RÉPUBLIQUE FRANÇAISE
Liberté Égalité Fraternité

ADEME – Arcep study
Evaluating the digital environmental footprint in France

Third volume of study: Forward-looking analysis up to 2030 and 2050

SUMMARY

On 6 August 2020, the Government assigned ADEME and Arcep the joint task of producing a study on assessing the digital environmental footprint in France.

<u>First two volumes of the report</u>

On 19 January 2022, ADEME and Arcep submitted the first two volumes of the report to Government.

The first volume underscored **the need to carry out the study based on a multi-component** (devices, networks and data centres), **multi-criteria** (carbon footprint and 10 other environmental indicators) **and multi-stage** (production, distribution, utilisation and end-of-life phases) **life cycle assessment (LCA).**

The second volume of the report uses this methodology to measure the digital environmental footprint in France in 2020.

- The carbon footprint of digital goods and services for one year in France **represented 2.5% of the country's total carbon footprint in 2020, or 17.2 Mt CO_2eq**.
- **Devices** represent **79% of the digital carbon footprint, data centres 16%, and networks 5%**.
- In addition to carbon footprint, the **depletion of abiotic resources** (minerals and metals) emerges as a relevant criterion for describing the digital environmental footprint.
- The **hardware production** phase accounts for **78% of the total footprint**, compared to 21% for the utilisation phase.

<u>Main findings of the third volume</u>

The third volume provides a forward-looking analysis of the digital environmental footprint in France up to 2030 and 2050, based on multiple scenarios, including one "business as usual" and several alternative scenarios. This forecasting exercise is inherently complex, and needs to be reviewed on a regular basis – especially for such a rapidly evolving sector characterised by a host of cross-cutting internal effects and positive and negative externalities on other sectors that cannot be taken into account here. This work nevertheless constitutes a first step in measuring and assessing the avenues to take, and the challenges involved in addressing the issue. To this end, this forward-looking exercise employs the methodology developed in the second volume of the study which breaks down the digital sector into three building blocks (devices, networks and data centres) using a multi-criteria life cycle assessment (LCA) approach.

Between now and 2030, if no steps are taken to reduce the digital environmental impact, and consumption continues to grow at the current pace (data traffic will increase sixfold and the number of devices by close to 65%, compared to 2020, particularly due to the rise of connected objects), the **digital carbon footprint in France will have increased by around 45% in 2030 compared to 2020:** reaching **25 Mt CO_2eq compared to 17.2 Mt CO_2eq in 2020**.

The alternative scenarios explored would result in a smaller increase if not a decrease in the digital carbon footprint.

- **The sustainable design of** equipment would help **lengthen devices' lifespan and decrease their unit power consumption.** The corresponding scenarios (moderate or widespread sustainable design) would help **curtail the increase in the digital carbon footprint by 5% to 20%, reduce the**

consumption of abiotic resources (metals and minerals) by 4% to 15% and to reduce final energy consumption by 23% to 42%, compared to 2020.

- **Under the Digital sobriety scenario**, users replace their existing devices with more energy-efficient ones, keep them longer and adopt more sober habits, notably in the area of video streaming. All of the stakeholders, including manufacturers, cap their device numbers, especially connected objects, at 2020 levels. This Digital sobriety scenario represents **the most powerful lever for controlling the digital environmental footprint.** It would enable a **16% reduction of the carbon footprint** (or 14 Mt CO_2eq), **a 30% reduction in abiotic resource (metals and minerals) consumption and a roughly 52% reduction in power consumption** (or 25 TWh) **compared to 2020**.
- In every scenario, **devices generate the largest carbon footprint (around 80%)** and are the prime source of depletion of abiotic resources (metals and minerals, over 90%). Devices are thus the **primary lever for reducing the digital environmental footprint**.
- These scenarios **reduce the power consumed by each of the digital sector's building blocks** (i.e. devices, data centres and networks) considerably.

Of course, sobriety and sustainable design are not mutually exclusive strategies. The goal, rather, **is to employ all of the avenues available to the different stakeholders. Users must be made more aware of the issue, and device suppliers, data centre operators and electronic communication operators all have a key role to play.**

For forecasts up to 2050, the study **relies on four societal models** established by ADEME for the purposes of its "Transition(s) 2050"[1] exercise, mapping out paths to carbon neutrality: "Frugal generation", "Territorial cooperation", "Green technologies" and "Self-correction wager". These four societal models are applied to the digital sector as alternative scenarios, then compared to the Business-as-usual scenario.

The analysis reveals that if no steps are taken to reduce the digital environmental footprint, **the carbon footprint could triple between 2020 and 2050 under the Business-as-usual scenario,** and represent more than 49 Mt CO_2eq. Meanwhile, power consumption in France would increase by around 80% to reach 93 TWh (of which 39 TWh can be attributed to data centres).

- **Under the "Self-correction wager" scenario, the carbon footprint could quintuple compared to 2020** (or 81 Mt CO_2eq) and power consumption could almost triple (x2.6) compared to 2020 (reaching 137 TWh) largely due to the explosion in the number of connected objects and the development of data centres.
- On the other end of the spectrum, the **"Frugal generation"** scenario would result in a digital carbon footprint that is **cut in half** compared to 2020 (or 9.3 Mt CO_2eq) and power consumption that would shrink by more than 75% (and reach 12 TWh). **This is the scenario that would go the farthest in reducing the digital environmental footprint.**
- Under all of the scenarios, **devices systematically account for the majority of the carbon footprint**. **Data centres are the second largest contributors,** due to ever-increasing processing needs.

On all other criteria, notably the depletion of abiotic resources (minerals and metals), devices also are the greatest source of impact (between 61% and 86% under the Business-as-usual scenario). **The "Self-correction wager" scenario involves a substantial shift in the source of the impact, notably on abiotic resources (minerals and metals)**. As a result, if all of the **scenarios create the ability to achieve carbon neutrality, they involve a very different share of the national carbon footprint being allocated to the digital sector. The scenario aimed at maximising the use of digital technology to reduce other sectors'**

[1] https://transitions2050.ademe.fr/

carbon footprint ("Self-correction wager") would **involve having a potentially very sizeable portion of the impact being transferred to other environmental** criteria (notably the depletion of abiotic resources "metals and minerals"), which could **undermine its sustainability.**

Here again, these **scenarios describe possible avenues that are not mutually exclusive, each of which can lead to carbon neutrality.** The solution may be found somewhere in between, **by taking all of the avenues available** (sobriety, sustainable design, circular economy) and by **relying on digital technology as a driving force in the transition, while ensuring that it also be incorporated into a trajectory that is compatible with reducing its own environmental footprint.** The fact that **digital technology is woven through other sectors renders the issue** all the more complex.

