IP REPORTS
INNOVATION & FORESIGHT
No. 09

Data, footprint and freedoms

Exploring the overlaps between data protection, freedoms and the environment

LINC
CNIL.

EDITORIAL

Back in 2019, the CNIL pledged its commitment alongside other authorities to develop collaborative arrangements embracing the climate objectives set out in the Paris Agreement in both its strategic directions and its operational activities. These commitments reflected the steadfast belief among regulators of the need to lend their support in driving the necessary changes while providing answers to the questions voiced by society on these particular issues.

In 2021, we launched our sustainable development action plan with the aim of engaging the CNIL with efforts to move the environmental transition forward as an organisation, especially promoting sustainable mobility, reducing consumption and waste, and reviewing IT and digital practices.

This ninth Innovation & Foresight Report from the CNIL's digital innovation laboratory examines the areas where data protection and environmental protection issues overlap at a time when the digital sector's carbon footprint represents nearly 4% of global emissions (2.5% in France). If no action is taken, that figure could rise by 45% across the country by 2030, according to forecasts by ADEME (French Agency for Ecological Transition) and Arcep ((Electronic Communications, Postal and Print media distribution Regulatory Authority).

The General Data Protection Regulation (GDPR) and the French Data Protection Act enshrine the principle of minimising personal data and streamlining the volume of data used, which explains the appeal behind the idea that data protection regulation could naturally rein in the digital footprint. That is why this report aims to gain a clearer insight into how these rules can act in symbiosis with protecting the environment. This report also endeavours to point out any potential contradictions or compromises that may need to be addressed between these two objectives. Data protection technologies, such as encryption, are a prime example, since they require resources and energy, meaning that they must be used wisely. The aim is also to anticipate any future situations that could create tensions and impede our freedoms, such as when new digital systems are rolled out to determine whether individuals are complying with environmental rules.

This report reviews these issues and offers a series of recommendations, which represent the CNIL's contributions and little building blocks for addressing this major challenge of the 21st century.

Marie-Laure Denis
President of the CNIL

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JUNE 2023
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Agence Linéal
+33 (0)3 20 41 40 76
Printing: DILA
+33 (0)4 71 48 51 05
ISSN: 2263-8881 /
Legal deposit: to be published

The CNIL would like to thank all the members of the Foresight Committee and the external experts whom they met or interviewed.

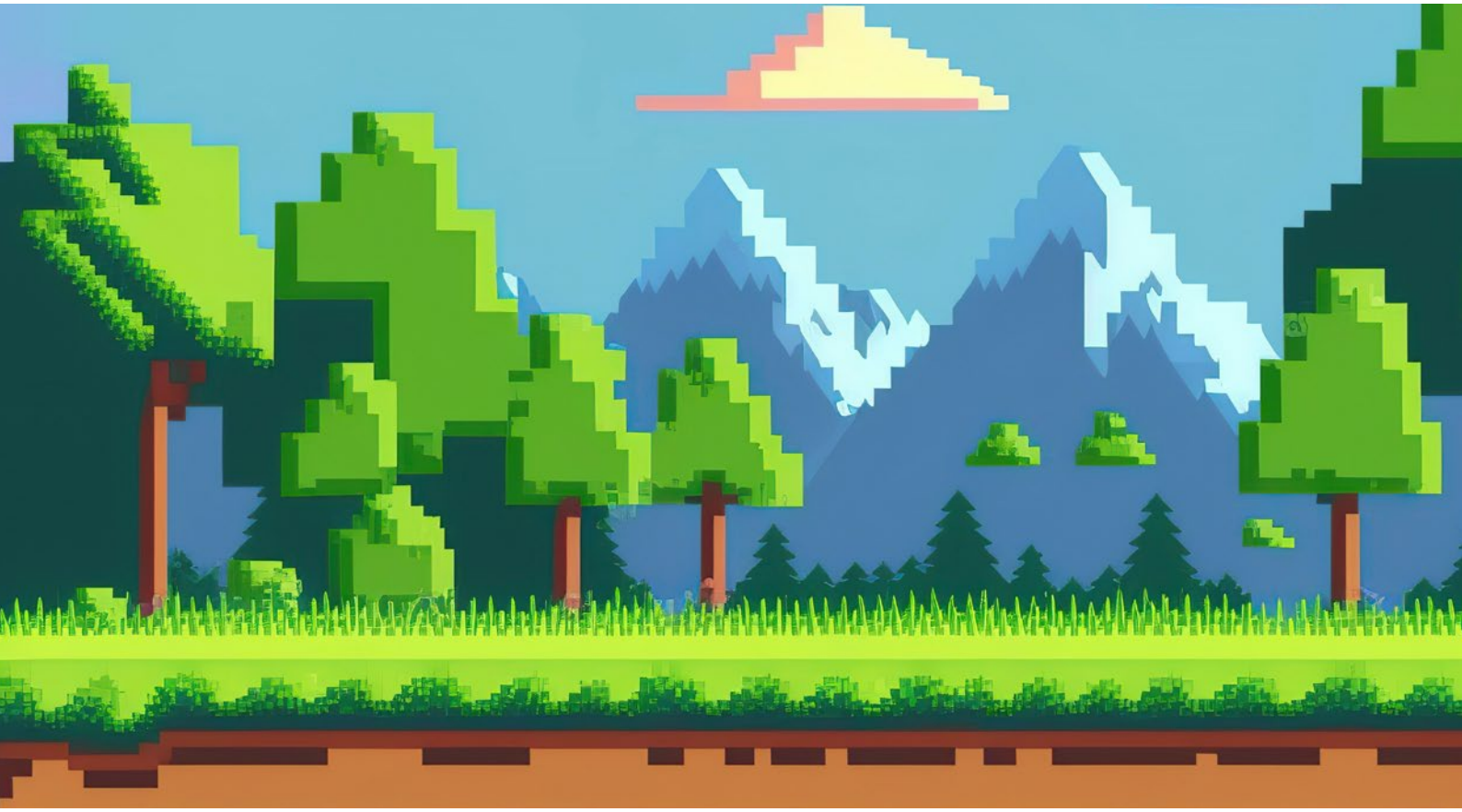
Digital technology and the environment: data in the balance

"More appears like less by simply moving it far, far away."

John Maeda, The Laws of Simplicity (2006)[1]

1 "More appears like less by simply moving it far, far away," quotation included by: Guillaume Carnino, Clément Marquet, "Les datacenters enfoncent le cloud : enjeux politiques et impacts environnementaux d'internet", Zilsel, 2018/1 (no. 3), p. 19-62. DOI: 10.3917/zil.003.0019. URL: https://www.cairn.info/revue-zilsel-2018-1-page-19.htm

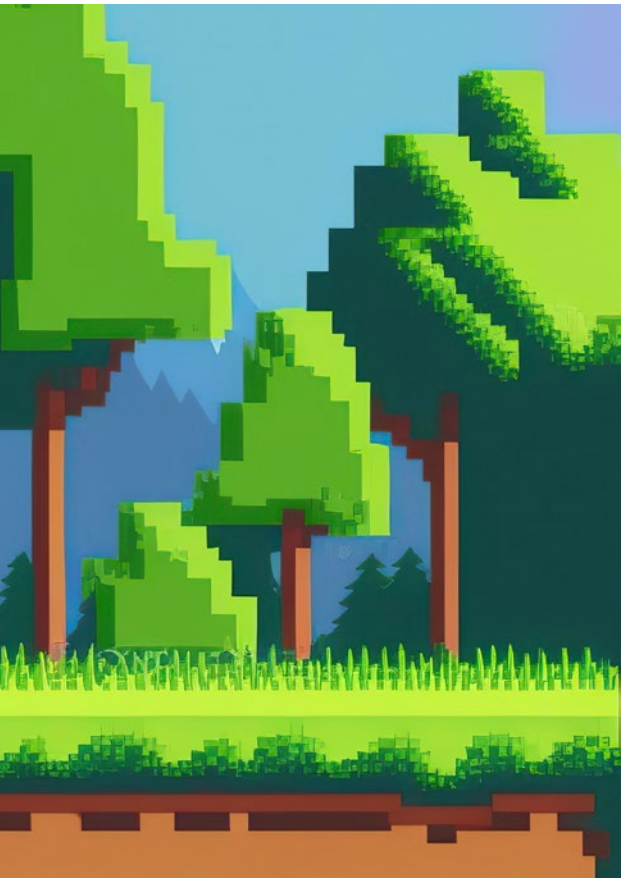
Digital technology and the environment: data in the balance



ECOLOGY(IES) OF DIGITAL TECHNOLOGY AND FREEDOMS

Adopting an environmental approach towards digital technology involves taking a closer look at the concept of "ecology" from both the etymological and scientific sense of the term. In other words, a clear understanding is required of the natural ecosystem that surrounds the process of producing and using digital services. In addition to measuring the footprint of the different digital components and services, which we will try to describe in the second chapter, it can be a valuable exercise to raise questions about the relationship between nature and technology, and not just the relationships between human activities and the environment. Similarly, we can compare how we approach digital technology - and therefore data protection and freedoms - with how we approach environmental protection.

Firstly, invisibility is the quality that these two areas have in common. As far as the general public is concerned, digitisation and virtualisation intuitively go hand-in-hand with



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reducing the environmental impact, because they have a direct effect on the individual's immediate environment (less paper, less travel, etc.).

The semantics used in public debates perpetuate the idea of a floating digital technology without any grip on the real world, i.e. a virtual digital technology in the cloud that offers a seamless experience, but which could disappear completely in an instant. However, these data tend to be considered as intangible goods, but they cannot exist without infrastructures, systems and devices, which are tangible goods. Digital technology also has many physical manifestations, as described in the following section. Data centres, devices and networks form the basic infrastructure, but also what authors Khoespel and Zhu[2] refer to as the "continuous materiality" of the code. Such materiality exists from the lowest layers through to human-readable programming languages, but also the way in which societies organise governance and usages through structural, legislative, social and cultural "codes". The scope of digital technology also includes the scope of its "infrastructures" which, according to Francesca Musiani[3], are "political, questionable and disputed, governance instruments and targets, objects of interest for countless stakeholders, from the most powerful and concentrated to the everyday Internet user."

In a way, the ecological scope has also remained somewhat intangible in modern-day societies[4]. Although the ecology concept began spreading in the 1960s and 1970s, its foundations in Europe can be traced back to the 19th century. Charles Darwin referred to the ecology in 1859 in the preface of *On the Origin of Species* as the "economy of nature". The term "ecology" was coined by biologist Ernst Haeckel in 1866 in his work entitled General Morphology of Organisms by combining the Greek words for "house" (οἶκος / oîkos) and "study of" (λόγος / logos). US historian Donald Worster wrote that humanity entered the "age of ecology" when the first nuclear bomb was tested on 16 July 1945[5] in the desert of New Mexico, and its subsequent use in Hiroshima and Nagasaki. These precipitous events alerted the world to man's ability to have a negative effect on the planet. The issue made its way onto the political agenda in the 1970s, including the Report to the Club of Rome and political statements driven by NGOs and political parties, but it was not until extreme weather events and environmental disasters began striking with growing regularity that the world's populations started waking up to the need to take action and protect the environment.

As the issue began taking shape and entering the collective consciousness, a change also occurred in how risks were perceived. The spate of tragic events associated with the increasing flow of information ushered in what Ulrich Beck called the risk society (1986). Whereas populations previously had to contend with "natural" risks over which they had no control, the new risks are most often caused by human activities and what is known as "technological

2 Kenneth Knoespel and Jichen Zhu, 2008, "Continuous materiality through a hierarchy of computational code", Théorie, Littérature, Épistémologie, no. 25, p. 235-247

3 Francesca Musiani, "L'invisible qui façonne. Études d'infrastructure et gouvernance d'Internet ", Tracés. Revue de Sciences humaines [online], 35 | 2018, published on 14 November 2018, viewed on 13 March 2023. URL: http://journals.openedition.org/traces/8419; DOI: https://doi.org/10.4000/traces.8419

4 Pre-modern societies, and especially indigenous populations, developed an obvious ecological bond with their natural environment, with its ability to provide sustenance and also its threats, but that relationship was confined to the local scale.

5 Daniel Worster, Les pionniers de l'écologie, Une histoire des idées écologiques, Sang de la Terre, Paris, 1992, p.365

overdevelopment". These risks are increasingly global and invisible, until we collide with them head-on. Similarly, when it comes to data protection, the way in which individuals viewed risks found its watershed moment in the wake of the Snowden affair, which opened the world's eyes to the surveillance measures driven by digital technologies, and then the Cambridge Analytica scandal, which revealed how data were circulating and being diverted from their intended use. These cases have not radically changed practices. Smartphone users do not always see how their personal data are processed "without their knowledge" just so that they can benefit from a "free" app (just like they do not directly feel the adverse effects of cobalt mining in Congo, even though cobalt is an essential component for smartphones). However, these events have shed light on the underlying digital infrastructure and fuelled the desire to strengthen people's rights in the GDPR. The whole risk concept actually forms an integral part of the recom-mended measures for protecting data since 2018, including the introduction of a data protection impact assessment (DPIA) for certain processing operations.[6]

The relationship with progress can also be found in both fields (in parallel forms). Some people believe that science, technology and innovation will save the planet or at least humanity, like Elon Musk and his plans to set up colonies on Mars. Meanwhile, foundations are planning to develop climate engineering to reflect some of the sunlight back into space and thereby reduce global warming[7]. As for technologies and freedoms, the relationship is different. The CNIL often points to the risk in believing that there is a technological solution for every decision and opinion, such as using facial recognition systems or augmented reality cameras, which can jeopardise individual freedoms without any way of assessing their actual effectiveness. This fascination with technology - as well as its outright rejection - combined with invisible digital infrastructures tends to make debates either extremely technical or highly divided. This situation impedes the ability to gain an overarching understanding of the issues involved and prevents informed discussions about which choices should be made by factoring in all the elements of the social and technological structures associated with the tools in question.

A final potential parallel between freedoms and the environment is the measures that need to be taken to prevent and, in some cases, correct. There is a strong temptation in the general discourse to shift the responsibility onto individuals alone and focus on giving individual instructions and sometimes lecturing: "remember to clean your cookies and recycle your waste" (see p. 17). But measures have mainly been taken within organisations. Risk perception was brought to the fore for organisations when France's Data Protection Act, and especially the GDPR, set out significant sanctions for offenders and imposed internal control mechanisms. Therefore, bureaucracy has spawned an abstract risk and its infrastructure (where are your data, who has access to the data). By creating friction, data protection regulations tend to make the systems more visible. By enacting legislation, the European Union has laid the foundations for companies and public institutions to establish dialogue with their customers and users on what was previously an unfamiliar topic for many of them. Organisations have been given a leading role in educating users about data protection issues[8]. These may be just parallels and avenues for exploration, but it can be a beneficial exercise to produce a comparison between these seemingly different fields.

As such, this report offers an analysis of how data protection measures can act in symbiosis with protecting the environment, or conversely the contradictions that may arise between these two objectives from the perspective of data protection's footprint, as well as the future tensions with our freedoms (Part 4, p. 39).

DIGITAL FOOTPRINT? WHAT DIGITAL FOOTPRINT?

We have long been presented with a virtual world where the only thing that is actually virtual is the ideas projected by our imagination. This is the case with the hardware infrastructures, data centres, cables, antennas, software and devices for connecting to the virtual world. Digital technology is powered by electricity, but also rare metals and earth elements. Every component has its own environmental footprint and is part of the lifecycle for digital goods and services. However, calculating the footprint is anything but a walk in the park, and this subject continues to inflame discussions in 2023. Such discussions involve the method for calculating the environmental costs/ benefits of digital technology, but it is not the actual figures that fan the flames of controversy.

6 Ce qu'il faut savoir sur l'analyse d'impact relative à la protection des données (AIPD), CNIL, https://www.cnil.fr/fr/ce-quil-faut-savoir-sur-lanalyse-dimpact-relative-la-protection-des-donnees-aipd.
7 "Annals of a Warming Planet", The New Yorker, https://www.newyorker.com/news/annals-of-a-warming-planet/dimming-the-sun-to-cool-the-planet-is-a-desperate-idea-yet-were-inching-toward-it
8 Antoine Courmont, "Le travail, premier vecteur de socialisation à la protection des données ?", LINC, February 2022 https://linc.cnil.fr/fr/le-travail-premier-vecteur-de-socialisation-la-protection-des-donnees

A strong footprint, "by ~~design~~ manufacture"

Calculating the digital carbon footprint is a tricky exercise using methods that are far from reaching a consensus. There are several different methods, whether measuring the energy footprint, measuring the carbon footprint by CO_2 equivalent, or expanding the calculation to include the overall environmental footprint of digital technology. The carbon footprint corresponds only to the greenhouse gas emissions produced by digital technology when manufacturing hardware, delivering services, using equipment, etc. A broader calculation is required for the environmental footprint and especially involves a life cycle assessment (LCA), which is a multi-step method for assessing a system's environmental performance (product, service, company or process) throughout its lifecycle using a number of criteria. The aim is to determine and benchmark a system's environmental impacts, from extracting the raw materials required for its manufacture (including rare earth elements, water, primary energy, etc.) through to its end-of-life treatment (landfill, recycling, etc.), including its use, maintenance and transport. We will refer to these types of footprint in the rest of this report, according to the calculation methods used.

ADEME (French Agency for Ecological Transition) and Arcep ((Electronic Communications, Postal and Print media distribution Regulatory Authority) were commissioned by the Ministry of Ecological Transition and the Ministry of the Economy, Finance and Recovery to submit a joint report in 2022[9] in which they endeavoured to measure the environmental footprint of digital technology and identify strategies and best practices to lower that footprint. The report examines three components of the digital carbon footprint, namely user devices, networks and data centres.

Devices: the main footprint generators

Devices (screens, TVs, smartphones, modems, game consoles, etc.) alone represent 65 to 90% of the digital carbon footprint, with televisions alone accounting for 11% to 30%. In particular, the report singles out the significant amount of energy used to manufacture equipment. The energy required to power the manu-facturing process is mainly produced in countries with a carbon-intensive energy mix (such as in Asia or the United States). The equipment manufacturing phase still has the largest environmental impact, especially due to the energy resources consumed, the carbon footprint and the depletion of abiotic resources (minerals and metals), but devices continue to impact the environment during their use for as long as they use energy, as well as at the end of their lifecycle when it comes to recycling them or at worst treating the waste. That is why users are often recommended to avoid changing their devices too often, particularly smartphones, since ADEME estimates that 75% of a smartphone's footprint can be attributed to its manufacture alone. Smartphones contain about 50 metals, which need to be extracted from different mines around the world (see the Howling Metals box, p. 10). In 2022, ADEME estimated that 63% of used smartphones were less than two years old[10].

However, repair practices began developing even before the world had realised that we were facing an environmental emergency, as indicated by Nicolas Nova, a social anthropologist of digital cultures, in the CNIL's Digital Innovation Laboratory (LINC) in 2021, following the release of his work entitled Dr Smartphone: an ethnography of mobile phone repair shops. "Growth in digital technology combined with the trend of regularly replacing devices has caused an upsurge in repair practices,"[11] which has led to a soaring rise in the number of repair shops (see box p. 37). The art of maintaining and servicing digital devices is explained in a work by Jérôme Denis and David Pontille[12], who point out that "caring for things has become redundant", where a concerted effort must be made to establish a real right to repair and promote repair practices and the people taking part. In 2017, ADEME estimated that only 14% of the French population tried to repair their devices[13].

Networks

The ADEME/Arcep report makes a distinction between fixed networks (xDSL and FTTx) and mobile networks (2G, 3G, 4G and 5G). Although they share some of the same infrastructures, the report explains that fixed networks in France generate 75% to 90% of the footprint compared to 10% to 25% for mobile phone networks, especially since they draw more power when in use and require more equipment (including modems installed in users' homes). This finding should be contrasted with the fact that fixed networks have a lower environmental cost when based on the amount of energy used per gigabyte (GB), since the impact of mobile networks is almost three times higher than fixed networks for this metric.

9 Évaluation de l'impact environnemental du numérique en France et analyse prospective, ADEME/ Arcep (PDF 528 KB), January 2022, https://www.arcep.fr/uploads/tx_gspublication/etude-numerique-environnement-ademe-arcep-note-synthese_janv2022.pdf

10 Longue vie à notre smartphone ! (PDF, 1.6 MB), ADEME, September 2022, https://librairie.ademe.fr/cadic/7327/guide-longue-vie-smartphone.pdf

11 Nicolas Nova: "les ateliers de réparation ouvrent à la durabilité des objets numériques", interview for LINC, 10 June 2021, https://linc.cnil.fr/fr/nicolas-nova-les-ateliers-de-reparation-oeuvrent-la-durabilite-des-objets-numeriques

12 Jérôme Denis, David Pontille, Le soin des choses. Politiques de la maintenance, Paris, La Découverte, "Terrains philosophiques" collection, 2022, 368 p., ISBN: 9782348064838.

13 "Smartphone, une relation compliquée", infographic, ADEME, 2017, https://multimedia.ademe.fr/infographies/smartphone-version-ademe

Closer look at...

Howling Metals

The use of raw materials (rare earth elements and metals) to manufacture digital devices is one of the major challenges going forward on several levels, whether geopolitical, social or environmental.

As indicated by think tank Etopia in its 2021 report[14], rare metal deposits (cobalt, copper, lithium, nickel, silicon, etc.) and their extraction are fairly spread out across the world, but Europe is only a low contributor. China remains the world's leading producer of rare earth elements (17 metals that are hard to extract). In 2021, China still held a 60% share of production and over 30% of the reserves. Dependence on China may be waning but it is still high, especially amidst the tensions affecting international relations. Extraction processes require the use of strong solvents and acids, and the use of large amounts of water and energy when those processes are performed at high temperatures[15]. Pollution with a direct impact on local populations, including leaks into waterways and groundwater, has prompted China to keep a closer eye on the sector's environmental performance.

Questions are currently being raised about the prospect of relocating the extraction of rare metals and earth elements to Europe, at a time when dependence on imports is plagued by supply security issues, political crises, pandemics and trade restrictions.

Europe maintains an up-to-date list of "critical raw materials", including such rare metals as cobalt and PGMs (platinum group metals). In the interests of European sovereignty, localising production is the aim. Although more virtuous solutions are being explored, such as open-pit mining, the risks of generating pollution, producing waste and using water resources still need to be contained, while contending with the population's heightened awareness of these issues. Applying European environmental regulations and reducing transport would tend to shrink the footprint and also attract greater attention from Europe's populations.

For example, a major source of rare earth oxides (in excess of one million tons) was discovered in the far north of Sweden in January 2023. It would take between 10 and 15 years before Sweden could start mining the deposit, but the discovery has already become a hot topic of debate, whether the enticing prospect of stimulating the economy or the chorus of concerns among the local populations, which will be directly affected by the adverse effects of the mines[16]. France has backtracked on its previous decision to stop all mining activities by opening new sites. For example, exclusive exploration permits have been granted in Allier and Alsace for lithium[17]. The development of these projects will give European companies an opportunity to face up to their environmental footprint and take the necessary organisational measures.

Data centres

Data centres

The impact caused by data centres is mainly due to the number of square meters allocated to the IT rooms, the number of servers, their power draw and, in some cases, their water consumption, as explained later in this report.

