, despite the latter being more energy efficient. Watt's innovations made coal a more cost-effective source of energy, driving more widespread use of his steam engine in manufacturing, which in turn drove up overall coal consumption.

Small cells: Small cells are akin to mini, low-power and short range (around 100m) cell sites.

Partner workshop

"Cyberthreat, environmental threat" hosted by ANSSI

In response to an invitation issued by ARCEP, the French National Agency for the Security of Information Systems (ANSSI) hosted an online workshop on 25 November 2020, called "Cyberthreat, environmental threat".

The aim of this workshop was to explore, for the first time, the links between cybersecurity and the environment. The workshop was also organised as part of ANSSI's first participation in the public sector innovation month, and brought together some fifty people from the cybersecurity and digital technology ecosystem and from civil society, from France, the European Union (ENISA) and the French-speaking world.

The discussion began with a query: considered a subset of digital activities in terms of its environmental impact, what role can and must cybersecurity play in the effort to achieve environmentally sustainable digital technology? Does it have any particular properties in this area that warrant examination?

How to enable cybersecurity to gain more control over its environmental impact without relinquishing the ever increasing need for increaed security and digital trust? Beyond that, are there overlaps between these two areas, similarities or shared challenges that could be tackled together? What are the possible synergies between experts from the two fields?

To open up discussions on these questions, the workshop was structured into three parts: an outline of the process (Jean-Baptiste Demaison, head of public sector innovation, ANSSI) followed by a warm-up session, with two talks devoted to the main challenges in taking cyberthreats (Camille Dubedout, PhD student, cybersecurity management division, ANSSI) and and environmental threats (Fabien Gainier, sustainable development instructor at EDHEC) into account. The purpose of this first part was to provide all of the participants with a common foundation of knowledge, and to elicit initial input and feedback.

A first group discussion, to explore the possible overlaps between cybersecurity and the environment, stemming from the hypothesis that they do have points in common, kicked off with the notion of "threat" as contained in the Workshop's title.

The second set of discussions, during which participants were invited to read a fictional future article describing cybersecurity in France in 2025, which has managed to master its environmental impact and, thanks to having worked with environmmental specialists, to create synergies that benefit both sides (this fictional

article is available on the ANSSI website). Participants were then invited to identify the main challenges that public authorities and all of the ecosystem's players needed to tackle to achieve this future success.

Each group was first asked to come up with concrete solutions (workstreams, initiatives, concepts, etc.) that could be deployed to meet this previously identified challenges. The third part concluded with the presentation of two solutions per group in a final plenary session.

All of the group work was supported by a team of facilitators (Lisa Allemand, student, Cybersecurity management division; Aline Barrault, Communications division, ANSSI; Juliette Baron, Chief of Staff, Strategy Department, ANSSI; Jean-Baptiste Demaison, ANSSI; Camille Dubedout and Laurent Toustou, Digital sustainability programme, ARCEP).

The first thing the workshop accomplished was to identify several areas of overlap between the two areas, on two main fronts:

- Shared concepts and characteristics, in different contexts:
  - The notion of threat: the need for security and digital trust elicited by threats coming from cyberspace against information systems and data, but also the threats that human activities pose to the delicate balances of life on earth, in part because of the rise of digital technologies and services.
  - The notion of crisis: cyber, when IT incidents reach a certain scale, often extending beyond the borders of a single country; environmental when the delicate balances of life on earth are disturbed on what is often a global scale, such as the climate crisis. And in both cases, with eminently local consequences.
  - The notion of ecosystem to protect: digital technology's and that of life on earth, in all their complexity and respective, complex systems of interdependence.
  - The notion of resilience: of the ecosystems in question, when faced with a crisis.
  - Growing interest in the two areas amongst civil society, public sector players, businesses, the world of research and innovation.

- **Shared challenges:**
  - That of developing a "sustainable" digital world – in the sense of its capacity to "last" – a resource that is common to (and shared by) cybersecurity players – working to secure the systems and data that are vital to trust in the uses enabled by digital technology – and to players working to further digital technology's green transition, which is crucial to its lasting development.
  - Beyond digital technology, the challenge of building a resilient society, at a time when cybersecurity and environmental threats are two of the most critical and systemic challenges facing society and the economy, both today and for years to come.
  - By extension, the challenge of persuading decision-mkaers, particularly corporate ones, that making no effort – notably budgetary – to master cybersecurity and their own environmental impact, could one day threaten their business and even their business models.