<u>Conclusion</u>

The findings of the ADEME-Arcep study call our attention to the trajectory that digital could take if nothing is done to correct it. The scenarios crafted by ADEME, all of which have carbon neutrality as their target, involve major changes in our societies, particularly in the areas of research and development, in products and services, some of which do not yet exist, in consumption habits, production methods and the adoption of best practices by users, but also by device manufacturers, and network and data centre operators.

The study highlights the fact that, in addition to the **carbon footprint,** one of the major environmental issues for digital technologies is the **availability of strategic metals** and the other resources used to manufacture devices — chiefly televisions, computers, STBs, ISP routers and smartphones up to 2030, as well as connected objects up to 2050, particularly due to the implementation of new mobile network technologies.

It emerges from the study that the first lever for action is the adoption of a digital sobriety policy, which begins with an examination of the scale of development of new digital products and services, and a reduction or levelling off of the number of devices in circulation. **Extending the life of digital devices, thanks to the release of sustainably designed hardware, by further developing device refurbishment and repair, and by raising consumer awareness of these issues to achieve greater digital sobriety must be one key area of focus.**

By the same token, to improve energy efficiency in particular, **sustainable design must become systematic**, not just for devices but **for all ICT equipment** (network infrastructure and data centres), and **for digital services** to reduce the amount of data traffic required to provide the same service and to improve energy efficiency.

To achieve the goals of the Paris Agreement 2050, **ICT must be accountable for their own impact** – which is why a **collective effort involving every stakeholder** (users, device and equipment suppliers, content and application providers, network and data centre operators) is so **crucial.**

1 Introduction

The summary[2] submitted to the Government on 19 January 2022 provides a reminder of the context in which the ADEME-Arcep study was launched, and of its goals, namely:

- **To qualify the current and future environmental footprint of fixed and mobile network infrastructures;**
- **To identify and assess the different factors that make it possible to quantify the digital environmental footprint** (including data centres, devices[3], and the different uses and applications),
- **Define levers for action and best practices** for the short, medium and long term, to reduce the digital environmental footprint.

The study is composed of three volumes.

The first part of the study includes a bibliographical review of methodologies and studies devoted to assessing the digital sector's environmental footprint. This review is completed by a state-of-the-art of the technologies, and interviews with stakeholders operating in France who are focused on the environmental aspects of digital technologies.

The second part of the study takes a life cycle assessment (LCA) based approach to covering all of digital industry equipment located on French soil (devices[4], networks and data centres). This LCA is **multi-criteria,** to assess other types of impact on the environment other than carbon footprint thanks to the use of **11 other indicators**. It is also **multi-component** to break down the digital environmental footprint into three building blocks (devices, networks and data centres). Lastly, it is **multi-stage** to incorporate the footprint generated across the life cycle of each of these three building blocks (production, distribution, utilisation and end of life). To comply with environmental communication standards and further strengthen the study's credibility, an ISO standards-compliant critical review was performed by three outside rapporteurs.

The third part of the study provides a forward-looking assessment the digital environmental footprint in France in 2030 and 2050. It employs the methodology developed in the second volume of the study, which breaks down the digital sector into three building blocks (devices, networks and data centres), and assesses the impacts generated during each phase of the life cycle using different environmental impact indicators, to forecast their possible progression using multiple scenarios. The study thus provides an estimate of the digital environmental footprint based on a Business-as-usual scenario and three alternative sustainable design and sobriety scenarios up to 2030. The forward-looking analysis up to 2050 is based on a different approach, namely comparing a Business-as-usual scenario to the four scenarios for achieving the goal of carbon neutrality nationwide, which ADEME defined as part of the "Transition(s) 2050" exercise. The aim of this summary is to outline the main findings of the third volume of the study, produced by a consortium made up of Deloitte, Negaoctet[5] and IDATE. The forecasting exercise developed in this third part is by nature imperfect, but nevertheless a first step towards measuring and assessing the directions available and the challenges to be tackled to address the issue. To this end, in addition to the different data and cross-referencing of sources available in the

[2] https://www.arcep.fr/uploads/tx_gspublication/etude-numerique-environnement-ademe-arcep-note-synthese_janv2022.pdf

[3] The user devices employed for the consumption of digital services, such as computers, mobile phones, tables, displays, TVs, internet boxes, game consoles, smart speakers, connected objects, etc.

[4] The user devices employed for the consumption of digital services, such as computers, mobile phones, tables, displays, TVs, internet boxes, game consoles, smart speakers, connected objects, etc.

[5] Negaoctet is itself a consortium made up of LCIE Bureau Veritas, APL DATACENTER, GreenIT.fr, 3bis – DDemain.

literature, the construction of the different scenarios is based on analyses to emerge from discussions, interviews with different digital industry experts, to share directions, views and hypotheses. Uncertainties nevertheless remain with respect to the modelling time horizons, over the course of which the modelling produced in the second part was then forecast.

2 Scenarios for 2030

2.1 The scenarios

Four forward-looking scenarios are examined: a scenario that corresponds to current trends ("Business as usual") and three alternative scenarios ("moderate sustainable design" scenario, "widespread sustainable design" scenario and a "digital sobriety" scenario).

The main parameters that differentiate the forward-looking scenarios up to 2030 are:

- the equipment base (breakdown of devices, networks and data centres);
- power consumption by device or piece of equipment;
- devices' lifespan;
- data traffic growth due to the development of uses and applications enabled by new mobile network technologies such as 5G.

Other technical parameters are factored in and detailed in the full report (network and data centre modelling parameters).

2.1.1 Business-as-usual scenario

The Business-as-usual scenario is established based on different reports, notably those produced by the French Senate (study Citizing *L'empreinte carbone du numérique en France 2020*[6]), the European Commission (ICT Impact Study 2020[7]) and the 2019 EDNA[8] report on connected objects[9], to estimate the growth rate for the different types of hardware.