Their footprint tends to be much more physical than virtual, since the cloud's feet are firmly planted on the ground. This situation strikes a chord with the quote by the Free Software Foundation Europe (FSFE): There is no cloud, just other people's computers.

14 "Des métaux pour une Europe verte et numérique, un agenda pour l'action", Etopia, 2021, https://etopia.be/blog/2021/12/16/des-metaux-pour-une-europe-verte-et-numerique-un-agenda-pour-laction

15 Marine Corniou, "La ruée vers les terres rares rares" [archive], Québec Science, 20 July 2012, https://www.quebecscience.qc.ca/environnement/la-ruee-vers-les-terres-rares (viewed on 30 April 2022).

16 Anne-Françoise Hivert, "Suède : la découverte d'un gisement de terres rares suscite l'inquiétude des populations autochtones", Le Monde, January 2023 https://www.lemonde.fr/planete/article/2023/01/17/suede-la-decouverte-d-un-gisement-de-terres-rares-suscite-l-inquietude-des-populations-autochtones_6158170_3244.html

17 Marie Verdier, "La France lance la traque aux métaux rares", La Croix, September 2022 https://www.la-croix.com/Economie/France-lance-traque-metaux-rares-2022-09-11-1201232684

ARE DATA CENTRES REALLY ENERGY GUZZLERS?

When exploring the links between data protection and environmental protection, an authority such as the CNIL will typically take a closer look at the data involved, as well as their movement and storage, which includes data centres. Data centres and especially the largest facilities, which centralise and process huge quantities of data, are often singled out as prime examples of how digital technology is encroaching on the environment. When it comes to protecting data, decentralised architectures and computing on local servers, or even edge computing, should be encouraged. However, the largest data centres are often more energy efficient than smaller facilities.[18] Paradoxically, there could be greater environmental benefits in centralising data storage and processing activities instead of promoting decentralised architectures, even though they are the preferred solution for protecting personal data.

Nevertheless, the largest data centres continue to be a popular topic of conversation around the world, especially since the summer of 2022 and growing global awareness of the climate crisis.

Unquenchable thirst

Blindsided by the record-breaking temperatures that swept the UK, Google Cloud reported in July 2022 that it had to cut some of its services while it was fixing a "cooling failure" at one of its London buildings hosting its "cloud services".[19] At the same time, Oracle had to close some of its London-hosted services to "prevent uncontrolled hardware outages." Amazon Web Services saw one of its data centres buckle under the strain of a "thermal event".[20]

In the Netherlands, colocation data centres were reported to use 550 million litres of water a year, compared to the 112 billion litres consumed by the country's population[21]. Such water use sparked a clash between Microsoft and the municipality of Hollands Kroon in the north of Amsterdam. Whereas the US corporation had announced that it consumed 12 to 20 million litres of water to cool its data centre, it apparently used 84 million litres over the space of a year. In an effort to define a controlled urban development strategy, the cities of Amsterdam and Haarlemmermeer imposed a moratorium in their communities between 2019 and 2020 on the installation of any new data centres, since their land-take and electricity needs were increasingly competing with local activities and infrastructures. According to Stijn Grove (Dutch Data Centres Association), as cited by Guillaume Pitron, "the same problems are arising in Frankfurt, the Danish peninsula of Jutland, London, Paris and Dublin."[22] In 2021, Dublin and Frankfurt also established moratoriums until such time as they had reviewed their energy supplies.

Spatial planning considerations

The industrial areas sprawling around the outskirts of large cities are often a prime location for colocation and cloud data centres. For example, old steel-framed industrial buildings and department stores in Paris are being repurposed to house these facilities. But data centres are no longer being set up exclusively in cities, as indicated by Cécile Diguet and Fanny Lopez in an article published in 2020, "large data centre operators have set their sights on the countryside and other outlying areas on account of their isolated location and available land, but also due to the tax breaks offered by local communities looking to inject new life into their economies."[23]

In the Île-de-France region, several data centres have clustered in the area run by the Plaine Commune regional public

18 "Impact environnemental du numérique : tendances à 5 ans et gouvernance de la 5G", The Shift Project, 26 March 2021, https://theshiftproject.org/en/article/environmental-impacts-of-digital-technology-5-year-trends-and-5g-governance/
19 Nat Rubio-Licht, "Google and Oracle data centres are melting in the UK heat wave", Protocol, July 19, 2022, https://www.protocol.com/bulletins/google-oracle-cloud-uk-heat
20 Olivia Solon, "Hosepipes on Roofs Are Keeping UK's Data Centres Cool", Bloomberg, July 2022, https://www.bloomberg.com/news/articles/2022-07-19/how-to-keep-cool-in-heatwave-uk-data-centers-use-hosepipes-on-roofs
21 François Tonic, "Microsoft, Google, la Hollande, et la consommation d'eau des datacenters", DCmag, August 2022, https://datacenter-magazine.fr/hollande-microsoft-et-google-et-la-consommation-deau
22 Guillaume Pitron, "L'enfer numérique", Les liens qui libèrent, Paris, 2012, p.154
23 Cécile Diguet, Fanny Lopez, "Territoires numériques et transition énergétique : les limites de la croissance", in: Isabelle Laudier, Prospective et co-construction des territoires au XXIe siècle. Paris, Hermann, "Colloque de Cerisy", 2020, p. 109-118. : https://www.cairn.info/prospective-et-co-construction-des-territoires--9791037002143-page-109.htm

institution (previously an agglomeration community), which features nine cities to the north of Paris, including Saint-Denis and Aubervilliers. Operators chose to build their data centres in this strategic area near the Stade de France, which had the advantage of available land and energy supplies, and close links to Paris. In 2015, Plaine Commune was home to the largest concentration of data centres in Europe (15 in all) over a surface area of around 180,000 m^2. These facilities did not go down smoothly with the local inhabitants. They seemingly sprang up in complete silence, as described by Guillaume Carnino and Clément Marquet[24], since the local population and officials had been left entirely in the dark. They were unaware of the specific characteristics of these facilities, their high energy use, the few local jobs created and their potential to cause noise pollution. However, there were countless discussions about the subject when a public debate was held, especially how these facilities saturate the local energy supply and disrupt the electricity supply networks. In 2015, the spatial planning authority for the Île-de-France region (formerly IAU Île-de-France, now Institut Paris Région) had questioned the public services about the need to calibrate energy supplies by 2030: "data centres alone are expected to account for one quarter of the increase in energy needs for the Greater Paris region, i.e. 1,000 MW out of an estimated total between 3,000 MW and 4,000 MW (+20%)." Data storage and availability are not just technological and cybersecurity issues, since they influence both spatial planning decisions and energy consumption considerations.

A concentrated market structure

The structure of the data centre market has a number of specific characteristics that explain why their design methods have seen little innovation over the last 20 years.

Although Amazon, Microsoft and Google alone operate more than 50% of the largest data centres in the world, they do not often build the centres themselves. Instead, they rent space capacities from specialised operators who are not exactly household names. À l'échelle mondiale, ce sont bien des acteurs différents qui agissent sur ces marchés des centres de données. Les promoteurs ont opéré historiquement sur des logiques financières immobilières, sans véritable contrainte légale la plupart du temps, mais des initiatives sont mises en œuvre par l'ensemble du secteur, et des solutions innovantes sont mises en place. According to Synergy Research Group[25], 70% of all hyperscale data centres in 2021 (whose technical architecture is designed to quickly scale capacity to major resource needs) were located in facilities leased from data centre operators or owned by partners of hyperscale operators. The sector for colocation data centre manufacturers and providers - who offer to rent out a private rack (full rack) or shared rack (half a rack) for hosting servers or telecommunications equipment - is highly concentrated. The 15 largest suppliers account for over 50% of the global market[26]. In 2021, the largest data centre company (Equinix) alone accounted for 11% of this $54 billion market, according to consulting firm Structure Research. While most of the leaders are US companies, the list also contains Chinese firms due to the country's protectionist policy, which makes it hard for foreign firms to gain a foothold. This explains the powerful growth behind Chinese companies, which provide infrastructures for Alibaba and Tencent. In a 2022 report[27], Structure Research notes that hyperscale data centres are still in their teething stages in France, but growth is expected to skyrocket ahead of the 2024 Olympic Games, as was the case with the Tokyo Olympic Games. The firm also reveals that Brexit prompted countries in continental Europe to begin repatriating their infrastructures in a bid to defend their sovereignty. Finally, the report also addresses the specific features of the French market with its mid-sized cloud suppliers operating their own data centres, especially OVH, but also Scaleway, Oustscale and Orange.

On a global scale, many different companies are active in these data centre markets. Developers have long been driven by a real estate and financial-oriented model with no real legal constraints most of the time, but initiatives are being implemented across the entire sector, and innovative solutions are being put into action.

On the road to innovation

In 2021, companies in the data centre sector signed the Climate Neutral Data Centre Pact (CNDCP), which includes 54 data centre operators and 22 trade associations. They are committed to taking measures to "make data centres climate neutral by 2030", with initiatives focusing on energy efficiency, clean energy, water conservation, circular economy and circular energy systems.

The CNDCP has developed an auditing framework "to test compliance with the Pact's sustainability goals". The framework was shared with the European Commission at the end of 2022 and is now "available for any independent auditing firms."

24 Guillaume Carnino, Clément Marquet, "Les datacenters enfoncent le cloud : enjeux politiques et impacts environnementaux d'internet", Zilsel, 2018/1 (no. 3), p. 19-62. : https://www.cairn.info/revue-zilsel-2018-1-page-19.htm

25 Mark Haranas, "AWS, Google, Microsoft Are Taking Over The Data Centre Market," in CRN, January 2021, https://www.crn.com/news/data-center/aws-google-microsoft-are-taking-over-the-data-center

26 "Top 11 BEST Data Centre Companies | Datacenter Services In 2023," Software Testing Help, January 2023, https://www.softwaretestinghelp.com/data-center-companies

27 Paris & Marseille DCI Report 2022: Data Centre Colocation, Hyperscale Cloud & Interconnection, Structure Research, 2022 https://structureresearch.net/product/paris-marseille-dci-report-2022-data-centre-colocation-hyperscale-cloud-interconnection

This type of initiative is beneficial, since the air condi-tioning systems are still the main method used to regulate the heat generated by data centres, which maintain a temperature of approximately 22°C all year round, regardless of the temperature outside. Alternative solutions to air conditioning are already helping cool these heat plants. Several operators, including French companies, offer alternative solutions.

OVHcloud designs and assembles its own servers, and is experimenting with the water cooling technology, which involves cooling the server components directly with a liquid cooling system instead of the air conditioning system in the server room. During the first year alone, energy costs plummeted by 30%, and then 50% in 2011 without needing to use the air conditioning system. In 2022, OVHcloud unveiled a new technology known as Hybrid Immersion Liquid Cooling, which immerses the components (motherboard, CPU, RAM sticks, etc.) in a non-conductive dielectric fluid to cool them directly. Orange Business Services has opted for the free cooling method for its data centres in Normandy. This technology uses ambient air (which rarely exceeds 26°C) to cool the servers, but needs to be paired with an air conditioning system. Scaleway offers a third model with its latest 20,000 m^2 hyperscale data centre - DC5[28] - which combines free cooling solutions when the outdoor air is cold, and adiabatic cooling when the outdoor temperature rises. This bio-air conditioning technology is based on the cooling effect produced by evaporating water, which can lower the temperature by up to 10°C compared to the outdoor temperature without using any air conditioning or consuming excessive amounts of water (equivalent to the consumption of 10 households a year for the entire data centre). Qarnot has gone for a different approach by offering its customers a distributed "high performance computing" infrastructure where the racks are divided between buildings and act as radiators, whose waste heat can be harnessed to heat the air or water, according to needs.

Empowered by the European Union's various regulatory tools and projects, such as plans to revise the EU Energy Efficiency Directive 2012 to potentially include provisions for data centres as part of the European Green Deal[29], and the 2019 Code of Conduct for Energy Efficiency in Data Centres, the GAFAMs and also Equinix (all signatories of the Climate Neutral Data Centre Pact) have announced plans to splice their main data centres into local heating networks. The only limitations are that data centres must be located near a district heating network, and heat needs must be spread over a six-month period in mild climates. Stakeholders are looking into other solutions.

The chosen site for data centres presents a number of land, political and social issues, just like Plaine Commune. Improving energy efficiency in data centres is an area that needs to be developed further and in some cases extended, which allows plenty of leeway for reducing the energy footprint of data processing activities alone.

DIGITAL TECHNOLOGY'S PROPORTION OF EMISSIONS - PRESENT AND FUTURE?

What is digital technology's share of global emissions?

Defining what the digital sector actually means tops the list of key questions that need answering when measuring its footprint. As explained by Gauthier Roussilhe on his website[30], various accounting methods and systems are used, depending on the study. Some studies exclude televisions, others disregard landline telephones or the Internet of Things (IoT), and so on. A team of researchers from the University of Lancaster led by Charlotte Freitag attempted to harmonise the data and estimated the range of ICT's emissions in 2020 to be between 2.1 and 3.9% of the global carbon footprint. However, the ability to produce accurate figures stumbles against the lack or scarce amount of data in what is actually a data-driven sector.

Arcep, which already collected information from telecoms operators, expanded its system in May 2020 to encompass environmental data (GHG emissions from networks and the electricity use of customers' modems) with the aim of incorporating an environmental component into its annual report on the state of the Internet in France. Ce qui a donné lieu en avril 2022 à la publication de sa première enquête annuelle, "Pour un numérique soutenable". Following this decision, Arcep published its first annual survey, entitled "Achieving Digital Sustainability", in April 2022. The collection has been expanded since November 2022[31] to include data from device manufac-turers (televisions, computers, smartphones, monitors, tablets, etc.), and data centre operators. Data concerning devices must involve the number of devices

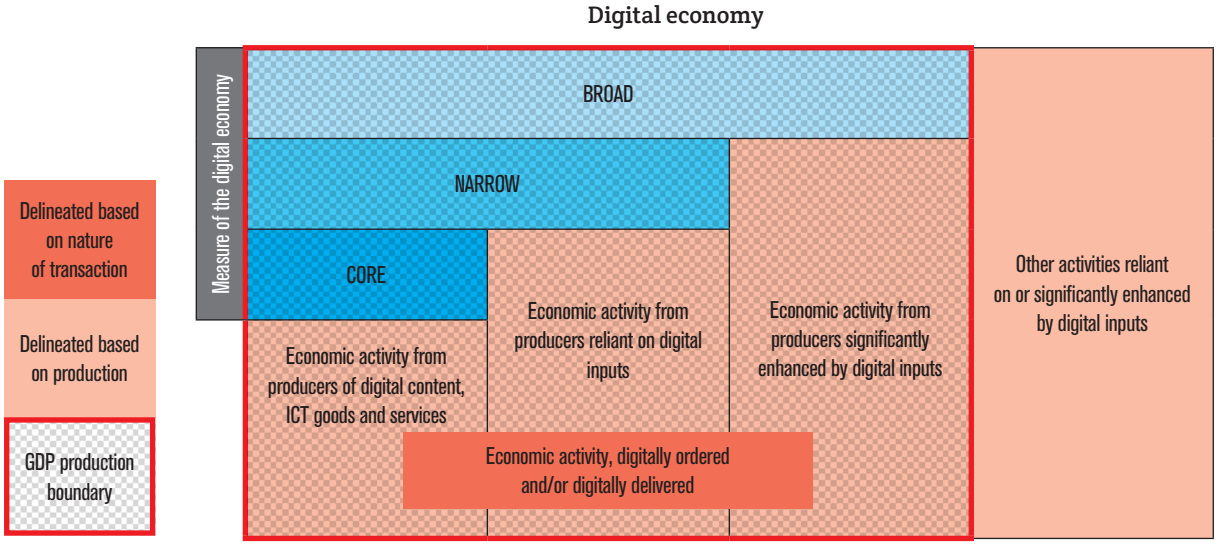
28 "DC5 PARIS - Scaleway Datacenter", Scaleway, https://pue.dc5.scaleway.com/fr
29 "Delivering the European Green Deal," European Commission, https://commission.europa.eu/strategy-and-policy/priorities-2019-2024/european-green-deal/delivering-european-green-deal_en
30 "Explications sur l'empreinte carbone du streaming et du transfert de données," Gauthier Roussilhe, January 2022, https://gauthierroussilhe.com/post/explication-empreinte.html
31 Décision n°2022-2149 de l'ARCEP du 22 novembre 2022 relative à la mise en place d'une collecte annuelle de données environnementales auprès des opérateurs de communications électroniques, de centres de données et des fabricants de terminaux, ARCEP, Arcep.fr https://www.arcep.fr/uploads/tx_gsavis/22-2149.pdf

in circulation and their service life, the measurement of the associated greenhouse gas emissions and the quantity of rare earth elements and metals used for their manufacture. Data centres will need to produce data on their greenhouse gas emissions, their energy use, their water consumption and their water sources. All these metrics must ultimately pave the way for a more detailed set of measurements on digital technology's environmental footprint.

What role can digital technology play in the economy and society?

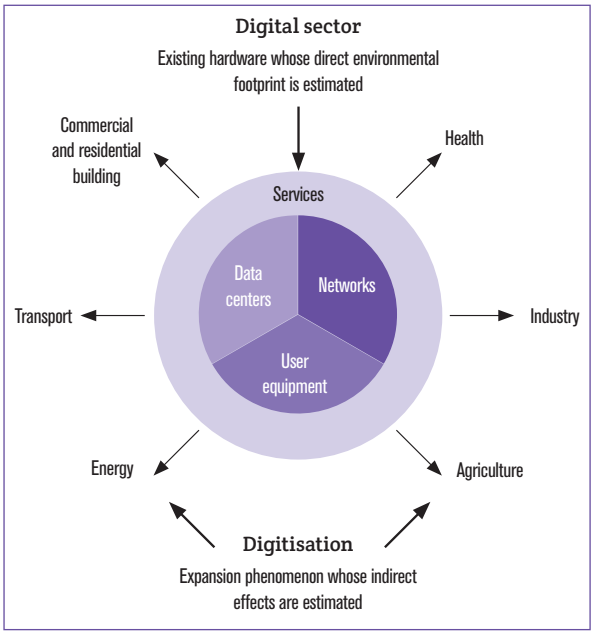
In the same way as creating a government (should there by a ministry for digital technology?), it becomes ever more complicated to consider digital technology as an isolated sector when it increasingly supports and powers the infrastructures (hardware, software and services) on which the other sectors are based. In this respect, the OECD[32] proposes a tiered definition of the digital economy that distinguishes between the core of the digital economy, the "narrow" measure, the "broad" measure and the "digital society" in general.

As in the Arcep/ADEME study, analysing the footprint is firstly based on three aspects of digital technology that mainly involve the "core" measure of the digital economy, i.e. data centres, networks and user equipment. This analysis will undoubtedly need to include an assessment into the impact of digital services across every sector, which may lead to a fall in energy use (by digitising certain activities), but also a rebound effect in the form of new components or services on top of the sector's existing activities.



Tiered definition of the digital economy (taken from the OECD roadmap)

32 *A roadmap toward a common framework for measuring the digital economy, Report for the G20 Digital Economy Task Force* (PDF, 9.4 MB), OECD, 2020 - 2020 - Chapter 2.2 in particular - https://www.oecd.org/sti/roadmap-toward-a-common-framework-for-measuring-the-digital-economy.pdff



Scope of the digital sector and digitisation from an environmental point of view (Gauthier Roussilhe)

What are the trends for the years ahead?

Measuring the footprint at a given moment in time may prove to be a complex task, but creating forecasts is even harder. Demand for data centres has gone through the roof as the use of digital technology has jumped since the beginning of the 21st century, but data centres' energy efficiency has improved over the same period with energy consumption stabilising over 10 years. In France, the annual carbon footprint from the use of digital goods and services in 2020 represented 2.5% of the national carbon footprint in 2020.

If no action is taken to curb that figure, Arcep and ADEME estimate that the digital carbon footprint in France could climb by approximately 45% in 2030 compared to 2020, which would represent 25 Mt CO_2eq (millions of tons of CO_2 equivalent) compared to 17.2 Mt CO_2eq in 2020.[33] The Shift Project (see box) also predicts a larger digital footprint in the coming years and decades, particularly due to the increase in data traffic generated by the development of new services and current uses, and the rise in personal equipment, but also slower progress in improving energy efficiency. It should also be pointed out that new technologies are being piled on top of older technologies instead of replacing them. For instance, several different telephone networks (2G, 3G, 4G and 5G) are currently available, although there are plans to retire certain networks. By way of example, the 3G network in the United States is no longer transmitting[34]: operator AT&T began removing users from its 3G network in February 2022, followed by T-Mobile and Verizon. Abandoning 3G should promote the roll-out of the 5G network, which includes some of the frequencies of the 3G network.

Optimistic forecasts for the 5G network often present it as an enhanced and more energy-efficient solution, particularly through slicing, which allows certain instances - or slices - of the 5G network to be allocated to certain types of use. Although the primary objective is improving economic performance rather than environmental performance (just like the main reason for virtualisation in the IT world), slicing enables the infrastructure to be shared, which has potential environmental benefits. But this does not consider the effect of adding networks together and is most often based on forecasts that focus on the optimal use of the network.

The Internet of Things (IoT) is another sector with exponential development potential. The International Energy Agency (IEA) estimates in a 2019 report[35] that the number of connected devices will increase from 20 billion to approximately 45 billion in 2030. As indicated in a report published by France Stratégie in February 2022[36], "the mass development of smart devices, the growing intensity of network use and the creation of new storage and processing infrastructures to exploit the especially large volumes of data produced will inevitably lead to an increase in energy use and a larger digital carbon footprint." Those devices are destined to become physically obsolete as their batteries wear out, but also obsolete in terms of their software when designed for very specific purposes. On the other hand, it is harder at this stage to measure the environmental benefits promised by the Internet of Things when it comes to reducing energy use, simplifying maintenance, etc.

All these devices require an infrastructure and hardware, as well as technologies, some of which are currently being developed, but they raise specific challenges on account of their footprint, such as artificial intelligence, blockchain and the metaverse (p. 19).

33 ADEME / Arcep, Evaluation environnementale des équipements et infrastructures numériques en France – analyse prospective à 2030 et 2050, March 2023
34 Mitchell Clark, "Farewell to 3G," The Verge, December 2022, https://www.theverge.com/2022/12/31/23490721/3g-sunset-verizon-history-december-2022
35 Total Energy Model for Connected Devices, IEA 4E EDNA, Technology Collaboration Programme of the International Energy Agency, June 2019. https://www.iea-4e.org/wp-content/uploads/2020/11/A2b_-_EDNA_TEM_Report_V1.0.pdf
36 Report: Le monde de l'Internet des objets : des dynamiques à maîtriser, France Stratégie, February 2022, (PDF 6.2 MB), https://www.strategie.gouv.fr/sites/strategie.gouv.fr/files/atoms/files/fs-2022-rapport-iot-fevrier.pdf

Closer look at...

Prospective scenarios for the environmental impacts of global digital technology (Shift Project)

On 30 March 2021, The Shift Project published an analysis note entitled "Environmental impacts of digital technology: 5-year trends and 5G governance." The report proposes a series of prospective scenarios for the environmental impacts of global digital technology based on two types of dynamics: the "annual decrease in energy intensity ratios", i.e. the unit electricity consumption of equipment, and network and data centre consumption per unit of traffic, resulting from technological and industrial progress; and the annual growth rates of digital "volumes" (device production, network traffic and data centre traffic), which are indicative of the evolution of uses.