The projection into 2025, into a future where cybersecurity and environmental players met several key challenges together, created an opportunity to identify which challenges were likely to guide their actions in the coming years. Three categories of challenge in particular were mentioned:

- Working to achieve better control of the environmental impact of cybersecurity
  - The challenge of training cybersecurity experts/raising their awareness of environmental issues to lend credibility and convince them that cybersecurity can and must do its part to gain control over digital technology's environmental impact.
  - The challenge of obtaining an accurate assessment of cybersecurity activities' (e.g. cyberdefense) environmental impact -- for instance the tools and equipment used but also data reducndancy to build resilience. Having reliable data over time, and sharing them, to facilitate data-driven regulation.

- Using this assessment as a springboard, the challenge in building cybersecurity that is both ambitious from a security standpoint and proportionate to its environmental impact, that could draw inspiration to some degree from the "minimalist" approach, including:
  - Underlying activities, tools and equipment, notably to achieve better control over the asssociated energy consumption and carbon footprint.
  - Recommended security measures for information systems. To focus in particular on the priority issue of combattting obsolescence, so that maintaining digital security solutions in top condition is not synonymous with being encouraged to replace them too frequently.

- Ask the question of what cybersecurity can do for the environment and what cyberthreats are tied to environmental crises
  - The challenge of identifying which dimensions to include in cybersecurity's environmental assessment – opening the way for possible areas of cooperation – by contributing, for instance, to:
    - Avoiding certain environmental threats (e.g. protecting infrastructures from cyber sabotage and so preventing pollution; preventing fraudulent use of computer equipment such as connected objects that form bot networks, consuming additional energy in an illegitimate and illicit fashion);
    - Reduce the environmental impact of certain activities, for instance by creating the ability to replace travel (notably air travel) with the use of remote digital solutions;
    - Help secure the digital dimension of the green transition (e.g. the technologies used to optimise production and energy consumption; the cybersecurity of businesses, associations, public operators, proposing eco-friendly solutions, etc.);
  - The challenge of obtaining a better assessment of the threats created by environmental crises – just like public health crises – from a cybersecurity standpoint:
    - Escalation of malicious acts in cyberspace.
    - Threats to equipment's physical safety (e.g. data centres overheating during heatwaves).

- Explore synergies between cybersecurity and the green transition
  - The challenge of managing to reconcile and, above all, avoid having to choose between cyberthreats and environmental ones in organisations..
  - Beyond that, the challenge of fostering shared approaches and processes, that are virtuous in both respects, rooted in a shared ambition: that of sustainable, hence safe, digital tech, protecting data and the environment. In particular, laying the groundwork for possible cooperation, including technical, that can lead to innovative solutions that satisfy both cyber and environmental imperatives To this end, putting research centres' and businesses' R&I to work on designing digital and cybersecurity solutions that are secure and green by design, notably in terms of energy consumption.

Based on these challenges, the different groups put forth several potential concrete solutions. Proposals included the following actions:

- Promote a risk-based approach as the cornerstone of cybersecurity which is demanding but whoser recommended measures are proportionate to their environmental impact.

- In addition to risk, factor in environmental imperatives by default when drafting cybersecurity recommendations and measures, without scaling back security targets. In particular, propose solutions that encompass both the drive to eliminate too swift hardware obsolescence and maintaining equipment in safe operating condition.

- Develop cybersecurity players' education and awareness of environmental issues, in particular with a view to integrating those issues at the solutions' design stage (equipment, services), first to foster more sober cybersecurity and, second, to ensure that low-carbon and green tech are not deprived of a security component.

- Initiate a dialogue between public sector players in charge of cybersecurity issues (e.g. ANSSI) and the green transition (e.g. ADEME). Encourage and offer broad support for initiatives from all of the players from the cyber and environmental ecosystems. Consider the European and international dimension when exploring these challenges.

- To further this dialogue, thought should also be given to promoting an umbrella concept for shared digital goals, by having "sustainable by design" encompass the various "security by design" and "privacy by design" concepts, with the understanding that "by design" refers to creating solutions that incorporate control over their environmental footprint from the outset.

- To this end, explore avenues for cooperation on concrete subjects such as:
  - obtainining a detailed assessment of the environmental impact of cybersecurity's different "building blocks";
  - fostering the emergence of a system of joint certification for digital solutions, that are both secure and green or, at the very least, that do not countervail set targets in those areas.
  - Discourage the use of personal computer equiment (BYOD, *bring your own device*) increasing the digital attack surface, as well the number of devices produced and used, which in turn increases the amount of subsequent waste.