The assumptions for this scenario are as follows:

- The fibre network will gradually replace the legacy copper network between now and 2030 (this is true for all the scenarios). Mobile networks continue to be deployed with 5G such that the current growth trend for antennas (cell sites and rooftop cell towers) continues. The surface area occupied by data centres increases by around 10% between 2020 and 2030.
- Each type of equipment's particular technical properties and environmental footprint are modelled with the help of the Négaoctet database and are considered to be constant (for the production, distribution and end-of-life phases). The unit power consumption of most devices decreases steadily – by 1% to 5% a year, depending on the type of device – but their lifespan remains largely the same as in 2020. Network equipment's unit power consumption remains constant. For data centres, power consumption by surface area unit increases by around 15% between 2020 and 2030, as data centres become increasingly dense.

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[6] https://www.citizing-consulting.com/wp-content/uploads/Report_Empreinte-carbone-du-num%C3%A9rique-2019-%C3%A0-2040_Citizing-1.pdf (The digital carbon footprint in France, 2020)

[7] https://www.vhk.nl/downloads/Reports/2020/IA_report-ICT_study_final_2020_(CIRCABC).pdf

[8] Electronic Devices & Networks Annex

[9] https://www.iea-4e.org/wp-content/uploads/publications/2019/06/A2b_-_EDNA_TEM_Report_V1.0.pdf

- Internet traffic growth is estimated based on International Energy Agency/l'*Agence Internationale de l'Energie* forecasts (around +20% a year, or a sixfold increase in traffic between 2020 and 2030).

2.1.2 Sustainable design scenarios

Alternatively to the Business-as-usual scenario, two sustainable design scenarios (moderate and widespread) were established and characterised by the following assumptions:

- The sustainable design of equipment results a unit power consumption decrease of -33% to - 50%, respectively, compared to 2020 for most equipment (devices, networks and data centres), depending on the sustainable design scenario (moderate or widespread).
- Data centres employ innovative cooling systems that enable a decrease in consumption per surface area unit of between -40% and -55%, depending on the sustainable design scenario.
- The number of devices grows at the same pace as under the Business-as-usual scenario (+66% to reach 1.3 billion devices, including around 800 million connected objects).
- The development of the sustainable design of devices increases their lifespan by one to two years, on average, depending on the sustainable design scenario (moderate or widespread).
- Uses develop in the same way as under the Business-as-usual scenario

2.1.3 Digital sobriety scenario

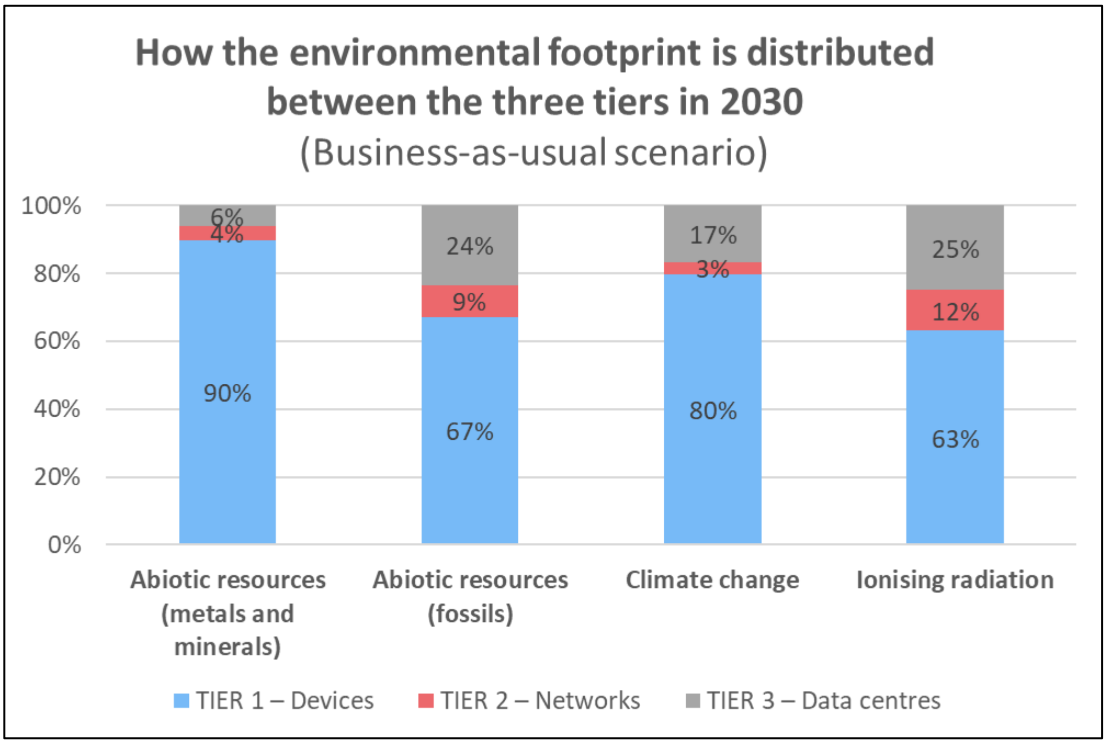
Under the Digital sobriety scenario, consumers, businesses and manufacturers make more sober use of digital technologies, which can be characterised as follows:

- More sober use of digital technology becomes increasingly widespread (reduced use of video streaming and digital services, longer intervals between digital device replacement). This translates into a two-year increase in devices' lifespan and unit power consumption being cut in half compared to 2020.
- The number of devices being put on the market flattens at 2020 levels (particularly the number of connected objects which level off at around 250 million units). Televisions are gradually replaced by projectors which have a smaller carbon footprint in the production phase.
- Total data traffic increases in the same proportions as under the Business-as-usual scenario (albeit slightly less) but with more mobile traffic being carried over to the fixed network as WiFi becomes the connection method of choice.