SCENARIOS	Energy efficiency	Data traffic	Equipment production
CONSERVATIVE	Historical pace	Moderate pace	Moderate pace
GROWTH	Historical pace	Rapid pace	Rapid pace
GROWTH LESS EE	Slight slowdown	Rapid pace	Rapid pace
NEW SOBRIETY	Historical pace	Deceleration	Deceleration

Table 1: Description of the Forecast Model 2021 scenarios
(assumptions different from the historical rate are applied to the period 2020 - 2025 only).

Among the four growth / decrease scenarios for these variables over the 2020-2025 period (see Figure 1), only the scenario based on a deceleration in data traffic and a deceleration in equipment production can be used to predict that the proportion of digital technology in global primary energy consumption will stabilise. The Shift Project estimates that digital technology's energy consumption can be stabilised if we manage to control our consumer practices (New Sobriety), particularly though more "selective video usage, longer retention time for smartphones, prioritisation of IoT use cases, etc." Under these conditions, the proportion of digital technology in global primary energy consumption will remain at around 5% until 2025.

The other three scenarios would lead to an increase in digital technology's share in energy consumption of up to 9% (Growth less EE), and 7% of global greenhouse gas emissions (compared to just over 3% in 2020).

- Read the full article: "Data and environment: how to prevent the oil spills of the 21st century?", LINC, 19 May 2021, https://linc.cnil.fr/fr/donnees-et-environnement-comment-prevenir-les-marees-noires-du-xxie-siecle
- "Environmental impacts of digital technology: 5-year trends and 5G governance," The Shift Project, https://theshiftproject.org/en/article/environmental-impacts-of-digital-technology-5-year-trends-and-5g-governance/

CONTROVERSIAL FIGURES

The real impact of digital technology on the environment can be a polarising topic of discussion. At one end of the spectrum, some people see digitisation as a pathway and solution for improving and lowering our use of resources and energy, while those at the other end view digital technology as a burden on the planet. Just like fossil fuels, digital technology could be a "*shared resource with adverse effects that persistently causes ruin over time.*[37]" In addition to this opposing view, the method for calculating the footprint and the necessary measures often raise questions and do not always allow people to realise the true cost of digital technology. The determination to provide a means of comparison (and the use of metaphors) tends to lower and sometimes simplify discussions without necessarily improving their quality.

Therefore, the way in which the digital carbon footprint is represented and explained varies according to the types of stakeholder. Whereas academics adopt a scientific approach aimed at measuring, explaining and discussing in order to stabilise knowledge in a cumulative and consensual manner, think tanks and institutions have a more ambivalent relationship with figures (Beauvisage, Beuscart and Coavoux) [38] and tend to release numbers that can easily be used by the media and other people to fuel political debates.

The distance involved in delivering an email is very often used to encourage people to stop sending unnecessary messages and attachments, and give their mailboxes a spring clean. However, deleting emails has very little impact: 85% of the emails circulating around the world are spam, which translates into an average daily volume of 122.33 billion messages[39]. The most common type of spam is advertising messages. Changing our behaviour would have a very limited impact, whereas the advertising industry could actually reduce the impact of sending emails. These figures do not deny the beneficial effects of certain digital hygiene practices, such as not letting data pile up or holding onto data indefinitely. The "virtual" storage solutions developed by major digital companies, such as Google Photos, actually create the illusion of providing users with infinite storage, who subsequently no longer see the need to sort through and arrange their photos. In 2020, Google reported that it stored some 4,000 billion photos, with 28 billion new images uploaded every week[40]. The rules for defining a limited storage period and sorting photos for archiving purposes could also be applied to our accumulated data, whether personal or otherwise.

Similarly, by emphasising individual practices, such as the size of online videos, these companies tend to single out individual behaviour and even add a "sense of environmental shame to the moral stigma"[41] when they look to draw attention to the size of certain types of video content that would be less "desirable" or "socially useful" for some people, whether pornography, gaming videos or short dance routines. This way of presenting the figures gives less focus to infrastructures and manufacturing, but leads to moral discussions about what constitutes legitimate and illegitimate uses. This desire to offload responsibility onto individual behaviour bears similarities to how data protection issues are sometimes (or often) understood. As we wrote in Innovation & Foresight Report no. 8, Scenes from Digital Life: "Prevention policies cannot aim to make individuals responsible for the harm they may suffer as a result of the processing of their personal data, or the visibility of their image and profile, for example. [...] Consequently, there is a risk in focusing on the individual and his or her practices rather than questioning the institutions and structures that put individuals in problematic situations." It goes without saying that individual practices play a considerable role in the size of the overall footprint, starting when users buy IT hardware and equipment, but sorting between the right and wrong uses of digital technology is not enough to minimise the short and long-term risks. They also spawn a society where environmental safety would become the leading freedom, while monitoring and controlling behaviour would become a standard part of everyday life. Whether dealing with the environment or other sectors, the idea is to address these issues globally and take them firmly in hand.

37 Alexandre Monnin, "Les "communs négatifs" - Entre déchets et ruines", in Etudes 2021/9 (September), pages 59 to 68

38 Thomas Beauvisage, Jean-Samuel Beuscart, Samuel Coavoux, "Mesurer l'empreinte environnementale du numérique : aux sources des chiffres et des controverses", Hello Future (Orange), December 2022, https://hellofuture.orange.com/en/measuring-digital-technologys-environmental-footprint-the-figures-and-debates//

39 Nikolina Cveticanin, "What's on the Other Side of Your Inbox - 20 SPAM Statistics for 2021", DataProt, 11 February 2021, https://dataprot.net/statistics/spam-statistics/

40 Matt Burgess, "Everyone Is Using Google Photos Wrong", Wired UK, December 2022, https://www.wired.co.uk/article/google-photos-delete

41 Ibid.

Assessing the impact of technology and practices on the environment

"Reality is that which, when you stop believing in it, doesn't go away."

Philip K. Dick, How To Build A Universe That Doesn't Fall Apart Two Days Later (1978)[42]

42 from The Shifting Realities anthology (first published in 1995).

Assessing the impact of technology and practices on the environment

IS ARTIFICIAL INTELLIGENCE CAPABLE OF LEARNING?

Some of the technologies and cases that the CNIL is often required to deal with raise major question marks about their environmental footprint. In this report, we have chosen to present the specific cases of artificial intelligence, blockchain, the metaverse and targeted advertising. This list might not be exhaustive, but it contains real-life cases where data protection and environmental issues overlap.

Artificial intelligence (which is often used in the singular) is not a technology, but a field of scientific study. In the words of the European Parliament, artificial intelligence encompasses a whole range of tools that machines use to "*reproduce human-like capabilities, such as reasoning, learning, planning and creativity.*" The CNIL, which published a series of articles and resources in April 2022[43] and an action plan in May 2023 on this particular subject, broadens this definition to include tools whose behaviour, when applied to certain tasks, is not limited to reproducing human-like capabilities but potentially exceeding them: "*Any system implementing mechanisms that approach human reasoning abilities could therefore be qualified as artificial intelligence.*"

43 "Intelligence artificielle, de quoi parle-t-on ?", CNIL, 5 April 2022, https://www.cnil.fr/fr/intelligence-artificielle/intelligence-artificielle-de-quoi-parle-t-on

Adobe Stock

These systems and tools present major challenges for protecting data. They may have already notched up a number of significant successes, but they are still subject to failures and attacks. In some cases, their impacts on individuals and society may have been overlooked. That explains why the CNIL has been working on a number of projects since 2017 to support the development of these technologies and provide effective advice to public authorities, researchers and organisations at a time when the final touches are being put to the EU AI Regulation.

To reproduce or even exceed human behaviour, AI tools also need feeding. Firstly, they require data, which explains why the CNIL has taken an interest in the topic and often has the opportunity to express its opinion about systems incorporating artificial intelligence algorithms. However, AI systems are also energy-intensive, especially when training models by learning and particularly through deep learning. Many researchers are attempting to analyse their impacts. AI systems are just like any computer system, since they have the potential to improve or enhance energy use but also the capacity to be a major energy user, and sometimes there is no way of measuring whether the right balance has been struck.

For example, the CNIL identified the case of the environmental impact caused by voice assistants in its 2020 white paper entitled "*On the record - Exploring the ethical, technical and legal issues of voice assistants*", which includes the known method for breaking down the energy consumption of a digital object, whether in terms of production (through the mass production of such new devices), data transit (through remote server-based operation) and the computing capacity required for voice processing. The report notes that the vast improvements made to the natural language models used in voice assistants come at the price of a significant increase in energy costs. For example, training Google's BERT language model required the learning of some 340 million data parameters, which cost enough electricity to power a US household for 50 days[44]. OpenAI's GPT-3 language model used for ChatGPT has 175 billion parameters. Google has announced 540 billion parameters for its Pathways language model.

A team of international researchers published a paper in June 2022 entitled "*Aligning artificial intelligence with climate change mitigation*[45]", in which they endeavoured to understand the relationship between AI systems and greenhouse gas emissions. They created three categories to describe AI's effects on GHG emissions:

- Impacts relating to the energy and hardware required for computing, developing and executing algorithms.
- The immediate impacts caused by these systems, which are positive if they improve a building's energy use, for example, or negative when they are aimed at accelerating fossil fuel exploration.
- System-level impacts caused by how AI affects human behaviour, such as through advertising systems or with autonomous cars. If the development of autonomous vehicles has the effect of improving public transport systems, then the impacts could be positive. However, if the AI system is designed to promote a specific vehicle model, then the effects would be negative.

One of the difficulties mentioned by the authors is measuring and anticipating the indirect effects of developing and using

44 Karen Hao, "Tiny AI models could supercharge autocorrect and voice assistants on your phone", MIT Technology Review, October 2019, https://www.technologyreview.com/2019/10/04/132755/tiny-ai-could-supercharge-autocorrect-voice-assistants-on-your-phone/

45 L. H. Kaack, PL. Donti, E. Strubell, et al., "Aligning artificial intelligence with climate change mitigation", Nature Climate Change 12, 518-527 (2022). https://doi.org/10.1038/s41558-022-01377-7

AI systems, which could potentially be much higher and in some cases lead to rebound effects.

In terms of data, building databases for algorithm learning and training purposes remains one of the key points for implementing data protection rules. AI systems and especially those based on machine learning need to process large amounts of data during the learning phase before they can be applied to other data when they are operational.

These databases are most often compiled using two different methods: "*the specific collection of personal data for this purpose and the reuse of data already collected for another purpose. In the second case, the question arises as to whether the purposes for which the data were initially collected are compatible with the conditions under which the initial database was compiled.*" Intensive data use also happens to be one of the major issues for data protection with regard to the data minimisation principle enshrined in the GDPR. As stated by the CNIL, "*while the use of large amounts of data is central to the development and use of AI systems, the minimisation principle is not in itself an obstacle to such processing.*" The idea is to "*critically assess the nature and quantity of data to be used.*" Data minimisation is stricter during the production phase, in which case "*it will be necessary to narrow down the type of personal data to include only data that have proved essential following the learning phase and to determine appropriate measures, since production constraints differ from design and development constraints.*" A more extensive set of recommendations is available on the CNIL website[46].

> *"AI is being used to track and reduce deforestation, but AI-based advertising systems are likely making climate change worse by increasing the amount that people buy."*
>
> ***David Rolnick, McGill University, Core Academic Member of Mila - Quebec AI Institute[47]***

As for the major energy resources required to power machine learning, the data centre's design and location come into play. As we saw on page 11, not all data centres are the same, and most of them still have tremendous room for improvement. A group of researchers has developed a tool for measuring the carbon emissions generated by cloud servers when training machine learning models[48], according to three criteria: the kilowatts-hours needed to run algorithms, the emissions from the local electricity grid, and the emissions generated during the creation, manufacture, usage and disposal of a hardware device. They conclude that training models in low-emissions regions, such as France or Norway, could save 70% of emissions compared to such regions as Central US and Germany. The time of day when computing is performed also has a meaningful impact.

Users of machine learning systems could therefore reduce their carbon emissions by choosing where and when they want to run their algorithms. Similarly, cloud providers could set up an incentivising pricing scheme to encourage such changes. The option of choosing the location for running algorithms for environmental purposes is consistent with the data location constraints laid down in the GDPR, and even more as a result of the decision to invalidate the Privacy Shield.

Allowing users and data controllers to actually choose the site and location for their data and processing activities would have a beneficial effect on several levels.

In addition to championing greater transparency about how machine learning systems are used, the scientific community is turning energy consumption into a research topic in a bid to pioneer training technologies offering greater energy performance. For example, some models for automatically configuring neural networks (AutoML) are considered to be particularly energy-intensive, while other practices such as transfer learning based on a pre-trained model (a technique that aims to apply the knowledge and skills learned from previous tasks) may be more energy efficient.

Several works are taking an in-depth look at the different possibilities and techniques for reining in the amount of energy used by AI systems, such as choosing the activation function[49], streamlining the number of parameters, introducing energy consumption as a function for optimising parameters[50], distilling models (transferring knowledge from a large model to a smaller model) and using the *few-shot learning framework* (a training method where the database contains limited information). Such initiatives as CodeCarbon (Data For Good) and MLCO$_2$ Impact aim to measure the impact of training and predicting algorithms. Furthermore, another branch of artificial intelligence that relies on rules (symbolic artificial intelligence) requires a very limited amount

46 IA : comment être en conformité avec le RGPD ?, CNIL, April 2022, https://www.cnil.fr/en/ai-ensuring-gdpr-compliance

47 "L'IA est-elle bonne ou mauvaise pour le climat ? C'est compliqué Mila", 28 June 2022, https://mila.quebec/en/is-ai-good-or-bad-for-the-climate-its-complicated/

48 Dodge, Jesse, et al., "Measuring the Carbon Intensity of AI in Cloud Instances", 2022 ACM Conference on Fairness, Accountability, and Transparency. 2022.

49 In the field of artificial neural networks, the activation function is a mathematical function applied to an output signal from an artificial neuron. [source Wikipedia: https://en.wikipedia.org/wiki/Activation_function]

50 Lucas Hoyberg Puvis de Chavannes et al., "Hyperparameter Power Impact in Transformer Language Model Training", in Proceedings of the Second Workshop on Simple and Efficient Natural Language Processing, pages 96-118, Association for Computational Linguistics, 2021

of resources and may be more relevant in many cases (in addition to the prospect of providing explanations about the AI system used, which is essential for some environments).

Aside from the systems involved, questions can also be raised about certain uses of AI that consume significant resources. For example, searching for advances in the detection of sudden infant death syndrome would seem to be a higher priority than producing new filters for the pictures posted on social media platforms. In the field of digital technology, harnessing the power of machine learning to ramp up a data centre's energy performance[51] can also be considered to be directly beneficial in fighting global warming, unlike adding more models to optimise advertisements. Ultimately, AI's environmental impact will largely depend on its use, and a lifecycle approach needs to be developed for measuring the overall positive or negative effects of AI's deployment.

BLOCKCHAIN… "IT'S COMPLICATED"

Blockchain continues to ride high among the techno-logies of interest in 2023, empowered by a renewed surge in popularity with the wave of decentralised metaverse platforms, and the bubbles surrounding NFTs (see below), cryptocurrencies and generally Web3 applications (decentralised web), decentralised autonomous organisations (DOAs) and decentralised finance (DeFi). These are just some of the services and practices laying out their vision for the future of a decentralised Internet driven by blockchain technologies, despite their high energy requirements.

"*Bitcoin's [high] energy use is a feature, not a bug*[52]," according to Mickey Koss in Bitcoin Magazine. The cryptocurrency's energy use continued spiralling upwards between 2019 and 2022 according to the Cambridge Bitcoin Electricity Consumption Index (CBECI), rising from 54 TWh in 2019 to an estimated 100 - 120 TWh in 2022. Bitcoin's advocates claim that the system is built upon a complex computational mechanism, which typically requires energy, but that the system is secure and hack-proof.[53] Therefore, Bitcoin's energy use can be attributed to the proof of work scheme underlying the system's performance. To add proof of work, several participants, known as "miners", compete in carrying out computational operations to encrypt all the transactions in a block, as well as the encrypted transactions in the previous blockchain. The first miner to find the encryption solution receives a bonus (award and remuneration). But considerable computational power is needed to verify a block, which means a lot of electricity. Such high energy use adds to the environmental footprint of the equipment used for mining. Therefore, the cryptocurrency bubble has inflated the demand for certain components, which in turn has cranked up pressure in the graphics card market.

Some blockchain applications are now being challenged amidst soaring energy prices and the climate crisis. In an interview with the Financial Times[54] in January 2022, Erik Thedéen, Vice Chair of the European Securities and Markets Authority (ESMA), called for a ban on proof of work blockchains in favour of proof of stake, which uses less energy. With this method, miners must be able to prove that they own a certain amount of cryptocurrency before they can validate additional blocks and receive a reward. The probability of being chosen to validate a block is proportional to the quantity of cryptocurrency owned and how long that currency has been held, and not to the amount of work provided. The principle behind the proof of stake scheme is that a miner with a lot of holdings in the associated cryptocurrency will have every reason to see the blockchain endure and will therefore "behave properly". A third method, known as delegated proof of stake, involves a small number of validators elected by the community. Validators coordinate their efforts with a simple algorithm for validating blocks.

Public blockchains implementing a proof of stake mechanism instead of a proof of work scheme could reduce electricity use by a factor of four to six orders of magnitude compared to the Bitcoin network, and the gains per transaction can even reach eight orders of magnitude and ultimately become negligible, which would be equivalent to the amount of energy required to load a web page or send an email[55]. According to Statista[56], a single Ethereum transaction in 2021 used approximately 60% more energy than 100,000 credit card transactions, with an average Bitcoin transaction equalling 14 times the energy consumption of 100,000 credit card transactions. In September 2022, however, Ethereum decided to migrate to a proof of stake mechanism as part of an operation called "*The Merge*". This "new engine" should reduce the energy consumption of each transaction by 99.5%. It should also enable Ethereum

51 Like these initiatives highlighted by Google since 2016: https://sustainability.google/progress/projects/

52 Cyril Fievet, Opinion, "Bitcoin's Energy Use is a Feature Not a Bug", Bitcoin Magazine, June 2022, https://bitcoinmagazine.com/business/bitcoins-energy-use-is-a-feature-not-a-bug

53 Cyril Fievet, "8 mythes et réalités sur l'impact écologique de Bitcoin", Clubic, August 2022, https://www.clubic.com/bitcoin/dossier-427860-mythes-et-realites-sur-l-impact-ecologique-de-bitcoin.html

54 Interview: "EU should ban energy-intensive mode of crypto mining, regulator says", Financial Times, January 2022, https://www.ft.com/content/8a29b412-348d-4f73-8af4-1f38e69f28cf/

55 Pierre Boulet, "Consommation énergétique des technologies blockchain", EcoInfo - CNRS-GDS, November 2021, https://ecoinfo.cnrs.fr/2021/11/05/consommation-energetique-des-technologies-blockchain/

56 "Ethereum average energy consumption per transaction compared to that of VISA as of January 10, 2022", Statista, 2022, https://www.statista.com/statistics/1265891/ethereum-energy-consumption-transaction-comparison-visa/; "Bitcoin average energy consumption per transaction compared to that of VISA as of March 14, 2022", Statista, 2022, https://www.statista.com/statistics/881541/bitcoin-energy-consumption-transaction-comparison-visa/

to process more transactions per second. Meanwhile, the Bitcoin community has decided to stay with the proof of work mechanism "by conviction and through the fear of seeing the entire network lose its security[57]."

The CNIL published a report in 2018 on blockchains[58] and is involved in efforts by the European Data Protection Board (EDPB) to establish future guidelines. Blockchains continue to represent major challenges when it comes to ensuring compliance with data protection regulations, such as implementing obligations relating to outsourcing and rules governing international transfers of personal data. Special care must be taken in these areas when public blockchains are involved. The CNIL's report specified that "*it is necessary to concretely assess the real necessity to use blockchain technology in light of the objectives and characteristics of each processing operation [...] in application of the privacy by design principle, the CNIL therefore calls for stakeholders to question, from a very early stage, the necessity of using blockchain technology, rather than an alternative technology, to carry out their processing operations.*"

The same analysis applies to the environmental aspects, since public blockchains (particularly due to the proof of work scheme) draw more energy than permissioned or private blockchains. Although specific applications may justify the use of such blockchains as bitcoin or other cryptocurrencies, implementing private blockchains has little or no value when based on a centralised arrangement and a single actor. Stakeholders can always set up secure systems and use encryption technologies without a consensus algorithm-based validation scheme and miners, whether by proof of work or proof of stake. In this case, the "privacy by design" approach is consistent with the "green by design" strategy, especially since the system's compliance will be easier to implement with simple centralised systems, thereby leaving blockchains for truly decentralised systems or at least based on a fairly broad consortium of stakeholders, for whom permissioned blockchains and proof of stake may pave the way to a smaller environmental footprint. This type of analysis is especially important at a time when new applications of the blockchain scheme are emerging in what is now known as Web3 and the metaverse.

THE METAVERSE: VIRTUAL OR INCREASED CONSUMPTION?

Virtual reality and augmented reality hit the headlines again in 2021 and subsequently in 2022 in the wake of Mark Zuckerberg's announcement in October 2021 that Facebook would morph into Meta and embrace the metaverse. The LINC has published two analytical articles on the metaverse[59]. In particular, it can be seen that there is nothing fundamentally new about these uses, but they represent a new form of spatial access to the Internet immersed in a virtual world, or conversely the addition of a digital technology to the physical space with augmented reality.

However, the different types of metaverse raise a whole host of questions about increasing the quality and quantity of the personal data collected. Designers face the challenge of creating metaverse interfaces that incorporate the principles of transparency and information, and allow the supervisory authorities to check for compliance. From an environmental point of view, attention tends to be directed towards the infrastructure that is required to support 3D immersive systems, especially when those systems are combined with decentralised, blockchain-powered models, like Decentraland and The Sandbox. In these versions of the metaverse, "*participants can build places or objects by combining title deeds in the form of NFTs based on the blockchain. These new forms of cryptographic tokens work like title deeds to digital objects (images, audio, videos, 3D objects, etc.) that are associated with people. Their value depends on supply and demand, and they can be sold and bought over dedicated platforms. This means creating new forms of ownership in the digital realm that are separate from copyright or user and sharing licences, which until now were the norm for digital productions. These tokens cannot be used to acquire intellectual property rights. It is a case of sole ownership of a copy of an object*" which, in practice, comprises a sequence of bytes. The LINC article specifies that "*far from being a commonly owned space, the metaverse is designed to include the principles of the enclosure movement.*"

57 Elsa Trujillo, "The Merge: tout savoir sur le grand bouleversement qui attend les cryptomonnaies", Le Figaro, 12 September 2022, the-merge-all-savoir-sur-le-grand-qui-expected-cryptocurrencies-20220912

57 "Blockchain et RGPD : quelles solutions pour un usage responsable en présence de données personnelles", September 2018, https://www.cnil.fr/en/blockchain-and-gdpr-solutions-responsible-use-blockchain-context-personal-data

57 Régis Chatellier, "Métavers : réalités virtuelles ou collectes augmentées ?", LINC, November 2021, https://linc.cnil.fr/fr/metavers-realites-virtuelles-ou-collectes-augmentees, and Régis Chatellier, "Métavers : ce jeu dont qui sera le héros ?" January 2022, LINC, https://linc.cnil.fr/fr/metavers-ce-jeu-dont-qui-sera-le-heros

FORESIGHT SCENARIO PUBLISHED ON LINC.CNIL.FR

Worlds offering refuge from the devastated planet

Both the disease and the cure, metaverses (or resource and energy super-users) greatly contributed to the explosion in energy use during the 2020s after nations failed to take any tangible action during the COP 26 conference, which left the door wide open for more energy-intensive models. Pandemics cropped up with increasing regularity, while the world's biodiversity buckled under the growing strain.