2.2 Forecasts up to 2030

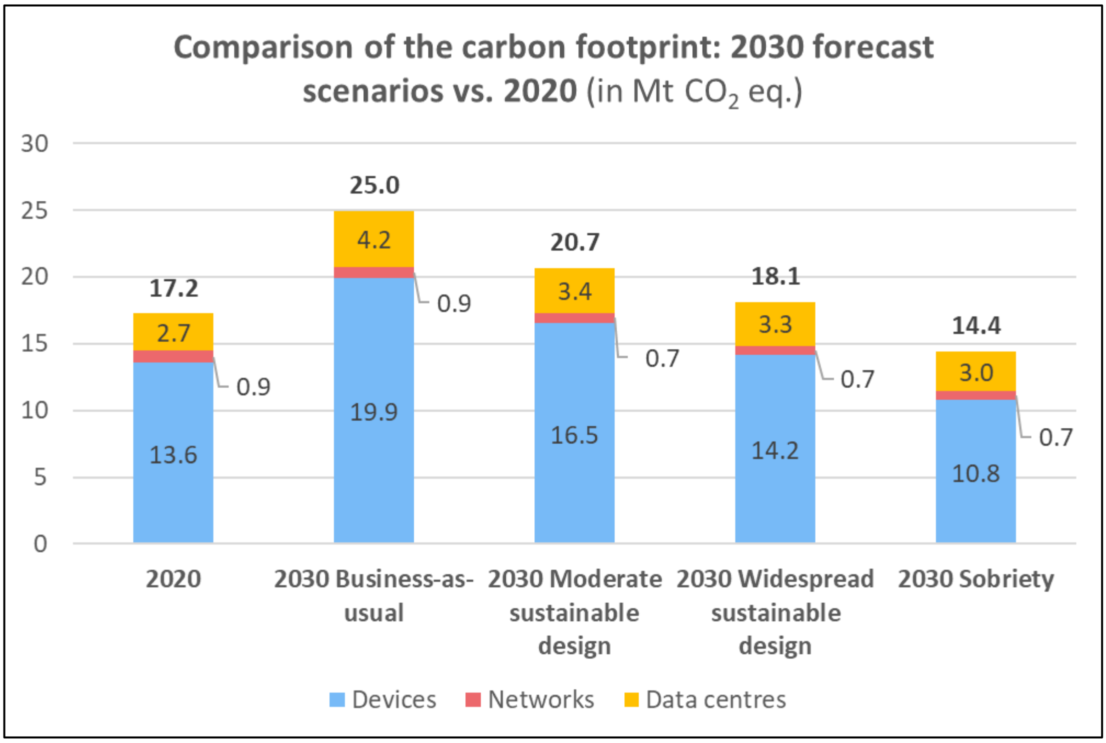
Between now and 2030, if no steps are taken to reduce the digital environmental footprint, and consumption continues to grow at the current pace, by 2030 data traffic will increase sixfold and the number of devices by close to 65%, compared to 2020, particularly due to the growing use of connected objects. The resulting increases between 2020 and 2030 would include **a roughly 45% increase in the digital environmental footprint in France,** reaching **25 Mt CO_2eq compared to 17.2 Mt CO_2eq, or 2.5% of the national carbon footprint in 2020**. The consumption of abiotic resources (metals and minerals) would increase by 14% compared to 2020, and final energy consumption during the device utilisation phase by 5% (to reach 54 TWh a year).

As the following graph shows, however, **devices continue to have the greatest impact on the environment (between 63% and 90% of digital's footprint) for all of the criteria studied, notably the depletion of abiotic resources (minerals and metals)** under the Business-as-usual scenario in 2030. These findings are similar, in order of magnitude, to the results calculated for 2020.

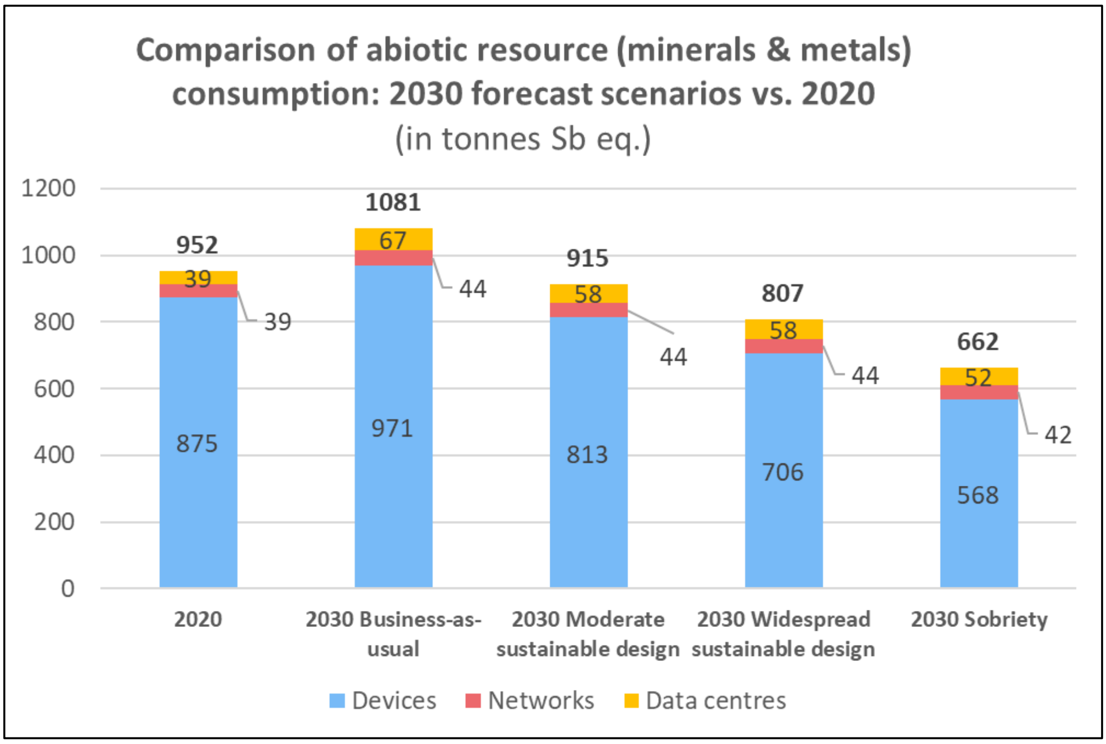


This trend could nevertheless be curbed. The study highlights the fact that the alternative scenarios mapped out could lead to a smaller increase if not a decrease in the digital carbon footprint:

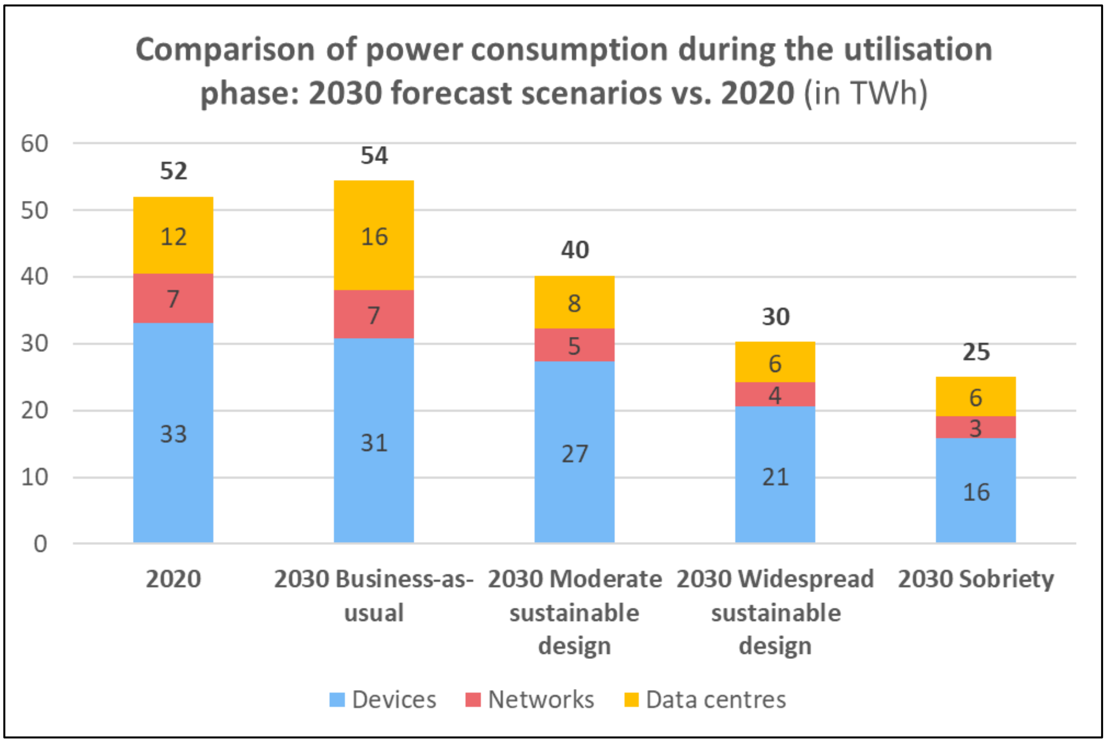
- **Sustainably designed** equipment would help **increase the devices' lifespan and decrease their unit power consumption**. These scenarios (moderate and widespread sustainable design) would **curtail the increase in the digital carbon footprint by 5% to 20%, reduce the consumption of abiotic resources (metals and minerals) by 4% to 15%, and reduce final energy consumption by 23% to 42%**, **compared to 2020**.
- **Increasing devices' lifespan by one or two years would save 3.2 Mt and 5.2 Mt of CO_2eq, respectively, during those devices' production phase** compared to the Business-as-usual scenario, and decrease the consumption of abiotic resources (metals and minerals) by 167 to 274 tonnes Sb eq. compared to the Business-as-usual scenario.
- **The decrease in devices' unit consumption will generate savings of between 0.16 Mt and 0.5 Mt CO_2eq during the utilisation phase** compared to the Business-as-usual scenario, and reduce final energy consumption by 14 to 24 TWh compared to the Business-as-usual scenario.
- **Under the Digital sobriety scenario**, users replace their existing devices with more energy-efficient ones, keep them longer and adopt more sober habits, notably in the area of video streaming. All of the stakeholders, including manufacturers, cap their device numbers, especially connected objects, at 2020 levels. This Digital sobriety scenario represents **the most powerful lever for controlling the digital environmental footprint.** It would enable a **16% reduction of the carbon footprint** (or 14 Mt CO_2eq), **a 30% reduction in abiotic resource (metals and minerals) consumption and a roughly 52% reduction in power consumption** (or 25 TWh) **compared to 2020**.
- **Devices** are the **first path to reducing the digital environmental footprint,** notably in terms of carbon footprint, depletion of abiotic resources and power consumption. In every scenario, in fact, **devices generate the largest digital environmental footprint** (around 80% of the total).



In all the scenarios, **devices are the heaviest consumers of abiotic resources (metals and minerals)** (cf. graph below).



In every scenario, **devices are heaviest consumers of electrical energy during the utilisation phase, but data centres could also account for a very large share by 2030** (up to 16 TWh, or 30% of the total power consumption in 2030 under the Business-as-usual scenario, cf. graph below).



3 Forward-looking scenarios for 2050

The forward-looking analysis up to 2050 is based on the four scenarios that ADEME produced in November 2020, to map out paths to France becoming carbon neutral (Frugal generation, Territorial cooperation, Green technologies and Self-correction wager).

These four scenarios result in carbon neutrality for the entire French economy by 2050, rather than by economic sector. The scenarios each follow a different path and correspond to different societal choices, all with strong and varied implications for the rest of the economy.

For each ADEME scenario for achieving carbon neutrality by 2050, a set of core assumptions define the role that digital technologies play in French society up to that date. These assumptions thus create the ability to model the digital environmental footprint in 2050. **As a result, if the digital carbon footprint varies from scenario to scenario, these four scenarios are designed to result in nationwide carbon neutrality across the entire French economy – contrary to the Business-as-usual scenario.**

3.1 The ADEME 2050 scenarios as applied to digital technology

3.1.1 Frugal generation scenario

Under this scenario, sober consumption levels that more closely align with actual needs help reduce demand for energy, raw materials and resources, while widespread sustainable design helps to minimise devices' environmental footprint:

- The number of devices in circulation decreases substantially thanks to lower levels of household ownership driven by sobriety: the number of computers in households, for instance, is cut in three, and the number of telephones decreases by 20% compared to 2020. The number of connected objects remains constant compared to 2020.
- Devices' lifespan increases by an average of two years.

- Manufacturers widely adopt the sustainable design of their equipment and usage levels are more sober: unit power consumption (for all segments, i.e. devices, networks and data centres) is divided by three compared to 2020.
- Mobile networks make heavier use of sharing (infrastructure, etc.).
- Data centres' occupied IT surface area is equal to 2020 levels (optimisation of data centres to curtail increased energy use).
- Data traffic is reduced compared to the Business-as-usual scenario, and grows by just over 10% a year (vs. 20% a year for the Business-as-usual scenario). Traffic on mobile networks increases less quickly due to the use of Wi-Fi as the connection method of choice.