Despite their role in the climate and health apocalypse, metaverses in 2036 are still keeping the flame of human civilisations alive. The air is no longer breathable, and face-to-face meetings are nothing more than a distant memory. The only people who are brave enough to venture outside beneath the scorching rays of the sun are those workers who are keeping the data centres running and maintaining the infrastructures supporting traffic on the information highway.

Even so, the metaverses are the last spaces where people can interact socially on a medium and large scale. Virtual social areas can be found, such as bars, concert halls, e-sport stadiums and library reading rooms. Whether true sensory experiences or a last resort for physical meetings, these places are merely a vestige of a terrestrial civilisation that only the eldest people have personally experienced.

Inspirations :
- Ready Player One, Ernest Cline (2011)
- COP26: Man announces he will quit drinking by 2050, 2021
- Wall-E, Andrew Stanton, 2008
- IPCC Report, 2021
- Climate: COP26 produces a low-key agreement, Le Monde, November 2021

These types of transactions place an extra burden on blockchain's energy consumption, in addition to the infrastructures that are needed to host the data and power the AI and 3D systems required to run virtual universes.

In the report submitted by the Metaverse Fact-Finding Mission[60] in October 2022, the authors (Adrien Basdevant, Camille François and Rémi Ronfard) identify the aspects of the metaverse with the largest impacts on the environment:

- Data storage and processing for navigable and persistent 3D worlds, where data are stored in formats offering "low volume efficiency"
- Training of artificial intelligence models
- Production of powerful microprocessors for the equipment used to access the virtual worlds
- Environmental impact of NFTs and cryptocurrencies

The metaverse, a portmanteau word that refers to a fairly broad series of applications and services, acts as a focal point for all the questions surrounding the development of digital technology in the years ahead, in a version that could be described as augmented, since the tools required for its implementation are inherent energy consumers. As with other technologies, some predict that the metaverse will help reduce our consumption in other areas, particularly through the mainstream use of homeworking and through solutions allowing people to virtually attend events and conferences, or even by the development of new forms of virtual tourism. The LINC has proposed a scenario in this sense (see box). However, the resulting rebound effects and the actual decrease in the associated real footprint remain to be seen, and not only in the metaverse. To quote the authors of the Metaverse report, "*In the transport sector, opening a new road often leads to an increase in traffic, never a decrease.*"

Therefore, it is worth questioning the value of certain uses that we would like to put into practice and analyse them in terms of their environmental footprint. They should also be included in the risk data protection impact assessments that need to be carried out, since these two areas may overlap.

60 Camille François, Adrien Basdevant, Rémi Ronfard, "Rapport public, Mission exploratoire sur les métavers", (PDF, 2.9 MB) published by: Ministry of Culture: Ministry of the Economy, Finance, and Industrial and Digital Sovereignty, October 2022, https://www.vie-publique.fr/sites/default/files/rapport/pdf/286878.pdf

ADVERTISING (ESPECIALLY TARGETED) AND THE ENVIRONMENT

The GDPR and the ePrivacy Directive do not prohibit targeted advertising or cookies, but most often subject them to the user's consent. These directives give data subjects the opportunity to accept or refuse cookies, opt out of targeted advertising and also indirectly reduce the energy footprint that can be attributed to these sites.

As early as 2018 when the GDPR became effective, a developer compared the US and European versions of the USA Today websites[61]. The daily newspaper had created a separate version of its website for EU users without any tracking scripts or advertising banners. The European version of the website loaded 500 KB of data, while the US version with its cookies and advertisements loaded 5.2 MB. In a 2015 study into Mozilla's Tracking Protection feature[62], which blocks trackers and cookies, researchers demonstrated that the feature improved website performance with a median reduction in page load time of 44% and a 39% reduction in the data usage. According to Frédérique Bordage (GreenIT), this represents "*39% of digital fat in the form of advertisements*[63]." Loading advertisements has a direct effect on the energy used by our smartphones. A team from INSA Lyon[64] found that advertisements have a major impact on battery life. Batteries can run out up to three times faster when browsing a website with ads compared to an ad-free version. These findings could be explained by the type of advertisements, which are often large files that need downloading, like images and videos. Such content also draws on the device's computing power. Advertisements not only weigh down our attention, but also our energy use, which cannot always be said of the traffic.

Early 2018, several Newsweek Group sites acknowledged that they had used bots to inflate their traffic with the aim of selling advertising space[65], while refuting any claims of advertising fraud. In 2018, Adobe estimated that approximately 28% of web traffic apparently came from robots and other "non-human signals", i.e. click farms[66]. In economic terms, a 2017 study published by Forrester[67] showed that digital advertising fraud caused losses of $7.4 billion for 2016 alone, and that figure could rise to $10.9 billion in 2021 if measures were not taken. In addition to fraud, the way in which ads are actually displayed is something of a blind spot in the digital advertising market and is not unrelated to their energy consumption. According to IAB and MRC standards (Media Rating Council)[68], an online advertisement is considered to be viewed when at least 50% of the banner's surface is in-focus for at least one continuous second.

For video ads, the duration is 2 seconds, but the 50% in-focus rule remains the same. This ad counting method should be contrasted with the click rate. The work carried out by Jean-Manuel Beuscart[69] showed that the click rate has been stable for 10 years across the entire digital advertising market, ranging between 0.05% and 0.1% for the different formats, i.e. one click every 1,000 or 2,000 displays. These ad counting practices have led to the following situation: if one million people have seen just a fragment of an advertisement for one second on their screen, one million ad views will be counted. Therefore, persistence of vision is widely highlighted as a criterion for measuring a targeted advertisement's effectiveness.

Environmentally speaking, advertisements can tip the digital carbon footprint scales even further. As such, data protection allows individuals to take direct action by refusing cookies and installing ad blockers. When these small gestures start gaining widespread adoption, they can truly benefit individuals and the planet alike.

61 Marcel Freinbichler [@fr3ino], 26 May 2018, https://twitter.com/fr3ino/status/1000166112615714816

62 Georgios Kontaxis & Monica Chew, (2015). "Tracking Protection in Firefox For Privacy and Performance", Arxiv, https://arxiv.org/ftp/arxiv/papers/1506/1506.04104.pdf

63 Frédéric Bordage, "La publicité représente 39 % du poids des pages web", GreenIT.fr, September 2015, https://www.greenit.fr/2015/09/01/la-publicite-represente-39-du-poids-des-pages-web/

64 Michael Saidani, Harrison Kim, Bernard Yannou, "Can Machine Learning Tools Support the Identification of Sustainable Design Leads From Product Reviews? Opportunities and Challenge", in Engineering Conference, August 2021, Virtual, United States, https://arxiv.org/abs/2112.09391

65 Craig Silverman, "The Publisher of Newsweek And The International Business Times Has Been Buying Traffic And Engaging In Ad Fraud", BuzzFeed, September 2018, https://www.buzzfeednews.com/article/craigsilverman/the-publisher-of-newsweek-and-the-international-business

66 Alexandra Bruell, Fraudulent Web Traffic Continues to Plague Advertisers, Other Businesses, The Wall Street Journal, March 2018, https://www.wsj.com/articles/fraudulent-web-traffic-continues-to-plague-advertisers-other-businesses-1522234801

67 Brandon Verblow, "Forrester Data: Ad Fraud And Viewability Forecast 2016 To 2021", Forrester March 2021, Forrester.com, March 2021, https://www.forrester.com/report/Forrester+Data+Ad+Fraud+And+Viewability+Forecast+2016+To+2021+US/-/E-RES137686

68 Thierry Wojciak, "Un nouvel indicateur de visibilité des campagnes display et vidéo pour le Digital Ad Ratings", CB News, April 2019, https://www.cbnews.fr/digital/nouvel-indicateur-visibilite-campagnes-display-video-digital-ad-ratings-42873

69 Jean-Manuel Beuscard, "Les deux corps du consommateur numérique. Décrire et critiquer les accompagnements marchands", introduction to the thesis for accreditation to supervise research, defended on 9 December 2019, https://www.academia.edu/41836247/Les_deux_corps_du_consommateur_numerique_Decrire_et_critiquer_les_accompagnements_marchands

Does protecting data protect the planet ?

"We should treat personal electronic data with the same care and respect as weapons-grade plutonium – it is dangerous, long-lasting and once it has leaked, there's no getting it back."

Cory Doctorow, (2018)[70]

70 " *Personal data is as hot as nuclear waste* ", The Guardian, 2008, https://www.theguardian.com/technology/2008/jan/15/data.security

Does protecting data protect the planet?

At the end of 2019, the CNIL pledged its commitment to a joint manifesto alongside seven independent administrative authorities for the purpose of "*supporting changes in stakeholders [...], responding to society's questions about these issues,*" in line with the objectives of the Paris Agreemen[71]. The CNIL has started reviewing its own practices as an organisation with the aim of developing actions to move the "sustainable development" agenda forward or scale down energy use (see p. 65), but what about its core activity, i.e. data protection?

Some of the principles in the GDPR strike a chord with environmental protection issues, even though they have not been conceived with this particular goal in mind, especially attempts to minimise data collection and processing activities.

The GDPR requires organisations to define a purpose for any processing activities beforehand. In other words, the objective for which data will be collected and/or processed must be specified and predefined. This requirement prevents data from being gathered indiscriminately and therefore avoids unnecessary storage and processsing. Defining the purpose for processing personal data leads to two other principles, namely minimisation and proportionality. According to these principles, data may only be collected and used if appropriate, relevant and strictly necessary for the previously defined purpose.

The principle of limiting the storage period also resonates with the challenge of reducing energy use. The storage period must be predefined and cannot be unlimited. Since it obviously relates to the purpose, it must not exceed the time required to achieve the purpose.

71 "Les autorités publiques et administratives indépendantes développent leur collaboration vis-à-vis des défis posés par le réchauffement climatique", CNIL, 20 December 2019, https://www.cnil.fr/fr/les-autorites-publiques-et-administratives-independantes-developpent-leur-collaboration-vis-vis-des

Adobe Stock

This principle prompted organisations to list and map their files, and subsequently clean or even purge their data (sometimes using automatic processes). However, it should be pointed out that this entails the risk of a rebound effect, insofar as companies develop a data culture and increase their data use for new purposes after mapping their data and managing them more effectively.

Finally, the individual rights granted by the GDPR and the French Data Protection Act, including the right to erase data and the right to object, as well as such related rights as the right to be forgotten and the right to be delisted, also provide a certain degree of control and a way of reducing processing activities and access to content.

In practice, all these provisions are implemented in an "ecosystem" of stakeholders who are responsible for ensuring that data are properly processed, which primarily means companies whose internal control over personal data processing operations is partly similar to CSR (Social and Environmental Responsibility), parti-cularly through the principle of accountability. In addition, supervisory authorities specify the requirements and verifications, while individuals exercise their rights and ensure transparent information. This transparency requirement for monitoring the impacts of data processing also coincides with the need for environmental transpa-rency as defined in the Aarhus Convention in 1998[72].

Far from the big data approach of the infinite "abundance" of data, data protection imposes a form of digital hygiene which, in some aspects, may contribute to the objective of moderating the use of digital technology and energy. We are exploring different ways of "greening" our data, particularly with low-tech approaches through ecodesign.

Conversely, other obligations in the GDPR or other recommendations issued by the CNIL tend to be perceived as increasing the environmental footprint of data processing activities. This applies to the obligation of securing data, especially through the use of cryptography. Their real carbon cost should be analysed and compared to their benefits.

IS PROTECTING SYNONYMOUS WITH GREENING?

The parallel between energy-efficient IT use and systems security is part of a context where more and more data leaks are being reported, which are caused by the vulnerability of centralised systems and the potential fallout from errors, failures or attacks. The leak of personal data belonging to 533 million Facebook users and uploaded to forums used by cybercriminals, as revealed in April 2021[73], and the data leaked from medical analysis laboratories[74] illustrate the parallel with hydrocarbons. These data, drifting like an oil slick on the ocean, can cause damage. The risks are even higher against the backdrop of efforts to reorganise the economic systems of the 21st century and the emergence of large platforms based on accumulating and recovering data, just like the industrial models of the 19th and 20th centuries had pinned their growth on extracting and stockpiling natural resources. This raises the question of an intrinsic

72 "Aarhus Convention", Wikipedia, https://en.wikipedia.org/wiki/Aarhus_Convention

73 "Document - Loi sur les données : Stockholm teste le degré de flexibilité des États sur le partage obligatoire avec le secteur public", Contexte Numérique, July 2017, https://www.contexte.com/numerique/bnefing/2021/04/07/#bnefitem-129993

74 "Violation de données de santé : la CNIL rappelle les obligations des organismes à la suite d'une fuite de données massive annoncée dans les médias", CNIL, February 2021, https://www.cnil.fr/fr/violation-de-donnees-de-sante-la-cnil-rappelle-les-obligations-des-organismes-la-suite-dune-fuite-de

contradiction between the growth of the digital economy, such as it has been developed so far, and the environmental transition.

How much does encryption weigh?

In most cases, the CNIL recommends using crypto-graphic methods (with varying levels of complexity depending on the needs or context) to protect the personal data collected or processed.

But these methods come at a price. Encryption automatically increases energy use, firstly by the computational power required to encrypt data, but also for decryption and storage ("encrypted" data tend to be longer than the original data). This extra layer has an impact on efforts to protect the environment, since it requires more power (increased use of memory, storage, batteries, etc.)[75]. But cryptography encompasses many tangible translations and forms across a fairly wide spectrum of possibilities, ranging from "lightweight crypto" (such as embedded in smart cards) to heavy calculations on encrypted data, or even the possibilities offered by quantum cryptography.

The primary objectives with cryptography are data security and integrity. With an ecodesign approach (see p. 36), the idea is to measure the need for its implementation, particularly when it involves energy-intensive encryption methods, such as homomorphic encryption, and only use it when necessary.

However, some security practices can also spill over by creating positive effects for environmental protection, i.e. compressing and encrypting archives at the same time to take up less storage space on hard drives (free tools like 7zip and Zed! work on this principle). Protected and compressed storage, rather than raw data, drastically reduces the storage surface in some cases. Similarly, cryptographic methods can generate evidence without actually retaining the file. When verifying an identity, instead of keeping the image or file (e.g. a scanned identity document), only the proof of its presentation, authenticity and verification could be retained by the organisation that needs to check the identity.

By way of illustration, the CNIL asks for only the templates to be kept when verifying biometric attributes rather than the entire proof.

Therefore, these cryptographic protocols have the potential to achieve savings when exchanging information. The zero-knowledge proof (ZKP) method can be used to prove knowledge of a secret without knowing what the actual secret is (and therefore comply with the principle of minimisation).

Researchers are aiming to ramp up and optimise cryptographic efficiency and performance[76], such as less computing time and less memory and battery use. Protecting the environment might not be the direct objective, but it stands to benefit.

The value in protecting systems

In 2017, Dallas's 156 emergency sirens rang for nearly two hours. There was no actual emergency[77]. Hackers had simply managed to connect to the remote control signal and switched the sirens back on whenever officials tried to turn them off. Even back in 2013, hackers had attempted to take control of a dam near New York.[78] In 2021 and 2022, several French hospitals fell victim to ransomware attacks, where attackers threatened to permanently block access to the hospitals' computer systems and data unless their ransom was paid off. In 2021, the Coop chain had to close 800 stores and supermarkets in Sweden after its treasury solution provider was hit by a ransomware attack, which prevented employees from processing in-store payments. This attack happened at a time when Sweden had chosen to switch over to a cashless economy, where cash already accounted for only 6% of transactions.

In 2015, Russia's Sandworm hacking group launched a series of attacks against a power plant in Ukraine. The campaign required approximately 19 months' preparation to cause an outage that only lasted six hours. This did not deter them from waging a new offensive against the Ukrainian government's computers in February 2022, just as Russia invaded Ukraine.

These examples paint a clear picture of how systems security has emerged as one of the hottest challenges for the years and decades ahead, since new forms of crime and warfare with direct or indirect environmental effects could be committed, such as attacks targeting city management facilities.

75 For example, read the article entitled "Energy saving of a computer program" on Wikipedia (viewed on 20/12/2022) in the SSL Security Protocol section, https://fr.wikipedia.org/wiki/Economie_d'energie_d'un_programme_informatique

76 For example: Toldinas, J., Damasevicius, R., Venckauskas, A., Blazauskas, T, & Ceponis, J. (2014). "Energy Consumption of Cryptographic Algorithms in Mobile Devices". Elektronika Ir Elektrotechnika, 20(5), 158-161. https://doi.org/10.5755/j01.eee.20.5.7118

77 Régis Chatellier, "À Dallas, des hackers tirent la sonnette d'alarme de la smart city", LINC, April 2017, https://linc.cnil.fr/fr/dallas-des-hackers-tirent-la-sonnette-dalarme-de-la-smart-city

78 Michael Schwirtz, Anton Troianovski, Yousur Al-Hlou, Masha Froliak, Adam Entous and Thomas Gibbons-Neff, "Putin's War: The Inside Story of a Catastrophe", New York Times, December 2022, https://www.nytimes.com/interactive/2022/12/16/world/europe/russia-putin-war-failures-ukraine.html

Should code be optimised?

Combining systems security, data protection and environmental protection was on the agenda of the 36th edition of the Chaos Communication Congress in 2019, whose motto was "Resource Exhaustion" as an ode to the exploit method[79] and the need to preserve resources. Among the solutions put forward, as cited by Le Monde[80], Hannes Mehnert proposed his MirageOS project with the aim of scaling down operating systems, and trimming down the number of lines of code to an absolute minimum, which he believes can reduce the need for resources and also limit the risks of any flaws or bugs in the code. More generally, the quality of the code may have a significant impact on energy resources in some cases, since the same problem can be solved with several methods and a different level of "algorithmic complexity". There is nothing new about analysing algorithmic complexity, since the practice dates back to the 1950s and involves a formal study of the amount of resources, such as in time and space, needed to execute an algorithm. Code reviews are still widely used today, with dedicated tools such as the SonarQube open-source solution, which aims to "*detect, classify and fix bugs in the code.*"

Other solutions are specifically focused on the environ-ment, such as Scaphandre[81], a project whose goal is measure the power consumption of digital services and produce metrics that organisations can use to guide their decisions in favour of more energy-efficient solutions (see p. 62).

Closer look at...

GreenData, a standard proposed by OpenDataFrance

The OpenDataFrance association brings together local authorities engaged in the open data movement. It has published a standard to support organisations (local authorities, institutions, associations, etc.) in taking control of the environmental impact of their data.

The standard was produced collaboratively during workshops with local authorities and experts, and provides opportunities for developing action plans to promote responsible digital technology, especially concerning data.

Programming languages are considered to be energy efficient. Code written in compiled low-level languages is generally more effective than interpreted languages. For example, languages such as C, C++ and Rust always achieve better results than JavaScript, PHP, Python, Ruby and Perl[82]. Rust grew out of a Mozilla Research project in 2010 with the specific objective of maximising memory safety "by design" and offering a lightweight language through its execution performance.

In some respects, this strategy of optimising the code dovetails with efforts to use low tech as an alternative solution to meet the challenges of the 21st century.

79 "Resource exhaustion attack", Wikipedia, https://en.wikipedia.org/wiki/Resource_exhaustion_attack

80 Damien Leloup, "A Leipzig, hackeurs et militants pour le climat font front commun" , Le Monde.fr, December 2019, https://www.lemonde.fr/pixels/article/2019/12/30/a-leipzig-hackers-et-militants-pour-le-climat-font-front-commun_6024362_4408996.html

81 Scaphandre, GitHub, https://github.com/hubblo-org/scaphandre

82 Edouard Pflimlin, "Le succès de l'argent mobile africain pourrait devenir mondial," Le Monde Afrique, 30 May 2017, https://www.lemonde.fr/afrique/article/2017/05/30/le-succes-de-l-argent-mobile-africain-pourrait-devenir-mondial_5135946_3212.htl

Closer look at…

The weight of "real life"

The rationale behind digitised and electronic services, especially public services, uses such keywords as simplification and optimisation. Certain bills are now prioritising measures to protect the environment, such as digital till receipts. The French law aimed at tackling waste and promoting the circular economy prohibits shops from consistently printing out till receipts for customers as from 1 August 2023[83]. The idea is for the legislator to take aim at the environ-mental footprint caused by the 30 billion till receipts and payment tickets printed every year in France. This measure aligns with the principle that digital must be lighter and better for users and customers.

A digital till receipt is obviously more eco-friendly than a printed receipt, but care must be taken about the equivalence between a printed receipt and an electronic version sent by email. Some studies considered that sending an email would generate more CO_2 emissions than printing a receipt, but it is extremely hard to produce any reliable findings with this type of assessment. In addition, paper receipts raise questions about their water use, their impact on forests, the toxicity of their inks, and so on. However, abandoning paper till receipts does not eliminate their environmental cost, since poorly designed digitisation technologies can undermine the protection of consumers' personal data, especially since digitising till receipts for environmental purposes gives stores the green light to collect and use personal data (email address and telephone numbers) on the legal basis of their legitimate interest[84].

Through this provision, the legislator has transformed analogue purchases into digital purchases, which ushers in its fair share of duties for data controllers, as well as certain rights, such as sending direct marketing emails to their customers for similar products (customers still have the right to object).

In case of public services, the CNIL states in its Innovation & Foresight Report no. 8, Scenes from Digital Life (p. 36), that "its opinions regularly include recommendations for setting up alternatives to the digital solutions used to access rights or public services where such solutions collect personal data." This is a legitimate request when it comes to giving individuals a choice between consenting to the collection of their data, but it also adds a greater element of inclusion, since we are not all equal or proficient when using digital services. However, from an environmental point of view, if we try to strike a greater environmental balance between the different solutions, there is no guarantee that maintaining a manned reception in a public service branch will be any better. It still needs to be quantified. Driving 10 kilometres to the reception desk of a public service will probably have a larger footprint than the digital method, with 2.2 kg of CO_2 for a car with an internal combustion engine, 1.1 kg for a bus, and 0.1 kg for a bicycle, according to the ADEME Impact Base[85]. But maintaining a dedicated physical space for public services in areas with a large catchment area is vital for ensuring fair access to those public services. Rural communities are sometimes faced with the disappearance of local public service branches combined with a lack of quality digital coverage[86].

83 French Regulation no. 2022-1565 of 14 December 2022 on the terms and conditions for enforcing Part IV of Article L. 541-15-10 of the French Environmental Code. Légifrance: https://www.legifrance.gouv.fr/jorf/id/JORFTEXT000046737771

84 CNIL, 10 March 2023, https://www.cnil.fr/fr/fin-de-limpression-systematique-du-ticket-de Fin de l'impression systématique du ticket de caisse : quelles solutions sont possibles et quelles sont les règles ? -caisse-quelles-solutions-sont-possibles-et-quelles-sont

85 Impact CO_2, https://impactco2.fr/integration?type=transport

86 "Rapport d'information sur l'évaluation de l'accès aux services publics dans les territoires ruraux", National Assembly, 2019, https://www.assemblee-nationale.fr/dyn/opendata/RINFANR5L15B2297.html

LOW TECHNOLOGY AND "POWER IN RESERVE"

The debate between technological development and the environment, which was covered in the first part of this report, is still open in some respects, between the real footprint and the benefits inherent in optimisation, which sometimes still need to be measured and demonstrated. In most cases, the simplest solution that some people use to prevent their data from being wrongfully collected is to "switch off their phone" or even "stop owning a phone". Such radical methods may be effective, but they do not provide any protection against external devices, whether CCTV cameras or smart cameras. Taking an in-depth look at the real needs for technological development falls in step with the key principles of data minimisation and proportionality of processing operations.

In his contribution to the "Annales des Mines" scientific review in December 2021[87], Philippe Bihouix proposed the idea of adopting a low-tech approach aimed at "saving resources, promoting energy efficiency at the source and thinking about what is really needed." Philippe Bihouix does not oppose technologies, but instead wants everyone to use technology in a responsible manner and only where it brings an undisputed advantage. Taking the example of a smart city, he says that the more we endeavour to digitise objects and services in the city, the more we are tapping into our resources, which amounts to extractivism. He also uses the example of a self-driving car, which he believes could generate several thousand gigabytes of data every day and for each car, before adding that "*nobody knows the proportion of data that will need to be archived (for safety, insurance or marketing purposes) and for how long.*" Likewise, we have no idea at this stage "*what the 5G networks will consume, bearing in mind that 5G is needed for apps with very low latency requirements (such as self-driving vehicles), or whether the density of smart objects will exceed a certain threshold.*"

Above all, although it is hard to quantify or measure the direct positive effects that the roll-out of digital services will have on energy and resource efficiency, the risk of a rebound effect has been documented. Technological efficiency is "*immediately translated into economic efficiency*", combined with a fall in prices. A more efficient and competitive product drives its own demand, which in turn increases the amount of use and therefore its environmental footprint.

Finding other ways to innovate or pioneering alternative innovations could also be one of the ways to develop a more energy-efficient breed of technology, whether by choice or necessity. Achille Mbembe explores and describes this line of thought in his book entitled Brutalism, which uses the example of Africa, where "*we cannot afford collapsology*" and where "*the future remains open.*"[88] In particular, he mentions that some regions lack the infrastructure to develop access to a wired internet or through mobile network antennas, which has given rise to new forms of innovation.

Mobile phone networks were already instrumental in the early development of SMS payment systems. The M-Pesa system created in Kenya in 2007 had 30 million subscribers by 2017, who used it to pay for goods and services, access loans and send money abroad[89]. Achille Mbembe describes the case of "disruption-tolerant networks", which were designed to overcome outages or the absence of networks in certain areas. Thanks to "data mules", low-cost asynchronous telecommunications networks can be recreated.

Digital storage devices, such as Android smartphones with Wi-Fi and Bluetooth connection and storage capabilities, are carried by car or motorcycle between certain points of the network (from village to village) to recover the digital content that inhabitants wish to send (emails, files, medical records, etc.). The content is then sent to the Internet when the data mule passes through a city with a connection point.

People can even place orders for web pages, which will be opened at the connection point, stored on the phone and then brought back to the village. Similarly, Achille Mbembe invites readers to pay special attention to the repair and maintenance practices currently being developed in Africa, the capacity for innovation and what he calls the "*power in reserve*", which has the ability to produce solutions for the future.

In some respects, these examples may appear to be far removed from western concerns about the strategy needed to develop sustainable digital technology. But the Western world can draw inspiration from these examples to produce innovative models that are no longer bound by the shackles of the law of supply, but designed to meet actual needs and "purposes".

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87 Rui Pereira, et al., " *Ranking programming languages by energy efficiency, Science of Computer Programming* ", Volume 205, 2021, https://doi.org/10.1016/j.scico.2021.102609.

89 Philippe Bihouix, " Le mythe de la smart city écologique ", Enjeux numériques , N° 16, Décembre 2021, http://www.annales.com/enjeux-numeriques/2021/en-16-12-21.pdf

90 Achille Mbembe, *Brutalisme*, Éditions La Découverte, 2020, p. 174

ECODESIGN AND PRIVACY BY DESIGN

According to the definition provided by the Ministry of Ecological Transition in 2019, ecodesign involves "*integrating environmental aspects into the design of products or services*" as part of an "*approach to prevent environmental problems.*" Although the term was initially used for "physical" products and services, it has spread widely since the late 2010s to encompass digital services and tools.

for Eco-Responsible Digital Technology) has been working within the Interministerial Directorate for Digital Technology (DINUM) to develop eco-friendly practices within the state's ministries, agencies and public bodies. Associations also publish guides or produce various works to raise awareness among all sections of society, such as the GreenIT association which published a book in 2015 on 115 ecodesign best practices[90], think-and-do tank Institut du Numérique Responsable which released a Sustainable IT MOOC in January 2021[91], and the Designers Éthiques association which uploaded a "Guide to digital services ecodesign" in 2022.[92] According to MiNumEco, "*Ecodesign is a method aimed at curbing the environmental impacts of a digital product or service by examining the needs and considering the environmental impact during its design and throughout its lifecycle as part of a continual improvement approach, by incorporating the principles of minimisation, stability, efficiency and maintainability.*"

Therefore, the objective is not only to improve performance or efficiency, but generally think about the use of technologies. The idea is to start considering the environmental aspects during the design stage, or by design as the GDPR puts it, in order to examine the actual purpose for a digital service before pressing ahead with its development. Does it meet a need? Could a non-digital alternative be developed? Would it be preferable? To support and guide public stakeholders and other interested parties with their efforts, the Interministerial Mission published[93] a general standard for digital services ecodesign (RGESN)[94] in October 2021 in the form of a FAQ, which contains answers to a series of questions relating to all the links in the digital service development chain (strategy, specifications, architecture, UX/UI, content, front-end, back-end and hosting).

All the questions and answers can prove useful as part of a more comprehensive approach to analysing risks when implementing services and personal data processing operations where ecodesign, cybersecurity and data protection issues converge.

Convergences between data protection, cybersecurity and ecodesign

The CNIL took part in a workshop alongside several other institutions (including ANSSI and the Cyber Campus), stakeholders and experts, with the aim of responding to the following question: "*What best practices should be implemented within organisations to break down the silos that often exist between rules and standards, and converge energy efficiency, security and data protection issues?*".

The three approaches converge in the following areas:

- The "by design" approach: the need to incorporate them as early as possible into the project develop-ment cycle.
- Minimisation principle: data (specified in the GDPR), features (essential and tailored to users' needs), least privilege (rights restricted to the bare minimum on client workstations, reduction in the amount of software installed, etc.).
- Sovereignty: systems and data.
- Compliance with standards and regulations: general security standard (RGS), General Data Protection Regulation (GDPR), general interoperability standard (RGI), general standard for digital services ecodesign (RGESN), etc.
- Control of the information system.
- "Lifecycle" approach: apply best practices at each stage of a project (design, use and end of life), particularly in terms of data for the CNIL.
- Continual improvement strategy.
- Training for people: individual and collective upskilling, and development of in-house skills.
- Other synergistic practices: risk analysis, supervision, no or few cookies, data storage period, static website or without any database exposure, bespoke code or free software.

These three approaches are highly complementary, but they still diverge in a few areas, especially with regard to ecodesign. Cybersecurity and data protection require procedures and processes that use resources, such as defence in depth systems (multiple layers of defensive mechanisms to protect

90 Frédéric Bordage, Ecoconception web : les 115 bonnes pratiques - Doper son site et réduire son empreinte écologique, published by Eyrolles, Paris, 2022 (4th edition)
91 Sustainable IT MOOC, ISIT Academy, https://www.isit-academy.org/
92 "Le guide d'écoconception de services numériques", Designers Éthiques, May 2022, https://eco-conception.designersethiques.org/guide/fr/
93 With the Ministry of Ecological Transition, ADEME and the Institut du Numérique Responsable.
94 "Référentiel général d'écoconception de services numériques (RGESN)", Interministerial Mission for Eco-Responsible Digital Technology, updated on 28 November 2022, https://ecoresponsable.numerique.gouv.fr/publications/referentiel-general-ecoconception/

sensitive data and information), encryption, high availability (which requires duplicate infrastructures, information, extra architecture layers, etc.), partitioning and redundancy (for backing up data, which requires multiple environments).

Nevertheless, the workshop found that the areas of divergence do not lead to any incompatibility between data protection and cybersecurity on the one hand, and ecodesign on the other hand. On the contrary, the idea is to strengthen the links between the three approaches and manage digital projects and services from a holistic point of view by considering all their aspects.

Closer look at...

Reconditioning

France's anti-waste and circular economy law of 10 February 2020 specifies a number of measures aimed at "taking action against planned obsolescence." Since 1 January 2021, vendors of electrical and electronic equipment (including online sellers) have been required to display a repairability index for certain products, and a sustainability index from 1 January 2024. They must also "*facilitate repairs and promote the use of spare parts from the circular economy*" for equipment and particularly electronic products. As for software, manufacturers and vendors must "*improve information on maintaining software compatibility*", particularly for smartphones, by telling consumers how long their device will be able to support successive updates. Manufacturers are also prohibited from requiring a device to be repaired or reconditioned by any process whatsoever. Manufacturers are also banned from releasing software updates resulting in slower or degraded performance on the device.

An initial decision preceded this law, not for planned obsolescence (this term was rejected by the courts), but for "*misleading commercial practices by omission*." The Directorate General for Competition, Consumer Affairs and Fraud Control (DGCCRF) fined Apple on 7 February 2020 because "*iPhone holders had not been informed that updating the iOS operating system (10.2.1 and 11.2) was likely to slow down their device's performance.*"[95]

However, repairing and reconditioning smartphones is not without its risks. For example, phones (especially iPhones) cannot be reconditioned unless the previous owner has unlocked and reset them. In an interview for the LINC, Nicolas Nova (who carried out a five-year ethnographic survey among telephone repair stores in Switzerland) explains how repair shops are sometimes required to act.

For example, phones (especially iPhones) cannot be reconditioned unless the previous owner has unlocked and reset them. "*Compared to manu-facturers, repairers really need to reverse engineer the devices to understand how they work and repair them more effectively*", since manufacturers do not document how they have made their devices. This leads to the "*creation of a whole set of technical documentation, comprising photos and videos, as well as files and folders; these disassembly reports (in both hardware and software versions) can sell for between €3,000 and €6,000.*" The primary objective behind these entrepreneurial ventures is to make money, but these shops "*contain real-life and pragmatic initiatives, with people who are not trying to convert others into environmentalists, but instead are working on prolonging the life of our digital objects and providing solutions to solve problems...*

95 "Transaction avec le groupe APPLE pour pratique commerciale trompeuse", DGCCRF February 2020, https://www.economie.gouv.fr/dgccrf/transaction-avec-le-groupe-apple-pour-pratique-commerciale-trompeuse

Closer look at...

Reconditioning

... As a community, they understand that we need to change how we use digital objects by creating an environmental message that is starting to appear in some spaces and could gain traction." They are also the first, along with reconditioning firms like Ateliers du Bocage[96], to specifically experiment with implementing sustainable digital practices on our hardware and data.

Used smartphones and computers cannot be sold unless all data and information that could be traced back to the previous owner have been erased. This applies to individuals as well as public companies and institutions, which are increasingly giving away or selling their used equipment. Openly providing the appropriate documentation, methods and tools for repairing electronic devices and erasing their data should therefore be high on the list of priorities for digital technology professionals, particularly manufacturers.

96 Ateliers du bocage, https://ateliers-du-bocage.fr/

Are freedoms in Transition?

"It's strange, because thousands of writers live in New York. But you'd be hard pressed to find a movie or novel that is set during Hurricane Sandy. However, there are at least seven or eight novels about the future destruction of New York through flooding. But there's nothing about flooding today. This says a lot about how the imagination prefers a fantastical vision of climate change rather than a representation of the reality that we already live in."

Amitav Ghosh, writer, author of The Great Derangement (2016)[98]

97 Sylvain Bourmeau, Interview with Amitav Ghosh: *"La crise climatique est aussi une crise de la culture et de l'imagination"*, AOC, August 2021 https://aoc.media/entretien/2021/08/20/amitav-ghosh-la-crise-climatique-est-aussi-une-crise-de-la-culture-et-de-limagination-2/

Are freedoms in Transition?

Sometimes there is a change of position between defenders of freedom, who are hostile to the use of surveillance systems for "security" purposes, and environmental defenders, who approve of such systems and are even in favour of reporting breaches if it means protecting the environment. This tends to legitimise surveillance techniques when they are used for this purpose. The definition of what constitutes a "good cause" or "value" is subject to everyone's discretion, according to their priorities. The term "liberticide" is consistently used by certain sections of the population, some for their right to free movement within the public space, and others for their right to freely use the means of transport at their disposal, whether an aircraft, a sports car or a petrol scooter.

These debates on our freedoms are sparking a new form of confrontation, and we always need to review how our fundamental freedoms are implemented.

They are also embedded in social and economic issues, as well as questions surrounding people's ability to meet new obligations, such as the advent of low emission zones in metropolitan areas. Local elected officials from across the political spectrum are resisting moves to put this system into practice, which tends to penalise the most impoverished populations, since they are unable to afford a recent vehicle producing fewer emissions.

Adobe stock

These debates are also part of a framework where we have collectively deployed, used and nurtured systems to track and measure our own actions, or certain segments of the population. These devices have not been designed to monitor populations and their ability to engage with the environmental transition, but they could be used for those purposes. Similarly, digital technology and the tools deployed by governments and local authorities lead to questions about the technical democracy, standpoint, role and debates concerning these systems to ensure that they do not undermine the foundations of society.

WHO CONTROLS - OR MONITORS - WHOM?

Harnessing data to benefit the environment is a likely slogan to promote the environmental transition. The whole arsenal of digital solutions rolled out over the past two decades could be aimed at improving our health or simply "saving the planet", instead of just helping us move faster and consume more. Together, we have produced systems that could easily be redesigned to help measure and control the environmental performance of our own behaviour, whether by our own initiative or in response to incentives from private and public stakeholders.

From quantified self to self-assessed impacts

Generally speaking, the digital tools associated with collecting data, especially since the advent of the smartphone, have been used to offer a way of monitoring both individual and collective behaviour. The quantified self movement, which the LINC studied in an I&F report as early as 2013[98], allowed people to "*measure the exact number of steps walked during the day with a step counter, track their weight with smart scales and measure the quality of their sleep with a smart bracelet or smartwatch*" for well-being purposes or for personally checking their own health.

In the city, our smartphones have turned into remote controls, which we use for a variety of urban services, and also into antennas for receiving "orders" to move left or right, whether on the bus or in the car, (remotely) guided by such apps as Waze and CityMapper.. Some route planners have already implemented environmental criteria into their suggested routes. Since March 2022, Google Maps has offered motorists in Canada (since September 2022 for European motorists)[99] "fuel-efficient routing" that "factors in traffic conditions, road gradients and several other variables to suggest the best route for reducing fuel consumption, thereby saving petrol." Apps have long been available for planning bicycle routes, like GeoVélo.

Mobility apps are bound by Article 122 of the Climate Law, as specified in Regulation No. 2022-1119 of 3 August 2022[100] to "*phase in a set of obligations for digital travel assistance services to better inform users.*" The objective

98 "IP Report 2 - Le corps, nouvel objet connecté", LINC, https://linc.cnil.fr/fr/cahier-ip2-le-corps-nouvel-objet-connecte

99 "Une conduite plus économique et écoresponsable grâce à Google Maps", Google France Blog, September 2023, Google, 7 September 2022, https://blog.google/intl/fr-fr/nouveautes-produits/explorez-obtenez-des-reponses/une-conduite-plus-economique-et-ecoresponsable-grace-a-google-maps/

100 "Regulation no. 2022-1119 of 3 August 2022 on digital travel assistance services", Légifrance, https://www.legifrance.gouv.fr/jorf/id/JORFTEXT000046144256

is to "*provide users with a ranked list of suggested routes according to their environmental impact, particularly in terms of greenhouse gas emissions*", and disseminate messages to encourage active forms of mobility, car-sharing and public transport, with the following types of incentivising message: "*For short journeys, preferably walk or cycle*", "*Remember to car-share*", "Slowing down from 130 to 110 km/h on the motorway can reduce your fuel consumption by 20%" and "*Don't forget about public transport for your everyday travel needs*". According to the government, the aim is to "*limit the negative external impact of these mobility services*" by informing users through encouraging messages.

Collective solutions implemented by local authorities

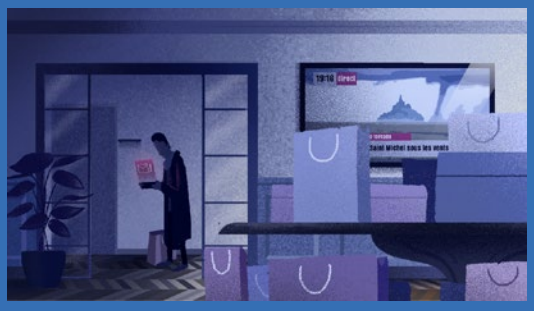
Some cities have fitted individual bins with sensors to measure the weight of the waste and thereby charge users a fair price for collecting their refuse, while encouraging users to reduce their waste. This "incentive-based pricing" initiative is based on the "polluter pays" principle. According to ADEME, such a scheme for household waste in 2016 helped lower the amount of waste produced per household from 30% to 50%[101]. This example of individualising a local public policy through digital technology shows how the level of freedom can be set anywhere along the scale between encouragement and control.

In a survey carried out by the Mobile Lives Forum research institute during the lockdown in the spring of 2020[102], 53% of people replied that they would be in favour of rationing measures to cut down on the amount of travel, provided that the rule is fair and does not allow exemptions for the wealthiest individuals. What could be better than personal data for measuring, controlling and limiting their impact on the environment?

Therefore, why not use innovation to drive the environmental transition and harness data to reduce everyone's individual footprint? Between May and December 2020, the city of Lahti in Finland trialled a scheme to ration the carbon emissions generated by the journeys of its 350 inhabitants.[103] Volunteers were equipped with a mobile app for measuring their emissions from each of their everyday journeys and managing their individual carbon budget. In Sweden, the Baltic Sea Card[104] is used to calculate the carbon footprint from card purchases by cross-referencing with Merchant Category Code data (MCC) and the Aland Index, which is a service for calculating the CO_2 impacts and water use of financial transactions.

Doconomy, which trialled the card between 2018 to 2020, offers an API[105] and SDK[106] offering the same possibilities. With the first version, the card could even block transactions if they exceeded a specific threshold1[07]. These examples inspired the LINC to publish "Climatopie" in January 2022, a series of fictional stories including "Payable in smoke" (see box).

PAYABLE IN SMOKE



Béranger Colette

What if pollution were turned into a currency? We can imagine a future about 20 years from now where every bank account also includes a carbon emissions account for keeping track of the pollution generated by our energy use. This account would limit our actions according to our impact. As the climate emergency increasingly makes its presence felt, this account will quickly become a nightmare for the hero in this short story. Between enjoying special events and dealing with unpleasant surprises, the hero will try to cope throughout the year, even though it got off to such a promising start.

Read the story at https://www.climatopie.fr/

101 "Enquête de perception de la redevance incitative", ADEME, 2016, https://librairie.ademe.fr/dechets-economie-circulaire/2172-enquete-de-perception-de-la-redevance-incitative.html

102 "Enquête sur les impacts du confinement sur la mobilité et les modes de vie des Français", Mobile Lives Forum & "Enquête sur les impacts du confinement sur la mobilité et les modes de vie des Français", Obsoco (research and consulting company), 2020, https://forumviesmobiles.org/en/project/13285/survey-impacts-lockdown-french-peoples-mobility-and-lifestyles https://forumviesmobiles.org/en/project/13285/survey-impacts-lockdown-french-peoples-mobility-and-lifestyles

103 "Lahti : La première expérimentation de rationnement du carbone appliqué aux déplacements locaux", Research notes, Mobile Lives Forum, 2021, https://forumviesmobiles.org/en/project/13794/lahti-first-carbon-rationing-experiment-applied-local-journeys

104 The Baltic Sea Card, Baltic Sea Project, https://en.itameriprojekti.fi/baltic-sea-card/

105 Application Programming Interface.

106 *Software Development Kit.*

107 Marie Privé, "En Suède, une carte de crédit permet de calculer l'empreinte carbone de chaque achat", Géo, June 2019, https://www.geo.fr/environnement/en-suede-une-carte-de-credit-permet-de-calculer-lempreinte-carbone-de-chaque-achat-196038

All these devices and trials are part of a framework that promotes collaboration with local communities on a voluntary basis or through incentive systems, including monetary incentives, to reduce consumption or change behaviour. They are aimed at building universally accepted solutions as part of a collective effort with the aim of achieving a common goal. Other schemes that are not necessarily focused on the environment rely on more coercive measures or sanctions.

How are top-down control methods changing?

The government is already using digital technology to assess people's behaviour or check their compliance with certain obligations in various areas, especially tax matters, and this approach could spill into the environmental sector.

For example, a provision that was added to the 2020 Finance Bill (Article 57) provided for the creation of an experimental anti-fraud mechanism, allowing the tax and customs authorities to collect "*freely accessible*" public data on social media sites and "*electronic networking platforms (such as Facebook, leboncoin and Twitter)*" and subsequently exploit those data using "computerised" processing operations. This three-year experiment aims to detect individual offences by analysing their posts on social media. Therefore, people can see that their online public behaviour is being examined to identify potential breaches of their tax obligations, such as determining whether their lifestyle matches their tax returns. The CNIL issued an opinion in September 2019[108] containing "*several reservations for maintaining a strict balance between the objective of tackling tax fraud and upholding data subjects' rights and freedoms.*" In particular, the CNIL feared that such a massive data collection system "*would significantly change the behaviour of Internet users, who could no longer express themselves freely on the targeted networks and platforms.*"

A system was trialled in 2021 to automatically detect private swimming pools that had not been declared to the tax authorities, which was subsequently extended throughout the country in September 2022. The system developed by the IGN (National Institute of Geographic and Forest Information), Capgemini and Google uses satellite images to detect outdoor buildings and structures, such as swimming pools, and verify whether they have been declared to the tax authorities or taxed for the right value. It could easily be imagined that this system, which raised €10 million in uncollected taxes, could be used for other purposes in the future, since some MPs called for private swimming pools to be banned in August 2022 in response to the heatwave and droughts that hit the country during the summer. Although politicians have yet to agree on such a ban, the technological resources for its implementation are already operational. However, their effectiveness remains to be established.

Similarly, monitoring behaviour on social media, such as trialled by the tax authorities, could be used to track behaviour that is currently illegal or will be illegal in the future, from the perspective of protecting the environment, in addition to flight tracking or vigilantism operations (see below).