3.1.2 Territorial cooperation scenario

Under this scenario, ADEME sketches out a society that transforms itself by engaging in shared governance and territorial cooperation, involving Non-governmental organisations, public institutions, the private sector and civil society. Networks equipment is structured into a territorial mesh, with the decentralisation of data centres helping to reduce access times and the energy needed to relay data traffic. Connected objects are used primarily to save energy (including in homes) to make public services more fluid.
As a result, the model's parameters supposes the following developments:

- The amount of hardware being used (for all segments: devices, networks, data centres) is close to 2020 levels, except for the number of connected objects which increases threefold compared to 2020.
- Manufacturers widely adopt the sustainable design of their equipment: unit power consumption (for all segments, i.e. devices, networks and data centres) is divided by two compared to 2020. The lifespan of devices increases by an average of one year compared to 2020.
- Data centres' surface area increases by around 50% compared to 2020.
- Data traffic is reduced compared to the Business-as-usual scenario, and increases by just over 15% a year (vs. 20% a year for the Business-as-usual scenario).

3.1.3 Green technologies scenario

Under this scenario, **environmental challenges are tackled more through technological development and less through more sober digital behaviours**. The number of connected objects increases sixfold compared to 2020. Data centres' occupied IT surface area doubles due to the widespread use of cloud computing.

This scenario is close to the Business-as-usual scenario in terms of unit power consumption, growth of the equipment base and hardware lifespan.

3.1.4 Self-correction wager scenario

The fourth scenario corresponds to a situation where usage continues to increase dramatically (everything is digitalised) and technological development provides enough of a solution to offset the resulting impact on the environment:

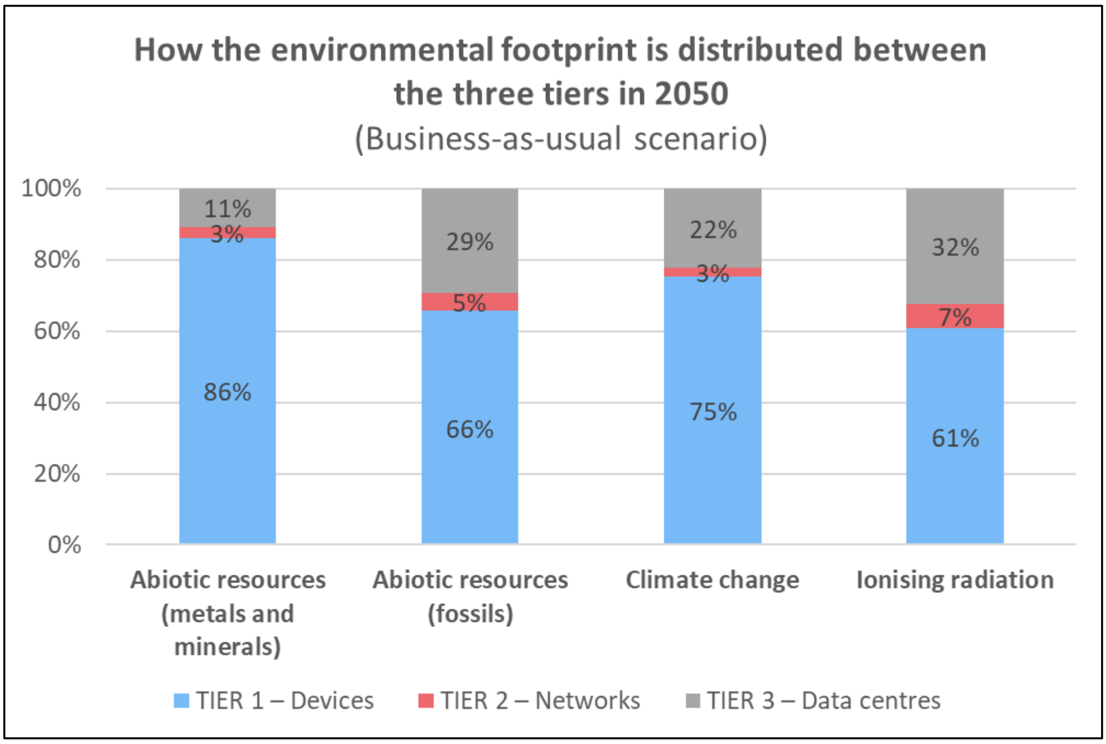
- The number of devices in circulation increases, chiefly due to the explosion in the number of connected objects (over 10 billion connected objects in 2050, x40 compared to 2020).
- Unit power consumption (for all segments: devices, networks, data centres) is equivalent to Business-as-usual scenario levels.

- Network rollouts continue to proceed at a rapid pace, notably for 5G and subsequent generations (6G and beyond).
- Data centres' occupied IT surface area increases fourfold compared to 2020.
- Devices' lifespan is identical to the Business-as-usual scenario.
- Data traffic increases more rapidly than under the Business-as-usual scenario, and grows by just over 25% a year (vs. 20% a year for the Business-as-usual scenario).

3.2 Main findings

Between now and 2050, if nothing is done to reduce the digital environmental footprint, the **carbon footprint could virtually triple compared to 2020 under the Business-as-usual scenario** (over 49 Mt CO_2eq). Power consumption would rise by around 80% compared to 2020 (and reach 93 TWh).

The forward-looking analysis reveals that **devices consistently have by far the greatest footprint (between 61% and 86% of the total) and this for all of the indicators studied, notably the depletion of abiotic resources (minerals and metals)**. The profile of devices has changed since 2020, particularly with the **surge in connected objects**. In addition, devices' share of the footprint is decreasing slightly on most of the indicators studied, while data centres' share has increased compared to the breakdown observed in 2020.

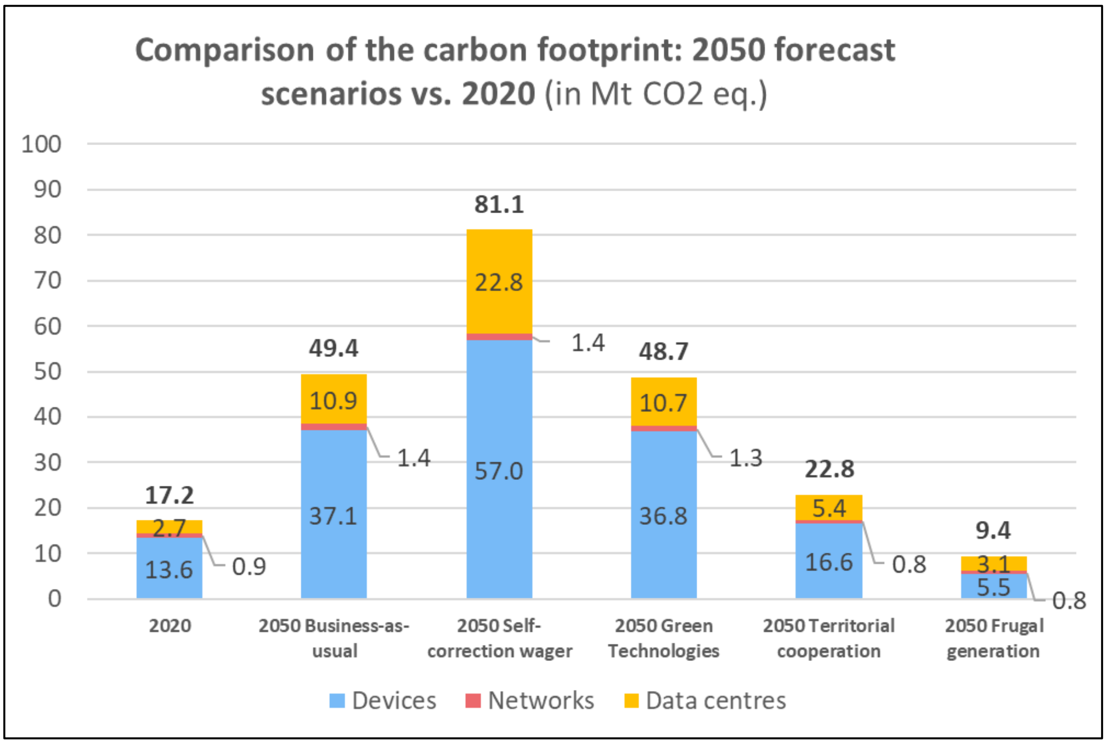


Under the "Self-correction wager" scenario, the carbon footprint could quintuple compared to 2020 (or 81 Mt CO_2eq), **the consumption of abiotic resources (metals and minerals) could double** compared to 2020 (to reach 2090 tonnes Sb eq.) and **power consumption could almost triple (x2.6)** (and reach 137 TWh) notably due to the explosion in the number of connected objects in circulation and the development of data centres.

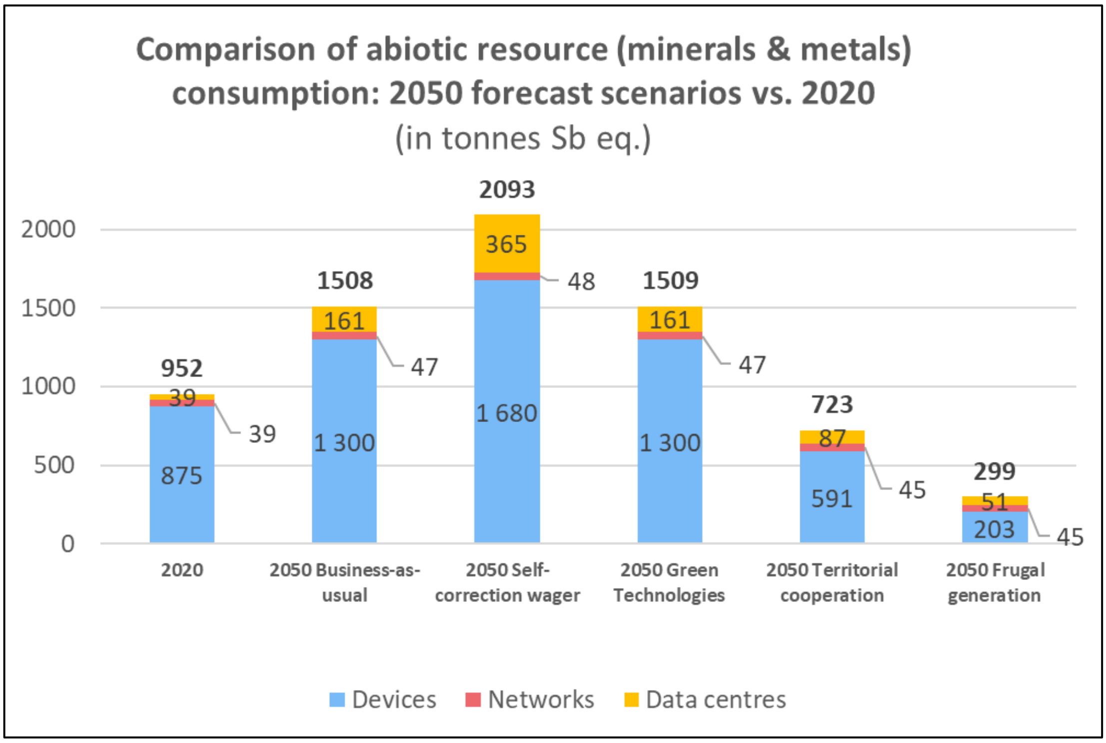
On the flip side, under the "Frugal generation" scenario, the carbon footprint could be cut in half compared to 2020 (to reach 9.3 Mt CO_2eq), **the consumption of abiotic resources (metals and minerals) could be cut in three** compared to 2020 (to reach 299 tonnes Sb eq) and **power consumption**

could be reduced by close to 75% (and reach 12 TWh). **This is the scenario that results in the most dramatic reduction of the digital environmental footprint.**