MEANS OF SOCIAL CONTROL... A NEW ENVIRONMENTAL WHIPPING POST?

Digital technology and social media exposure have been used since the 2010s for activism and political action. Attempts to defend the environment are no exception, and users are witness to a growing number of online actions to promote or condemn certain practices. Sometimes, these actions involve targeting the behaviour of certain categories of people or even well-known personalities, just like the social media accounts that use flight tracking to call them out on their environmental impact.

New forms of digital vigilantism

Digital technology has already demonstrated its ability to reinforce empowerment, and the use of social-tech devices has helped stimulate individual or collective action for political purposes, as covered in our I&F Report no. 7, entitled *Civic tech, data and demos*. Prime examples include the "Arab Spring" and the "Yellow Jackets" movements, which were especially organised using digital tools and social media. Other more radical forms exist, as described by Benjamin Loveluck[109], such as digital vigilantism, which may refer to the practices employed by "justice fighters operating without legal authority". "*Not only do they involve alerting the authorities or public opinion, but they are also an attempt to "take justice into one's own hands" by engaging in forms of active*

108 Délibération n° 2019-114 du 12 septembre 2019 portant avis sur le projet d'article 9 du projet de loi de finances pour 2020, https://www.legifrance.gouv.fr/cnil/id/CNILTEXT000039167079/

109 Benjamin Loveluck, "Le vigilantisme numérique, entre dénonciation et sanction. Auto-justice en ligne et agencements de la visibilité". Online self-justice and arrangements of visibility, Politix, 2016/3 (No. 115), p. 127-153, https://www.cairn-int.info/article-E_POX_115_0127--digital-vigilantism-between.htm

Closer look at...

AskGPT3

**What is the priority?
Protecting freedoms or the environment?**

"There is no way to say whether one thing has priority over the other, because the protection of freedoms and protection of the environment are both important. The fundamental rights and freedoms of individuals are essential for ensuring justice and human dignity, while the environment is vital to our long-term well-being and survival. Therefore, it is important to strike a balance between these two aspects and work together to reach a compromise that protects both freedoms and the environment."

GPT3, openai.com, Wednesday, 4 January 20

and targeted surveillance, repression or dissuasion. These are often achieved by an excess of unsolicited attention or negative publicity." In some cases, these practices descend into aggressive digital manhunts against specific individuals.

The origins of vigilantism can be traced back to the 18th-19th century United States and community self-defence groups, which were not only driven by class conflicts but also attempts to assert membership to a specific community or ethno-racial group. The traditional description of vigilantism has evolved. On the one hand, the "*regime of visibility with which the digital technology is associated*" implies that the data and information posted online can easily be shared and disseminated to support militant causes. On the other hand, the propensity to self-regulate online behaviour is organising the public digital space, developing from earlier netiquette into rules governing interactions on forums, and even reporting and detecting hate messages or unlawful content on social media, as specified in the site's terms of use. Self-regulation is tending to evolve, since the EU Member States agreed in July 2022 on the Digital Services Act, which imposes new content management rules and transparency obligations on platforms.

The public digital space has therefore become a place for reporting people and forming public opinion. Sometimes it can turn into a collective trial based on "evidence" (provided by images or data) or even an instrument for direct coercion, particularly by an anathema, around four main forms of online self-justice: flagging, investigation, hounding and organised denunciation. There are countless examples in every area, and now they are gaining traction for environmental causes.

From behaviour shaming to horizontal shaming

The summer of 2022 was a hotbed of discussions about flight tracking. This old practice was initially developed by aviation fans and involved dynamically mapping commercial and military flights in real time. Since the spring of 2022, social media accounts have been directly targeting the flights of private jets owned by major business leaders or celebrities to call them out on their environmental footprint, at a time when people are dealing with the fallout from climate change, and pressure them to change their behaviour, as described in the LINC article published in October 2022, "*The great hijack*": flight data and private jets[110].

These practices are specifically focused on a very narrow section of the population - 1% of the world's population is responsible for more than half of the CO_2 emissions from air transport[111] - and aimed at encouraging debates on the issue and calling for greater fairness in the efforts that everyone will have to make. The legitimacy of such debates and actions lies in the right to information, but is confronted with public personalities' right to protect their personal data. Although personal data that are publicly available online are still subject to the GDPR, the right to personal data protection is not absolute and may be tied into other fundamental rights. In the case of flight tracking, the balance between the right to data protection and the right to information is at stake, particularly exemptions for journalistic purposes as provided for in Article 85 of the GDPR: "*Member States shall by law reconcile the right to the protection of personal data pursuant to this Regulation with the right to freedom of expression and information, including processing for journalistic purposes and the purposes of academic, artistic or literary expression.*"

Denunciation is already rife on the Internet against people exhibiting behaviour or expressing opinions that offend certain sections of the population, such as on moral, religious

110 Thomas Le Bonniec, "Le grand détournement : les données de vol et les jets privés", LINC, October 2022, https://linc.cnil.fr/le-grand-detournement-les-donnees-de-vol-et-les-jets-prives

111 According to a study published in 2020 in scientific journal Global Environmental Change.

JOB PROFILE

Béranger Colette

2029, two years after the COP 34 conference and its resolutions. The world is still in the throes of a climate emergency, but younger generations have changed their behaviour. They are more responsible and more affected by global warming, but this time the lifestyle change for new working professionals seems to be sustainable, even though the causes that prompted this behavioural revolution are not necessarily the right ones.

Read the story at https://www.climatopie.fr/

or political grounds. Greta Thunberg has come in for a torrent of abuse online and also in the real world (an effigy of the climate activist was found hanging under a bridge in 2019[112]). Flagging individuals and committing acts of online self-justice are not without their risks, not only in terms of protecting data and upholding freedoms, but also safeguarding the psychological and physical safety of the people targeted. In his book entitled Denunciation[113] published in 1984, Luc Boltanski draws a parallel with a very real form of violence: "*publicly accusing one or more people is tantamount to an act of violence by attacking their reputation or the recognition that they enjoyed at that particular time, or to use an outdated expression, attacking their "honour". But in most cases, such accusations constitute a different type of violence, namely physical violence, which is considered necessary to take the opponent out of action.*"

VARIABLE-GEOMETRY FREEDOMS

The impact that digital technology may have on individual freedoms should also be examined against the concept of freedom and the changing expectations of individuals and the social world in democratic societies.

Therefore, the most fundamental freedoms, such as freedom of movement, the freedom to demonstrate, the freedom to assemble and freedom of expression, appear to have been especially protected for more than 200 years. However, their limitations are constantly subject to debate as new abuses, new possibilities for control and new opportunities emerge.

Several examples are available in recent history to illustrate how digital technology can contribute to freedoms and allow individuals to exercise their rights:

- Means of transport (bicycles, trains, cars and aircraft) have extended the freedom of movement on a global scale and have profoundly changed the perception of what individuals can legitimately access.
- After several years of debate, the Internet constituted a radical extension to the freedom of expression, in a move that is reminiscent of the freedom of the press from the end of the 18th century.
- The new means of generating electricity, such as wind turbines and especially solar panels, have given individuals a new opportunity to contribute and manage their energy consumption and production themselves. However, authorising such a right is not always straightforward due to the constraints of managing a highly centralised electricity grid and whose balance is both a sensitive and strategic issue.

At the same time, society's consensus on certain practices has also radically changed. For example, individuals are no longer allowed to manufacture their own alcohol or smoke in enclosed public spaces. In terms of transport, the freedom brought by technology has grown at the same time as regulations and restrictions have developed (seatbelts, speed limits, MOTs, luggage checks at the airport, and so on).

Health issues have clearly paved the way to the most stringent limitations on individual freedoms, as further illustrated by the Covid-19 pandemic. These concerns have ushered in a strict set of measures governing economic

112 "AFP, Rome : Un mannequin à l'effigie de Greta Thunberg pendu sous un pont", 20 minutes, October 2019, https://www.20minutes.fr/monde/2622311-20191007-rome-mannequin-effigie-greta-thunberg-pendu-sous-pont

113 L. Boltanski, Y Darré, M-A Schiltz, "La dénonciation", Actes de la recherche en sciences sociales, 51, 1984 and L. Boltanski, L'amour et la justice comme compétences. Trois essais de sociologie de l'action, Paris, Metalia, 1990.

activity and entrepreneurial freedom. At the same time, they have led to demands for greater transparency, initially from the authorities and then more broadly from the general public[114].

The same phenomenon affected environmental issues, first of all for protecting populations against industrial projects (particularly the chemical industry) and subsequently with the rise of industrial society and infrastructure projects. In France, public inquiries were implemented in 1810 for establishing industrial sites, and supervision of such projects was entrusted to government authorities through the local prefect, and the 1980s[115] saw a need to strengthen transparency and citizen participation with the aim of striking the right balance between entrepreneurial freedom and modifying the environment and desires of individuals and communities. In 1995, the creation of the National Commission for Public Hearings (modelled on Quebec's Public Hearings Office) enshrined this need for transparency and debate. These changing perceptions of freedoms, as well as increased transparency, illustrate the growing difficulty in unambiguously determining the concept of freedom and the measures required to protect those freedoms.

Finally, extending the public's desire for transparency, which is used by the public authorities as a new public policy tool instead of authorising or banning, runs head-on into the wish for greater personal data protection, which creates a kind of collective "privacy paradox" across society.

TECHNICAL DEMOCRACY AMIDST A CLIMATE CRISIS

As our planet faces an environmental emergency, initia-tives aimed at changing our behaviour to adopt energy-efficient practices or lower our use of resources are appropriate when they create a positive impact, when participation is voluntary or when their deployment has been discussed as part of a true democratic process. However, the idea is not to enforce those initiatives in such a way that they undermine the very principles of democratic life and violate the social contract.

Heading towards digital ration stamps?

In a chapter of his book called *Rethinking freedoms*[116], Jacques-François Marchandises warns about the risk of transforming digital technology into the "*ration stamps*" of tomorrow. With "*sensors in the city, smart meters, urban road tolls, gantry-mounted eco-tax cameras and waste weighing systems, digital technology now provides significant means to check individual consumption and practices with the aim of tackling resource depletion and driving the need for a radical change.*" But he adds that "*if we are not careful, the environmental emergency will not be much nicer than a terrorist emergency or a health emergency, and it will draw on the same digital hardware, which will be the techno-power systems used to address the crises of tomorrow.*"

Rationing may be seen as a virtuous way of lobbying for a change in behaviour[117], "*by choosing to allocate to everyone, regardless of income, the same right to emit while travelling, the rationing of carbon-emitting trips is meant to be fairer than the carbon tax. This policy places the main effort on people whose lifestyles are the most emitting.*" But misusing ration stamps could very quickly cause an imbalance in their distribution and affect the deployment of freedom control measures for certain parts of the population. Imposing quotas and behavioural standards implies that they can be controlled and that advances in technical democracy can be achieved.

As with safety, the aim is to balance different obligations, such as the need to protect the environment on the one hand, and protect / safeguard our fundamental rights on the other. It is not a question of giving up our freedoms, but adapting them to the context. In his book entitled *Affluence and Freedom*[118], Pierre Charbonnier states: Who *would want an authoritarian ecology or freedom without a tomorrow?*" He believes that it is a matter of reinventing freedom during the current climate crisis and moving away from the idea that infinite freedom is possible in a finite world.

Heading towards a society under anthropogenic control?

"*The rise of authoritarianism is unavoidable. [...] demo-cracies don't solve the existential problems of our time: climate change, depletion of energy reserves, soil erosion, the*

114 For example, any citizen can access the physicians' transparency register to see what gifts they have been offered by pharmaceutical laboratories: https://transparence.sante.gouv.fr/pages/accueil

115 Especially with the enactment of the Bouchardeau Law - https://www.cairn.info/revue-responsabilite-et-environnement-2016-1-page-6.htm

116 Repenser la Liberté, a collective work supervised by Philippe Lemoine, Descartes Editions, 2022

117 "Rationing carbon emissions for travel: a promising alternative to the carbon tax?" (IDDRI, 2020, student project) https://forumviesmobiles.org/en/project/13515/rationing-carbon-emissions-travel-promising-alternative-carbon-tax

118 Pierre Charbonnier, Abondance et liberté, La Découverte, Paris, 2020.

growing income gap between rich and poor, etc. Do individual freedoms have to be given up to solve that? [...] Individual freedoms are already restricted and I think this trend will inevitably continue[119]." This quote, which dates back to 2019, comes from scientist Dennis Meadows, co-author of the Report commissioned by the Club of Rome in 1972[120], which already announced the limits to growth in a finite world.

While tensions between freedoms, the right to data pro-tection and privacy, and the environmental transition are tending to grow, it is the actual political regimes that come under question in this particular area.Some already point to the risk of a "green dictatorship" or "ecocracy", i.e. a regime where environmental protection would take precedence over protecting human rights.

Representative and liberal democracy would be ineffective at meeting climate emergency challenges, since it is based on very short timescales and a tight elections calendar, which tend to favour a short-term approach and "*quick wins that are potentially damaging in the long term*."[121] Criticisms are often levelled at the ecology (which some would describe as punitive) for restricting individual freedoms by imposing taxes, prohibiting certain uses or simply using technology to monitor individuals[122]. But as Emeline Baudet points out, these arguments are "*especially brandished by social groups who are worried about losing their privileges.*"

The Chinese model: more complex than it seems

The Chinese model is often used to illustrate this relationship between authoritarian regimes and the ecological transition. According to Stéphane Grumbach[123], Director of Research at INRIA, "*China is the most advanced country when it comes to anthropogenic control, and control of persons, institutions and spaces in relation to the global environment.*" The concept of an "ecological civilisation" - and its binding nature - was enshrined in the Constitution in 2018. The security concept in China encompasses environmental monitoring systems for "*managing natural resources, protecting natural ecosystems and promoting eco-friendly growth models and lifestyles.*" These guidelines are part of a country where population control through technology is already well underway, as demonstrated by the fight against Covid or experiments with the Chinese social credit system.

As Stéphane Grumbach also points out, the idea is not to caricaturise. The Chinese government's proactive approach coincides with the rise in protests among the population on environmental issues or local pollution[124]. As Éric Vidalenc[125] explains in a report for the Fabrique Écologique[126], "*these demonstrations are 'democratic' forms of expression other than elections*", and it is in the authorities' best interests to stop such demonstrations from spreading and "*instead 'listen' to the population.*" Authoritarian regimes, just like representative democracies, are subject to short-term pressure from the population and seek to keep the current regime in place. Authoritarian regimes are not necessarily better prepared to meet these challenges, far from it. Green dictatorship is still an expression without any basis. Nevertheless, democracies will have to open new debates on establishing the common rules that apply to everyone and are shared by all, especially to adapt our lifestyles and consumption habits, sometimes with a helping hand from technology.

119 Dennis Meadows, scientist, co-author of the Meadows report (1972) on the dangers of growth, "La montée de l'autoritarisme est inévitable", Libération, https://www.liberation.fr/france/2019/07/29/dennis-meadows-scientifique-coauteur-du-rapport-meadows-1972-sur-les-dangers-de-la-croissance-la-mon_1742741/

120 Donella Meadows, Dennis Meadows, Jorgen Randers and William W. Behrens, "The Limits to Growth", Universe Books, 1972 (ISBN 978-0-4510-9835-1)

121 Émeline Baudet, "Dictature verte, la tentation", Revue Projet, 2021/3 (No. 382), p. 46-49. DOI: 10.3917/pro.382.0046. URL: https://www.cairn.info/revue-projet-2021-3-page-46.htm

122 "Motorcycle MOTs must be implemented, Decision No. 466125", Respire Association et al., 31 October 2022, Council of State, https://www.conseil-etat.fr/actualites/le-controle-technique-des-deux-roues-doit-etre-mis-en-aeuvre

123 Stéphane Grumbach, "Gouvernance numérique et changement climatique", Hérodote, 2020/2-3 (No. 177-178), p. 17-31. DOI: 10.3917/her. 177.0017. URL: https://www.cairn.info/revue-herodote-2020-2-page-17.htm

124 Concepcion Alvarez, " En Chine, 500 manifestations quotidiennes contre la pollution" Novethic, 19 July 2016, https://www.novethic.fr/actualite/environnement/pollution/isr-rse/en-chine-500-manifestations-quotidiennes-contre-la-pollution143976.html

125 Head of the Energy Transition Division in ADEME's Regional Directorate for Hauts-de-France

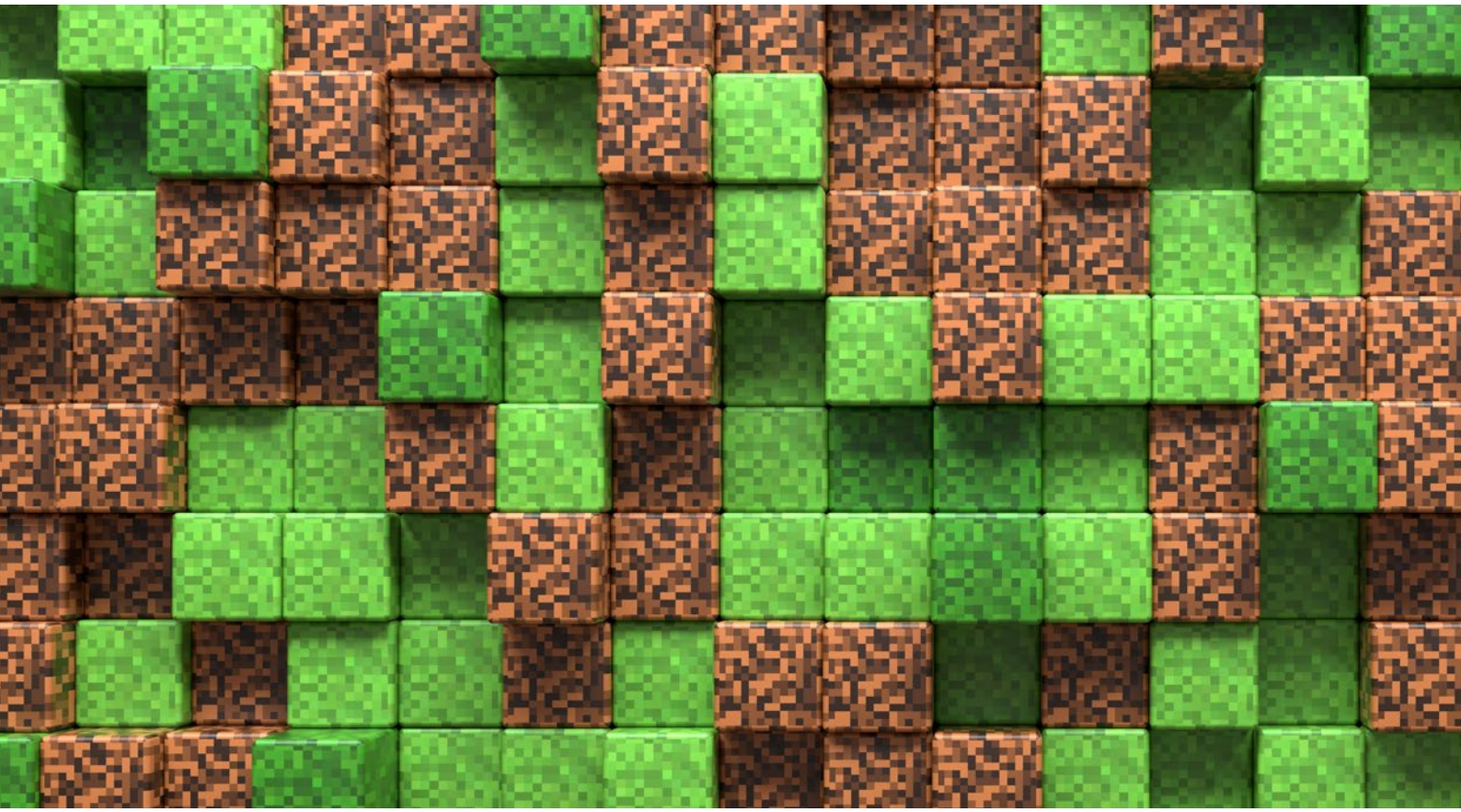
126 Eric Vidalenc et al., "Gouverner la transition écologique, démocratie ou autoritarisme ?", report for La Fabrique Écologique, 2020.

Sharing data to protect the environment

"A-Io had led the world for centuries, they said, in ecological control and the husbanding of natural resources. The excesses of the Ninth Millennium were ancient history, their only lasting effect being the shortage of certain metals, which fortunately could be imported from the Moon."

Ursula K. Le Guin, The Dispossessed, 1974

Sharing data to protect the environment



Although few people agree about the real benefits of digital technology for moving the environmental transition forward, everyone can see value in collecting, using and reusing certain data to better understand, analyse and quantify our impacts, both individually and collectively, as well as take action and make informed decisions.

These environmental data come from various sources. Just like the information produced for managing cities, most of the data will often overlap our personal data.

How can we take advantage of this information for the purpose of serving the general interest without fundamentally undermining individuals' rights? This is one of the objectives that require further investigation. We saw in Part 4 (p. 39) that the use of personal data for environmental purposes may erode individuals' rights or in some cases upset the balance between collective and individual rights.

Adobe Stock

Working on the concept of environmental data and virtuous sharing is an attainable objective, as long as the principles of data protection by design are applied, or provided that we build models and methods for sharing and disseminating data that garner the support and trust of the population[127].

DO ENVIRONMENTAL DATA EXIST?

In a report published in July 2020[128] entitled "Using environmental data to serve the general interest", CNNum offers a definition for the concept of "environ-mental data" that draws its inspiration from various texts. This concept is especially based on the Aarhus Convention of 1998 on "*access to information, public participation in decision-making and access to justice in environmental matters*", and on Article L. 124-2 of the French Environmental Code, which provides an exten-sive definition, i.e. "*any available information, irrespective of the medium*", which relates to the state of elements of the environment and the interactions among these elements (air, atmosphere, water, soil, land, landscape, etc.); decisions and activities likely to affect the elements of the environment (energy, noise, waste, emissions, etc.); the state of human health, inasmuch as it may be affected by elements of the environment; the cost-benefit and other analyses used in decision-making; and the reports issued by the public authorities on the state of the environment.

This broad definition reflects the cross-cutting nature of environmental issues and how they tie into several different fields, including personal data protection. Just like the way in which the CNIL has defined personal health data, CNNum proposes a distinction between environmental data by nature and environmental data by destination[129]. Environmental data by nature include geographic data and metadata that are produced directly for developing knowledge and analysing land use. Environmental data by destination include data that are collected and processed initially for uses that are not directly related, but can provide information about aspects of human activity. This category includes multimodal travel and mobility data, data about water and energy use, and so forth. These environmental data may come from several sources, whether private stakeholders as explained below, or public stakeholders which are already governed by several laws and regulations.

The environmental data (like smart city data) explored in our I&F Report no. 5 *Platform of a city* have the defining characteristic of featuring a wealth of data. They may fall under data protection measures and the GDPR when they are directly or indirectly related to an individual, such as mobility data or health data. The question of sharing these data for the

127 "Qu'est-ce ce qu'une donnée de santé ?", CNIL, https://www.cnil.fr/fr/quest-ce-ce-quune-donnee-de-sante

128 This section is partly taken (including additions and modifications) from an article published on the Linc website: "Environnement : des données, des capteurs et des captés" , Régis Chatellier, LINC, September 2021. https://linc.cnil.fr/fr/environnement-des-donnees-des-capteurs-et-des-captes

129 "Faire des données environnementales des données d'intérêt général", opinion of the French National Digital Council, July 2020, https://cnnumerique.fr/files/uploads/2020/CNNum%20-%20Avis%20Donnees%20environnementales%20d%27interet%20general.pdf

general interest, which we developed in our forward-looking recommendation[130], must be examined in accordance with individuals' rights.

THE WAY TO GET YOUR DATA COLLECTED

Smartphones: an individual weapon of mass collection

The wide variety of environmental data can be attributed to the way in which they are produced and captured. Although large-scale data sensors are being developed and installed to measure temperature and air quality, and identify macro-level changes, smartphones remain a potential source for extremely rich and highly granular data in this area and elsewhere. As described in the first part of this report (p. 5), smartphones come with an especially large environmental footprint. However, they can be used to harvest valuable data for analysing and understanding certain types of environmental criteria thanks to their many sensors. Wired magazine called this method of capturing data *pocketsourcing* to describe the process of "*using smartphones in people's pockets as passive sensors to crowdsource information about their environment.*"[131]

Each of the sensors available in smartphones is capable of collecting data, which Moez Krichen from the ReDCAD Laboratory of the University of Sfax (Tunisia)[132] lists and describes in a research report published in 2021.

These devices can provide information about people's trips, movements and health status (GPS, proximity sensor, LiDAR sensor, step counter, heart rate, etc.), and also directly about their environmental data. Microphones can identify ambient sound levels, and many smartphones are equipped with a barometer. While each smartphone is supplied with an embedded thermometer to check the temperature inside the device and avoid any damage, some are equipped with additional thermometers for measuring the ambient temperature. Rarer still, some smartphones have a relative humidity sensor. In Japan, the SoftBank Pantone 5 smartphone launched in 2012 after the Fukushima disaster was the first (and only?) smartphone with a Geiger counter capable of measuring ambient radiation levels in the surrounding area[133]. At the time, concerned citizens began participating in a radiation mapping process using their own data measurements or republishing data from official websites[134]. In 2020, Google launched the Android Earthquake Alerts System. Smartphone accelerometers are used like mini-seismic sensors to create a global detection network. Location information is sent as soon as the embedded system believes that it has recognised an earthquake tremor[135].

The data collected by smartphones are also used indirectly for urban planning projects and promoting bicycles in the city, which the Strava app proposed back in 2016. Strava, the social media platform for tracking and sharing details about sports activities, has developed Strava Metro for cities and local communities, so that they can access and harness aggregated data on cyclists' trips to improve and upgrade their infrastructures.

That very service hit the headlines in 2018 when heat maps openly published on the platform revealed activities near "secret" military bases. The Waze service has also been offering its Waze Connected Citizen data sharing platform since 2015.

Data are not collected for environmental requirements, but their uses "by destination" qualify them as environmental data, and smartphones are the primary source of capture.

Crowdsourced and personal data collection

Projects that involve crowdsourcing data on ambient noise levels are being developed and made available to the public in the form of apps (NoiseTube, NoiseSpy and WideNoise). These services collect audio data captured by the smartphone's microphone, which are combined with GPS data to create real-time noise pollution maps. Therefore, these sensors are integrated into the digital infrastructures (IT servers, mobile apps, websites, etc.) that have been implemented for circulating, processing and formatting these crowdsourced and/or citizen data.

130 Régis Chatellier, " [IP5] Engager un rééquilibrage privé/public par les données ", LINC, 10 octobre 2017, https://linc.cnil.fr/fr/ip5-engager-un-reequilibrage-privepublic-par-les-donnees

132 *La plateforme d'une ville* (PDF, 1,7 Mo), CNIL, Cahier IP5, Plateforme d'une ville, p. 25

133 Moez Krichen, " Détection des anomalies environnementales via les capteurs des smartphones ", Sfax University - ReDCAD Laboratory, 2021, https://hal.science/hal-03214225

134 Alexandra Chang, *SoftBank Unveils World's First Phone With Radiation Detection*, Wired, mai 2012, https://www.wired.com/2012/05/softbank-unveils-worlds-first-phone-with-radiation-detection/softbank-unveils-worlds-first-phone-with-radiation-detection/

135 Jean-Christophe Plantin, " *The Politics of Mapping Platforms: Participatory Radiation Mapping after the Fukushima Daiichi Disaster* ", Media, Culture & Society, Vol. 37, No. 6, pp. 904-921, 2015, https://ssrn.com/abstract=2797115

136 " *Earthquake detection and early alerts, now on your Android phone* " (en anglais), Google, https://blog.google/products/android/earthquake-detection-and-alerts/

Groups or people looking to shine the spotlight on damage to the environment or the harmful effects on their health already used participatory citizen-driven projects to collect data before smartphones even hit the scene. In a study published in 2010[136] , Gwen Ottinger particularly studied a community-based initiative in Louisiana, US, where Afro-Americans living in disadvantaged areas used air-sampling buckets to collect the ambient air near a factory for subsequent analysis and substantiate their claims about spikes in pollution to the authorities.

These collection methods were called "citizen-based capture" by sociologist Laurence Allard in 2015[137] to describe the practices of "*producing our own capture tools and knowing how to interpret the data under our own control in a secure social-technical scenario.*" People are increasingly using specific devices in addition to their smartphones, since their many sensors vary in quality and cannot satisfy every need. In some cases, mobile phones are paired with extra sensors to monitor such metrics as air quality and UV light, and therefore serve as a "gateway and controller" for collecting and transferring data to remote servers. The data uploaded are then directly related to that person.

The practice of using citizens to capture data has long run into resistance among the traditional and official stakeholders responsible for producing environmental data. Sociologists Sylvain Parasie and François Dedieu[138] point out that "*these digital sensors produce measurements according to processes and standards that bear no relation to those used by official stations, which not only use larger and more expensive equipment, but also a set of metrological processes guaranteed by law and industry professionals. [...] Both in the United States and France, the air quality supervisory authorities have expressed their deep reservations about these measuring devices.*" Their study examines three Californian associations leading projects using citizen science to measure air quality, whose members colla-boratively develop measurement protocols with the Environmental Protection Agency (EPA) and academia. The authors point out that "*calibrating citizen sensors with government stations should convince the official authorities that their measures are sufficiently robust.*" This collaborative arrangement was enabled by California Assembly Bill 1550, which in 2016 required the EPA to ensure that 25% of its climate investments benefit disadvantaged communities. "*[These] citizen sensors [gave] California's officials an opportunity, since they produce air quality measurements across the local population at a much lower cost than building a new official station.*"

The value of this "data activism" practice does not lie in the accuracy of each sensor, even though sensors can be calibrated. Above all, value is created by the widely disseminated sensors and their ability to accurately identify changes in time and space, with measurement levels available on an individual scale. Consequently, this new way of collecting environmental personal data meets individual and collective needs for tackling pollution. It also represents an opportunity for health applications, especially in the field of exposure science, which aims to objectify the actual conditions under which individuals are exposed to pollutants. Whereas traditional pollution measurement practices involved macro and meso-level measurements, these new devices allow for micro-level and localised measurements.

Such systems already exist in France and Europe. Workshops are organised to promote citizen sensors (In Paris with AirCitizen, and in Rennes with LabFab). Since 2018, the LabFab association has been holding workshops to build environmental sensors[139]. LabFab proposes a model based on the Sensor Community sensor (initially developed in Germany), whose measurements are uploaded to a map[140]. In 2020, the association announced that although it did not initially have "*any real guarantees about the reliability of the measurements and therefore the data [...], with over 20 sensors installed by citizens across the city of Rennes, [it] was able to check the quality of the measurements*," particularly by comparing them against official measurements. The Sensor Community project was developed in 2014 as part of the "Code For" initiative spearheaded by the Open Knowledge Foundation (OKF) Germany to promote free data, open-source software and transparency in political life. In 2016, crowdfunding helped the foundation install 300 sensors across Stuttgart, one of the most polluted cities in Germany, where data were thin on the ground. The project has since spread and been translated into 26 languages. Official bodies are beginning to recognise the data produced by such schemes, and the Netherlands' Ministry of the Environment is even using those data for its official maps.[141] In 2020, Atmo Nouvelle Aquitaine in France carried out an exploratory study into the reliability of the proposed sensor.[142] Sensors are also being developed by companies, such as French startup Plume Labs, which markets a handheld pollution sensor combined with a mapping system.

136 Gwen Ottinger, Buckets of Resistance: *Standards and the Effectiveness of Citizen Science, In Science, Technology, & Human Values*, vol. 35, no. 2, 2010, pp. 244-70. http://www.jstor.org/stable/27786204

137 Laurence Allard, "L'engagement du chercheur à l'heure de la fabrication numérique personnelle", Hermès - La Revue, 2015, https://www.cairn-int.info/journal-hermes-la-revue-2015-3-page-159.htm

138 Sylvain Parasie and François Dedieu, "À quoi tient la crédibilité des données citoyennes ?", Revue d'anthropologie des connaissances [Online], 13-4 | 2019, published on 1 December 2019, viewed on 9 January 2023. URL: http://journals.openedition.org/rac/2554

139 "Faire son capteur …et ensuite ?", LABFAB, March 2019, https://labfab.fr/blog/faire-son-capteur-et-ensuite

140 Map Sensor.Community, https://maps.sensor.community/#5/49.604/7.031

141 Samenmeten (in Dutch), https://samenmeten.rivm.nl/dataportaal/

142 " Mesure des particules fines PM10 et PM2.5 par micro-capteurs - Étude exploratoire – 2020", Atmo Nouvelle-Aquitaine, 24 February 2021, https://www.atmo-nouvelleaquitaine.org/publications/mesure-des-particules-fines-pm10-et-pm25-par-micro-capteurs-etude-exploratoire-2020

The health sector is another fertile area for data sharing. In Germany, the Datenspende.de initiative launched by the Robert Koch Institute in April 2020 during the Covid pandemic is a clear example. Citizens download the app and then share the data produced by their smart bracelets and health tracking apps with the institute, such as their heart rate and the number of steps walked every day. This intel is then used to monitor Covid trends over time, as well as identify and map new outbreaks. In 2020 and 2022, some 500,000 people took part in the experiment by consenting to the collection and processing of their health data. A blog publishes regular reports so that contributors can see the purposes for which their data have been collected and processed.

In terms of mobility, the Fabrique des Mobilités asso-ciation has developed the TraceMob app, which was trialled in La Rochelle, to allow its users to collect their mobility traces and create a trip history with a view to sharing their information with the local authorities, who can harness the data to plan their infrastructures and transport services more effectively, while respecting users' privacy. This type of initiative straddles the dividing line between citizen participation, the quantified self phenomenon and incentives, insofar as the data are associated with personal accounts and incentive mechanisms (p.41).

Transparency by design

All these devices and initiatives overlap personal data collection to varying degrees. When sensors are paired with a smartphone, IP address or personal address, the data produced are covered under personal data protection measures and protection of freedoms, and therefore the GDPR, if the measured variable reveals something about the natural person using the phone. The environmental usages ("by destination") of certain data, such as the mobility data collected by dedicated apps, must comply with the legal framework governing their transfer and processing. There must be a legal basis for those processing operations. At the very least, there must also be information for users, anonymisation and/or compliance with data subjects' rights. In all cases, the different systems and their purposes must be transparent before citizens can agree to share their data.

Although the voluntary and activist nature of community-driven sensor networks may persuade people to understand and accept, and even collaboratively define the privacy policies for these solutions, the development of crowdsourced and citizen-based data collection processes must spread beyond the boundaries of activism to achieve critical mass. New people can only be convinced by implementing systems whose direct or indirect added value is clear to see, and whose design is not only transparent but capable of protecting their personal data. In any event, the scale and duration of the collection process largely depends on the manner in which data are aggregated and reused, which again highlights the key role played by the way (governance, platforms, stakeholders, etc.) in which data are centra-lised or exposed in the system.

DIFFERENT CIRCULATION AND GOVERNANCE MODELS

Data: fuel for the environmental planning process?

Certain historical events have brought long forgotten terms out of the past and into modern-day public and political messages. The Plan and especially environmental planning have once again become "*urgent obligations.*[143]"

Post-war planning in France is a state policy that endeavours to organise national production and state-owned companies according to a set of objectives defined by a centralised organisation. This organisational principle lost momentum and culminated in the end of the Planning Commission in 2006. But the term made its comeback in September 2020 when the position of High Commissioner for Planning was created, and was widely echoed during the 2022 presidential campaign. The General Secretariat for Environmental Planning was established in June 2022. These developments show signs of renewed interest in this method for organising the public authorities, whose effectiveness is largely based on the ability to collect the data required for a centralised management system.

Therefore, combining digital technology, data and environmental planning in 2023 would be tantamount to designing and organising data collection and circulation processes (according to both a centralised and decentralised arrangement) so that

143 "The objectives to be determined by the Plan [...] constitute an urgent obligation for all French people," (translated) Charles de Gaulle (1890-1970), radio/TV speech, 8 May 1961

the authorities can measure, predict and therefore plan. What is known as planning is not only confined to the government or public stakeholders. Companies use similar methods to sense their needs and anticipate their objectives, as explained by Razmig Keucheyan and Cédric Durand in their article entitled Planning in the age of algorithms[144], such as using ERP systems, which are "*essential support systems by providing managers with an overarching and consistent view of the company's business activities and strengthening their ability to take control in real time,*" associated with indicators for tracking the extent to which objectives have been achieved. Therefore, planning has become something of a generic word that encompasses any desire to anticipate, predict and adapt. The Covid pandemic and the craze for figures and statistics were a real-life example that featured an unprecedented level of communication between the government and the public. Consequently, the ability to control data is becoming a decisive issue for the stakeholders concerned, especially public authorities.

In stark contrast to post-war planning, a large part of the meaningful data is first produced by private stakeholders, while public authorities increasingly organise their own access to private data instead of setting up ad hoc infrastructures, which raises question marks about transparency (a public action requirement) and the protection of trade secrets. In this context, the public sector tends to lose control over some of the data that would be useful for "planning", such as spatial planning, as we already mentioned in I&F Report no. 5 in 2017. We proposed the idea of "*restoring the private/public balance through data*" when new smart city services - and now all services - rely on personal data that are collected and processed for a commercial service by private firms. Data "*that do not fall within the organic scope of the Public Service (direct governance, concession, etc.) [...] strongly interact with public service issues or are even valuable for fulfilling public service missions,*" for the environmental transition or even "environmental planning". Of the four scenarios, the LINC suggested the idea of extending the concept of general-interest data developed in the Digital Republic Act 2016, which was restricted to public utility companies, to include private stakeholders without any contractual ties to the community. This scenario involved complementary solutions for private stakeholders to provide data on a contractual basis, using technical sharing platforms and citizen portability processes. Other avenues for exploration are included in the CNNum report, which proposes incentives for private sector data (by project or contract), as well as taxation measures either stipulated in legislation or adopted through case law.

Many texts in France and Europe are already planning to regulate the movement of public data, and also the sharing of private data with the public sector.

French and European initiatives

In France, the Digital Republic Act 2016 has helped regulate the policies for open data and also data sharing and reuse. Other texts have supplemented the Act, such as the Digital Roadmap for the Environment published by the Ministry of Ecological Transition in February 2021. The government was considering "*promoting the emer-gence of common data spaces to ramp up data sharing practices between the private and/or public actors*", especially to "clarify public policies through data, particularly in such key sectors as agriculture, mobility/logistics and the circular economy." The government was also keen to "*pursue an action plan to mobilise additional environmental data sources to consolidate the public environmental databases managed by ADEME.*"

Article 109 of the law of 22 August 2021, known as the "Climate and Resilience Act", requires digital mobility actors to share their data with the public authorities responsible for managing and planning transport. Other agencies have specific authority on this particular subject and collect data from companies explicitly for environmental purposes, such as Arcep (see p. 9), which produces a "report on the digital carbon footprint" in line with the authority granted by the law of 23 December 2021[145] and collects data agglomerated by the digital actors concerned.

In September 2021, the Ministry of Ecological Transition, Ministry for Territorial Cohesion and Relations with Local Authorities, and Ministry of the Sea published a "Data, algorithms and source code roadmap" containing a series of objectives aimed at "*exploiting data to lead more relevant and efficient public policies*", "*share data, algorithms and source code to strengthen the environmental impact of public policies*" and "*promote the widespread use of data, algorithms and source code to improve transparency in public action and encourage innovation.*" This roadmap is supported by the Ecolab innovation laboratory within the Sustainable Development Commission (CGDD), with the priority of "*organising and successfully sharing datasets with local authorities, public operators, companies, associations, digital commons (e.g. OpenStreetMap and Open Food Fact) and private individuals.*"

144 "The objectives to be determined by the Plan [...] constitute an urgent obligation for all French people," (translated) Charles de Gaulle (1890-1970), radio/TV speech, 8 May 1961

145 Cédric Durand, Razmig Keucheyan, "Planifier à l'âge des algorithmes", Actuel Marx, 2019/1 (no. 65), p. 81-102. DOI: 10.3917/amx.065.0081. URL: https://www.cairn.info/revue-actuel-marx-2019-1-page-81.htm

These examples are by no means exhaustive, but they demonstrate that the French state, like the local autho-rities, deploys strategies to ensure control over key environmental data and exploit those data to move the environmental transition forward. This involves assessing data protection risks on a case-by-case basis and adopting the necessary mechanisms to protect individuals' rights

On a European level, similar initiatives are being developed, especially European data spaces, four of which are directly related to environmental issues (Green Deal, Mobility, Energy and Agriculture)[146].

Data altruism in search of incentives

In Europe, the INSPIRE Directive is aimed at establishing an infrastructure for spatial information in the European Community to promote environmental protection (2007), in line with the 1988 Aarhus Convention. The Data Governance Act (DGA), which was adopted in May 2022 and is due for implementation in September 2023, also makes provisions for setting up rules and mechanisms for "data altruism", meaning that "*data are made available without reward for purely non-commercial usage that benefits communities or society at large. [...] The objective is to create the right conditions for individuals and businesses to trust that when they share their data, it will be handled by trusted organisations, based on EU values and principles.*" Environmental data, by nature or by destination, could fall within this framework. The directive sets out two main conditions for qualifying this method of data sharing as altruistic: it must be without a reward and *it must be for purposes of general interest*. In the case of personal data, sharing is subject to specific consent.

The directive proposes creating a register of "altruistic" organisations approved by the public authorities. These are the public or private actors, and sometimes associations, that may become the recipients of the data for projects and data processing operations for purposes of general interest. This data altruism mechanism has especially been prompted by the observation that the constraint for private actors to share their data is not the only option, but that a more incentivising mechanism based on data subjects' consent and intended for non-competitors could facilitate the movement of data for the general interest. The DGA also provides for supervising "data-sharing intermediaries", whose objective is to establish a business relationship between several types of persons, namely between data holders and data users (e.g. B2B data exchange platforms), between data subjects and users (e.g. personal information management systems), and with data cooperatives (e.g. data pooling for joint management).

These mechanisms and the various possibilities offered by the tools within the *Data Governance Act* draw part of their inspiration from the projects in the MyData ecosystem, particularly for data-sharing intermediaries, which the CNIL and LINC have been following since its inception in 2016. International non-profit MyData[147], which particularly aims to promote the tools and solutions that "*empower individuals with their personal data, thus helping them and their communities develop knowledge, make informed decisions and interact more consciously and efficiently with each other as well as with organisations.*"

In terms of the link between data altruism and data protection, the EDPB issued a joint opinion in 2021 containing a few concerns about the way in which the purposes of general interest are defined, insofar as the definition is used to determine whether organisations are data altruistic. The EDPB warned that this "*lack of definition may lead to legal uncertainty, as well as to lower the level of protection of personal data in the EU,*" since the general interest is not in itself a purpose within the meaning of the GDPR, and consent cannot be applied in a general manner. The EDPB opinion makes provisions for establishing a consent form. Its implementation and its link with the specific and unequivocal nature of consent are prerequisites for the success of these new mechanisms and gaining support from data subjects.

The other challenge facing the *Data Governance Act* and data altruism lies in the ability to encourage private stakeholders to pave the way for sharing their data for the general interest, without any obligations attached. The text provides for the possibility of counterbalancing the costs of making data available, and even economic incentives for sharing data by private actors. All these models still need to be defined and developed. In February 2023, the CNIL published an economic study on data-sharing intermediaries[148] and the way in which the rule of economic neutrality for intermediaries could be translated in order to obtain a "trusted third party" label. Several business models are viable and correspond to several configurations for suppliers and customers. When developing these solutions, the idea is to provide legal certainty, a clear vision of interoperability, and specific action to facilitate the right to data portability, both for data subjects and public / private actors. As such, environmental data are use cases that warrant further exploration.

146 "Commission staff working document on Common European Data Spaces", European Commission, February 2022, https://ec.europa.eu/newsroom/dae/redirection/document/83562

147 "MyData, https://oldwww.mydata.org/declaration/

148 "Les enjeux économiques de la mise en œuvre du règlement sur la gouvernance des données", CNIL, February 2023, https://www.cnil.fr/fr/les-enjeux-economiques-de-la-mise-en-oeuvre-du-reglement-sur-la-gouvernance-des-donnees

Data commons to the rescue

Creating environmental data commons is the third pathway to sharing data for the general interest. Such commons could lead to organisational and governance models that are conducive to encouraging sharing and building trust in the system.

Elinor Ostrom, a US political scientist and economist, and the first woman to receive the Nobel Memorial Prize in Economic Sciences in 2009, theorised about the "commons"[149] based on natural resources, by proposing common methods for managing these limited resources through a collective organisation to prevent them from being over-exploited. This concept has since been applied to digital technology and so-called "digital commons", the most successful examples of which are Wikipedia and OpenStreetMap. The 2020s could see both applications merge into "environmental data commons".

A defining feature of commons-based management is the provision of collective resources that are managed according to shared governance rules by all stakeholders, who establish a common set of management rules. Therefore, data do not fall within the public data system managed by the state or under the market regime. Digital commons consider the data produced and their use to be a form of common control and management of the data concerned. Bundles of rights are associated with the commons and determine the access and usage rights for stakeholders wishing to access the resource[150]. Finally, an organisation is specifically appointed to manage the commons and the associated rights. However, the main difficulty in setting up such spaces is creating or supporting stakeholders who are capable of producing the rules, maintaining the infrastructures and delivering advice. Developing commons not only requires a consensus, but also investments leading to tangible initiatives for scaling up these practices.

The initiative launched by the IGN (National Institute of Geographic and Forest Information) in 2021 could be used as an example. After opening its data in 2021, the IGN launched an initiative to build geo-commons, meaning *"a set of spatial information databases (production) and digital tools (dissemination) available to the widest possible audience."*

These environmental data (by destination, according to CNNum's typology) are intended to be produced, disseminated and managed collectively by a community in line with a set of governance rules, while relying on the operational capacities of an established player. The Ministry of Ecological Transition also considered this prospect in its 2021 Digital Roadmap for the Environment: "*accelerate the creation of common data spaces in the environmental, logistics and agricultural sectors.*" Initiating processes for sharing environmental data for the general interest raises the same issues as sharing urban or health data. Environmental data cover a wide range of fields, meaning that the resources and mechanisms implemented to collect and process data are also varied. Sharing, opening and creating data is not without its risks for the protection of data and freedoms, especially when citizens are used as sensors, whether proactively or even more without their direct knowledge. In this area and elsewhere, data protection considerations should not be seen as a hindrance, but as a driving force for engaging citizens and ensuring their support.