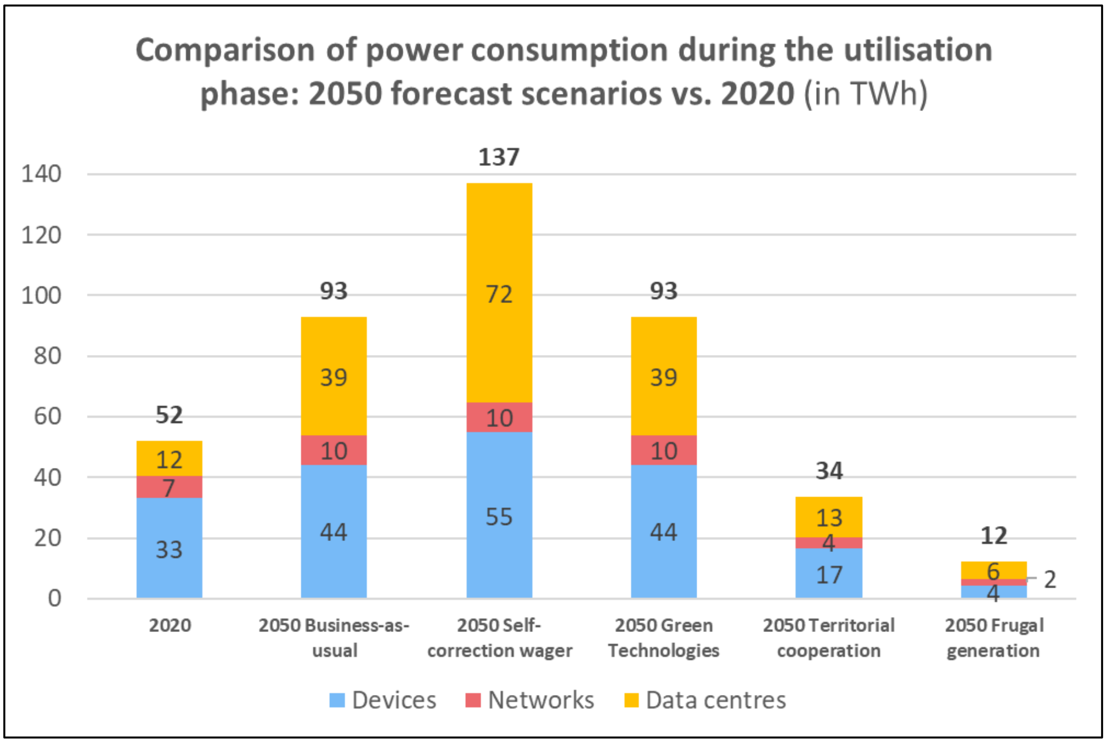
In every scenario, **devices invariably have the largest carbon footprint**. **Data centres come second,** due to the ever-increasing data traffic processing needs (cf. graph below). If all of the **ADEME scenarios have carbon neutrality as their end goal, they each involve a very different share of the national carbon footprint allocated to digital technology.**



The scenario aimed at maximising the use of digital technology to reduce other sectors' carbon footprint ("Self-correction wager") **may mean a** potentially very sizeable **footprint transposed to other areas** (notably the depletion of abiotic resources "metals and minerals") which could **thereby undermine its sustainability** (cf. graph below).



Data centres could become the heaviest consumers of energy by 2050 (up to 72 TWh, or 52% of digital's total power consumption in 2050 under the "Self-correction wager" scenario) and overtake devices' power consumption (cf. graph below).



4 Limitations

There are inherent uncertainties in any forecasting exercise, especially for the very rapidly evolving digital sector, and for timelines as far off as 2050. In addition to which the modelling employed (based on inventory and energy consumption data forecasting assumptions) does not make it possible to fully factor in the complexity of digital infrastructure's future evolution. This would require a more finely tuned and more complex modelling approach to capture the interdependence between the digital sector's different tiers (devices, networks, data centres).

The report details the methodological limitations, notably in terms of the uncertainties over the number of devices/pieces of equipment, their characteristics, their footprint outside the utilisation phase, their lifespan and energy consumption.

5 Conclusion

The findings of the ADEME-Arcep study call our attention to the trajectory that digital could take if nothing is done to correct it. The scenarios crafted by ADEME, all of which have carbon neutrality as their target, involve major changes in our societies, particularly in the areas of research and development, in products and services, some of which do not yet exist, in consumption habits, production modes and the adoption of best practices by users, but also by device manufacturers, and network and data centre operators.

Analysing the business-as-usual scenarios up to 2030 and 2050 reveals that the digital sector would not commit to a path of decarbonation and reducing its environmental impacts, contrary to the commitments made by France. While France set itself the goal of reducing GHG emissions drastically by 2050, at its current pace the digital carbon footprint will triple by 2050, and so shift the burden of compensation over to other sectors, or to the capacities of carbon sinks.

The study highlights the fact that, in addition to the **carbon footprint,** one of the major environmental issues for digital technologies is the **availability of strategic metals and the other resources used to manufacture devices** — chiefly televisions, computers, STBs, ISP routers and smartphones up to 2030, as well as connected objects up to 2050, particularly due to the implementation of new mobile network technologies.

It emerges from the study that the first lever for action is the adoption of a digital sobriety policy, which begins with an examination of the scale of development of new digital products and services, and a reduction or levelling off of the number of devices in circulation. **Extending the life of digital devices, thanks to the release of sustainably designed hardware, further developing device refurbishment and repair, and raising consumer awareness of these issues to achieve greater digital sobriety must be a key area of focus.**

By the same token, to improve energy efficiency in particular, **sustainable design must become systematic**, not just for devices but **for all ICT equipment** (network infrastructure and data centres), and **for digital services** to reduce the amount of data traffic required to provide the same service and to improve energy efficiency.

To achieve the goals of the Paris Agreement 2050, **ICT must be accountable for their own impact – which is why a collective effort involving every stakeholder** (users, device and equipment suppliers, content and application providers, network and data centre operators) is **so crucial.**

Perspectives:/ Looking ahead

This study will be completed by **workstreams undertaken jointly between Arcep, Arcom and ADEME** and notably by the publication of a report every two years measuring the environmental footprint of the different audiovisual media services broadcasting methods (pursuant to the Act of 22 August 2021[10]).

ADEME will also conduct a study dedicated to metals and digital technology, along with other works on certain digital applications and technologies. In addition, a multiannual Energy performance certificate (EPC) programme on digital sobriety will be launched in 2023 in partnership with INRIA and EcoInfo.

Lastly, the **expansion of Arcep's power to collect environmental data,** pursuant to the Act of 23 December 2021[11], will help build the repository of sufficiently high quality data, which remains a crucial issue, following the initial publication in April 2022[12]. It will also create the ability to track the evolution of the digital environmental footprint over time.

[10] Act No. 2021-1104 of 22 August 2021 on combatting climate change and strengthening resilience to its effects https://www.legifrance.gouv.fr/jorf/id/JORFTEXT000043956924

[11] Act No. 2021-1755 of 23 December 2021 on reinforcing regulation of the digital sector by Arcep https://www.legifrance.gouv.fr/jorf/id/JORFTEXT000044553569

[12] https://www.arcep.fr/cartes-et-donnees/nos-publications-chiffrees/impact-environnemental/derniers-chiffres.html