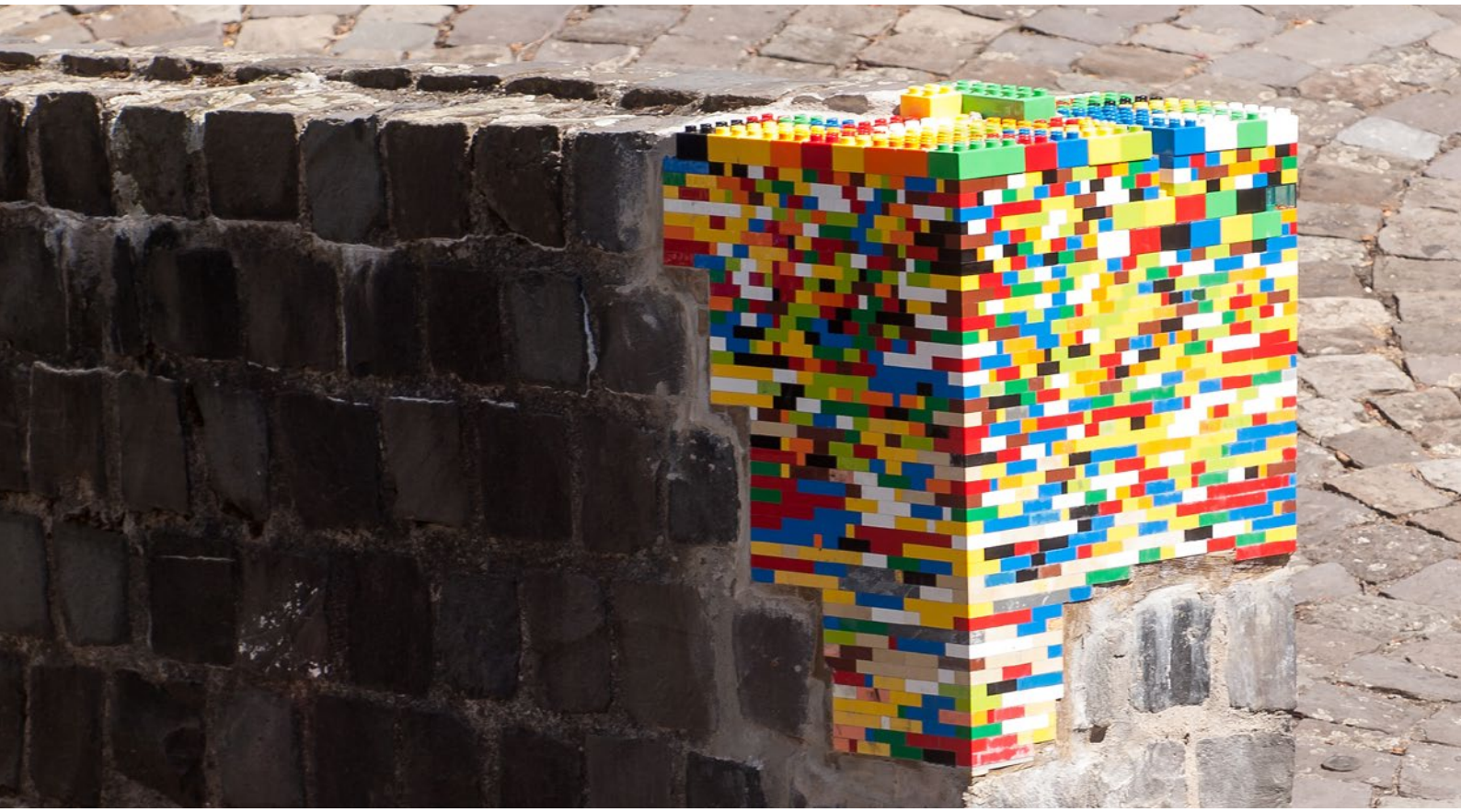
149 Elinor Ostrom, *Governing the Commons: The Evolution of Institutions for Collective Action*, Cambridge University Press, 1990
150 ibid.

Pathways for combining data protection with environmental protection

"No one is too small to make a difference and change the world, so do what you can."

Greta Thunberg (2019)

Pathways for combining data protection with environmental protection



PROMOTE DIGITAL SOBRIETY AND FRUGALITY

As we have seen in this report, considering data protection as a natural way of fully protecting the environment is a shortcut that should be avoided at all costs.

However, based on their understanding of the measures needed to comply with the GDPR, data controllers (companies, public organisations, associations, etc.) find useful ways of implementing systems with a lower footprint, particularly by looking to produce data-frugal systems through minimisation, and robust systems to restrict flaws and data leaks. Similarly, thinking about data safety and data availability is not inherently inconsistent with the search for greater environmental performance. As we will see later, ecodesign principles can also play a contributory role. In addition, one of the major challenges with modern IT is deciding between efficient and rapid developments, which are increasingly associated with so-called "agile" methods, or controlling the legacy left behind by these

Adobe Stock

developments, which can often lead to maintaining obsolete systems running on dedicated machines. From a systems administration point of view, the same contradiction exists between the desire for architectures that are easier operate (such as dockers) and the guarantee of higher availability, which implies a more complex set of underlying technology (virtualisation, orchestration, redundancy, etc.).

In response to these challenges, some practices can be promoted, such as streamlined functionality to ensure that systems are properly scaled, reviewing and even opening code to ensure its effectiveness, and making moderate and controlled use of libraries and off-the-shelf components.

Since its creation, the CNIL has been lobbying to ensure that IT is available to all sections of society and designed as an additional service for each citizen. By making provisions for a mechanism for authorising certain processing operations (registration numbers in the National Directory for the Identification of Natural Persons, files in interconnected systems, etc.), the French Data Protection Act was even initially intended to prevent certain types of processing activities perceived as dangerous. More recently, the CNIL regularly pointed out the need to provide an alternative to digital services aimed at the entire population to avoid any form of digital exclusion. This history of regulating IT and limiting its impact strikes a chord with the first stage of the general standard for digital services ecodesign: "*Avoid unnecessary digital services: if the digital service is not in line with at least one of the Sustainable Development Goals (SDGs), one of the targets for limiting the global impact, or any other such framework, then all the environmental impacts that it generates are futile and should be avoided.*"

Therefore, IT projects could first be assessed as a pure opportunity by evaluating whether their contribution has a positive effect on environmental issues or whether a non-IT alternative could provide the same service without an environmental impact. If the opportunity is confirmed, an approach using minimal functionality and applications could be pursued to ensure that any impact is as limited as possible.

STRENGTHEN AND DOCUMENT SECTOR-LEVEL BEST PRACTICES AND ENSURE INTEROPERABILITY

Bring ecodesign, data protection and cybersecurity practices closer together

The workshop that DINUM held in 2022 with ecodesign, data protection and cybersecurity professionals (see p. 36) determined that there is no contradiction between these three practices of digital services. Each of the three

approaches is based on the need to practise them "by design". If the constraints involved in protecting data and ensuring cybersecurity are incorporated into ecodesign practices, they could have the upside of making sure that all these issues are taken into consideration, which in turn would benefit each of the objectives. This would involve strengthening the links between the three approaches for managing digital projects and services from a holistic point of view by considering all their aspects, through the use of interoperable common tools and standards, particularly the general security standard (RGS), the general interoperability standard (RGI), the general standard for digital services ecodesign (RGESN), and obviously the General Data Protection Regulation (GDPR).

A project to integrate these different needs, as part of a strategy involving minimal functionality and applications, could combine the virtuous effects on all the objectives and the footprint of the digital services concerned.

Align the "environmental regulation of electronic communications" with data protection

Article 25 of the law aimed at reducing the environmental footprint of digital technology in France (REEN) builds on the Postal and Electronic Communications Act with a section on the "environmental regulation of electronic communications". This section specifies that Arcep, Arcom and ADEME shall "*define the content for a general standard for digital services ecodesign*," which will particularly concern "*the display and reading of multimedia content for limiting the use of strategies aimed at capturing the attention of digital service users.*" This standard and these ecodesign criteria could explicitly include the data protection provisions associated with this framework, particularly the recommendation about cookies (refer to "Assessing the impact of technology and practices on the environment", p. 26), but also misleading designs - especially on social media - which encourage users to share more data and generate what are sometimes unwanted processing activities. Therefore, the CNIL could be more directly involved in developing the standard and would be able to align it with its recommendations on cybersecurity and personal data protection.

Document best practices for repairing and reconditioning devices

Since devices are responsible for producing a major part of the digital carbon footprint (see p. 9), promoting repair and reconditioning practices should be a priority. Public and private organisations are adopting such processes, such as by allowing their employees to take back hardware, or by selling or giving away their used digital devices. In the public sector, Article 7 of the REEN Act of November 2021, which aims to reduce the environmental footprint of digital technology in France, states that "*government services or local authorities and their groups looking to dispose of their functional IT equipment shall prioritise reuse or recycling.*" However, transferring and reusing PCs, smartphones and other devices must comply with data protection regulations. Therefore, guides, best practices and tools[151] should be provided to organisations to help with erasing the data on their electronic devices.

Similarly, openly providing the appropriate document-tation, methods and tools for repairing electronic devices should be high on the list of priorities for digital technology professionals, particularly manufacturers.

Frugal use of artificial intelligence

Artificial intelligence continues to make greater inroads into digital technology and our societies as we realise the need to push ahead with the environmental transition. Opinions differ about whether AI uses resources or holds the solution, just like IT in general, and the overall impact of AI and its integration remains to be assessed. However, industry players, designers and users would benefit from moving towards the frugal use of AI systems as soon as possible.

In this respect, embedding criteria into AI-labelling projects is one of the best practices. For example, Labelia Labs has inserted into its "Assessment frame-work for responsible and trustworthy data science"[152] a section aimed at "*Anticipating, monitoring and minimising the negative external impacts on the data science activity.*"

Various solutions have been proposed to reduce the environmental impact, and one Google engineer has come up with the 4M strategy[153]: Model: select efficient ML model architectures that are known for using less energy; Machine: use processors and systems optimised for ML training;

151 In particular, ANSSI awarded certification to the Blancco data erasure software in 2021 https://www.ssi.gouv.fr/entreprise/certification_cspn/blancco-drive-eraser-version-6-12-0/

152 "Data science responsable et de confiance - Référentiel d'évaluation", GitHub, https://github.com/LabeliaLabs/referentiel-evaluation-dsrc

153 "Good News About the Carbon Footprint of Machine Learning Training", ai.googleblog.com, 15 February 2022, https://ai.googleblog.com/2022/02/good-news-about-carbon-footprint-of.html

Mechanization: promote cloud computing with data centres that are often better optimised than on-premise servers; Map Optimisation: pick the location for processing operations according to energy performance, and particularly the energy mix used by the data centres. This idea of choosing the location for algorithmic processing dovetails with the data location constraints laid down in the GDPR. In addition, data centres could contribute by offering incentivising pricing schemes based on when computing power is used. Solutions are also available for measuring the impact of training and predicting algorithms, such as CodeCarbon[154], a Data For Good project initiated by Yoshua Bengio, who won the Turing Award for his founding work on Deep Learning, or the MLCO$_2$ Impact[155] launched in Quebec.

Machine learning solution designers should publish their energy consumption and carbon footprint as a way of encouraging competition between different learning models and allowing users to make informed decisions. In this regard, a variation of the lifecycle analysis that has been adapted to training and using learning algorithms could facilitate this type of publication. These publications could either be voluntary or required by law, such as the regulation that granted Arcep authority in 2020 to collect data from telecommunications operators. In 2023, the CNIL set up a dedicated artificial intelligence department within its Technology and Innovation Division. This department could incorporate these different approaches and criteria into its focus sessions and actions alongside data protection.

DEVELOP DISCUSSIONS ABOUT FREEDOMS AND TRANSPARENCY

Develop discussions about freedoms during the climate crisis

As we saw in Part 4 (p. 39), the protection of personal data and freedoms is already balanced with other rights.

This issue of balancing rights and freedoms could change as governments grapple with the climate crisis by proposing to bring in legislation and/or solutions aimed at regulating people's behaviour based on their personal data, or even restricting their right to free movement, which was exemplified during the Covid pandemic. Public authorities could then claim that they are acting in accordance with the accountability principle by developing tools for monitoring or limiting behaviour and use. In this case, a real debate would be needed to collectively assess how people could waive certain freedoms, given that both the "Red Caps" and "Yellow Jackets" protest movements were sparked as a rejection of the government's environmental policies.

These discussions could be carried out on an ongoing basis or, in the case of personal data, as and when cases are referred to the CNIL. However, projects would benefit if they were assessed and discussed from the outset with all interested parties, such as using impact assessments. Establishing a sustainable framework and system for dealing with climate emergencies and, more widely, the environmental transition is a prospect for preventing and regulating schemes and measures with an impact on freedoms, like a bill that was not presented before parliament and for which the Council of State issued an opinion in December 2020[156] . An interesting feature of the bill was that it provided a framework for anticipating crises with varying levels of intensity, complete with an associated set of measures. The analysis framework had to consider the extent (and accuracy) of the threat, the duration for which measures would be required, and their proportionality. The framework law established a form of proportionality control over a catalogue of potential measures, which should be actioned through implementing decrees, where such control would be exercised by the administrative judge on a case-by-case basis. Initiating such an approach for environmental issues, not only to deal with climate emergencies, but also to implement long-term solutions, could shine greater light on those issues and help reach a form of consensus - especially if they are combined with citizen convention-type processes from the outset - and thereby prevent risks to freedoms and the risk of seeing the corresponding measures rejected by parts of society or even triggering protests at a time when those very measures are needed.

Adopt truly experimental strategies a nd produce reliable impact assessments

Although the challenges associated with the different projects that could occur are prospective, the CNIL's experience in other areas compels us to issue a warning about project leaders using experimentation and instead push for the adoption of sincere experimental strategies.

154 "CodeCarbon, https://codecarbon.io/
155 ML CO$_2$ Impact, https://mlco2.github.io/impact/
156 "Avis sur un projet de loi instituant un régime pérenne de gestion des urgences sanitaires," Council of State, 21 December 2020, https://www.conseil-etat.fr/avis-consultatifs/derniers-avis-rendus/au-gouvernement/avis-sur-un-projet-de-loi-instituant-un-regime-perenne-de-gestion-des-urgences-sanitaires

Experimental processes should be put in place that involve a limit on their duration and scope, an accurate identification of the objectives pursued, their criteria for success and, in the case of the environment, a measurement of their benefits but also any negative external impacts. The definition for these assessment methods should be rigorous, multidisciplinary, conducted within a reasonable time and involve an agreement by all interested parties.

Similarly, impact assessments should fall within the same framework and guide politicians with the necessary choices in full knowledge of the facts with the aim of measuring the consequences of their decisions, which may sometimes appear to be remote as in the case of digitising till receipts (see box on p. 34).

The CNIL would have a role to play in its corresponding missions, but the idea would also be, as recommended by the Council of State in a study in 2019[157], to engage the widest possible audience: "*the public, civil servants, elected officials, trade organisations, trade unions and relevant associations [should be] involved as far as possible in carrying out experiments while ensuring the greatest transparency.*" The transparency and legibility of such experiments could, on the one hand, gauge the level of support among the population, especially when people are directly affected, and on the other hand raise awareness about environmental issues and the consequences of certain decisions on their daily lives.

Initiate citizen consultation processes on the use of data to drive the environmental transition

The Citizens' Convention for Climate in 2019, which included 150 randomly selected participants representing the full diversity of French society over six weekends of three days, demonstrated that solutions can be developed collaboratively with the population. Based on a similar model, the French Ministerial Delegation for eHealth led a "citizen's committee for e-health" in 2021 in the form of a citizens' assembly to produce a report on the "My health space" project.

In its I&F Report no. 7 on civic tech[158], the CNIL has the opportunity to issue recommendations about the use of technologies for organising public debate and online citizen participation by pushing for hybrid high-tech and low-tech systems to enhance public discussions. Such forms of discussion are also aimed at preventing "*social media from becoming the official platforms for political participation.*"

The idea is to set up processes and platforms for partici-pation while giving special consideration to transparency and users' rights, with regard to individuals' rights, but as we have seen above, the aim is also to ensure transparency about the actual solutions and their different effects and impacts in order to collectively engage the population in the transition and thereby make sure that choices are truly based on full knowledge of the facts.

PROVIDE THE MEANS FOR VIRTUOUSLY SHARING ENVIRONMENTAL DATA

Propose solutions for virtuous data sharing

As discussed on p. 39 in Part 4, sharing data for environmental purposes is a valuable way for public and private stakeholders involved in the environmental transition to assess, measure and implement public policies and/or actions and projects.

In 2022, the CNIL launched a working group on freely accessible online data with the aim of defining the guidelines for their reuse in accordance with individuals' rights. This working group is continuing its mission in 2023 by establishing the data sharing framework with the objective of producing soft law elements that will serve as a guide for organisations wishing to engage with the process. Many regulatory projects already pave the way for sharing data across France and Europe, and others will not fail to be enacted. The purpose of the Data Governance Act (see p. 55) is to allow for the movement of data, with data altruism, data-sharing intermediaries and a "European consent form". The Data Act also provides for sharing private sector data with public actors under certain conditions.

Organisations will benefit from a clearer framework and tools enabling them to engage people and businesses in a virtuous data sharing mechanism. The CNIL has a role to play by producing the tools, recommendations and even guidelines to support virtuous data movement processes that

157 "Améliorer et développer les expérimentations pour des politiques publiques plus efficaces et innovantes", Council of State, 3 October 2019, https://www.conseil-etat.fr/actualites/ameliorer-et-developper-les-experimentations-pour-des-politiques-publiques-plus-efficaces-et-innovantes

158 Civic tech, data and demos (PDF, 4 MB), LINC, https://linc.cnil.fr/sites/linc/files/2023-08/cnil_ip_report_06_civic_tech_data_demos.pdf

Clarify the data protection authorities' position on data commons

Data commons are sometimes claimed to be incompa-tible with data protection rules, as if there were a natural form of antagonism between both concepts. Yet data commons, as a process for implementing a shared data governance system between organisat-ions and/or individuals, involve producing transparent internal rules for participants that can be negotiated in a way that is specific to each common. Data protection principles are not incompatible with this ambition.

The most sensitive issue in the various commons projects involving personal data relates to the application of the principle of defining a purpose for processing personal data. These types of projects naturally have many and varied purposes for processing personal data in order to derive maximum value from the common created. When applied to personal data, managing a common leads to questions about the governance structure to set up contract-based acceptance systems for all or part of the purposes, associated with consent mechanisms where necessary.

CONTINUE THE CNIL'S ENGAGEMENT WITH ITS ENVIRONMENTAL TRANSITION

Pursue the initiatives within the sustainable development action plan launched in 2021

As early as 2020, the CNIL began taking tangible steps and actions to lead its environmental transition ambitions. The CNIL's action plan is specifically aimed at "Promoting sustainable mobility" by setting up a bicycle plan or sustainable mobility package. The action plan is also focused on reducing the CNIL's paper use, minimising plastic waste, improving waste sorting practices and lowering electricity use.

It also includes a digital component that has been formalised in a working group called "*Reviewing our IT and digital practices*". As such, the CNIL has extended the service life of its agents' laptops to five years, and they also have the option of owning a computer when IT assets are renewed, which extends the equipment's lifetime even further.

The working group has also taken action to raise awareness among agents about their digital uses and propose real-life actions promoting sustainable digital use. Building on this action plan, the CNIL (which had over 250 agents in 2022) will carry out its greenhouse gas emissions audit as stipulated and governed by Article L. 229-25 of the French Environmental Code, and will produce a "*voluntary action plan to reduce GHG emissions every three or four years.*"

Start work on assessing the footprint of the CNIL's recommendations

Where the CNIL is required to issue recommendations on technology and practices, it could start examining and developing ways of assessing the environmental impact of those recommendations.

The CNIL recommends encryption as a core technology for ensuring data protection and security. However, encryption methods require computing power, which leads to extra energy consumption. In its recommenddations, the CNIL could push for the most virtuous solutions from this point of view without undermining data protection, such as by indicating recognised criteria for each of the recommended methods. Similarly, as we saw earlier, these elements could be included in recommendations relating to other technological fields, such as artificial intelligence or cloud data storage and processing.

If it does not possess the in-house skills to carry out these types of measurements and assessments, the CNIL could use the external evaluation grids produced through research, and partner with stakeholders who are capable of conducting real assessments.

Add an environmental dimension to the CNIL's decisions

The CNIL's Board could add an environmental dimension to its decisions, in addition to examining digital projects in terms of their legality and compliance. The CNIL regularly introduces observations and an ethical component into its decisions and opinions when analysing legal and technological compliance. This move would give greater focus to

elements that are not directly within its remit and area of responsibility. For example, the CNIL could point out that a mechanism, although legally compliant and beyond the CNIL's control, raises ethical questions that warrant a further investigation by the project's sponsors.

Similarly and whenever appropriate, the CNIL could include environmental aspects when required to examine systems and issue an opinion.

The **Foresight** Committee

The CNIL hosts a committee of 21 experts with varied backgrounds and profiles to enrich forward thinking and contribute to the debate on digital ethics. Being more attentive and open to the outside world, and working in partnership with the world of research and innovation, these are the objectives pursued by the CNIL with this Committee.

Chaired by the President of the CNIL, **Marie-Laure Denis**, the committee is composed of the following members:

EXTERNAL EXPERTS

Pierre Bellanger,
Pioneer of free radio, entrepreneur and Internet expert.

Pierre-Jean Benghozi,
Emeritus Director of Research at the National Centre for Scientific Research (CNRS) and Ecole Polytechnique.

Françoise Benhamou,
Economist, Emeritus Professor at Sorbonne Paris North University and Sciences Po Paris, President of the Cercle des Économistes.

Stefana Broadbent,
Psychologist, anthropologist, associate professor in the design department of the Politecnico di Milano.

Isabelle Bordry,
Entrepreneur, pioneer in the French digital media industry.

Dominique Cardon,
Sociologist, Scientific Director of the Médialab of Sciences Po Paris, member of the editorial board of the Réseaux journal.

Xavier de La Porte,
Journalist, radio producer, particularly the podcast “The code has changed” on France Inter.

Milad Doueihi,
Philosopher, historian of religions.

Célia Hodent,
Psychologist specialising in the application of the user experience in video game design.

Claude Kirchner,
Director of Research at Inria, Director of the Comité national pilote d’éthique du numérique (CNPEN), advisor to the Chairman of Inria.

Philippe Lemoine,
Entrepreneur and essayist, Chair of the Action-Modernities forum.

Lionel Maurel,
Deputy Scientific Director at the National Institute of Humanities and Social Sciences of the CNRS - InSHS Institute of Human and Social Sciences, author of the S.I.Lex blog on the transformations of law in the digital age.

Cécile Méadel,
Sociologist, Professor at Panthéon-Assas University, head of the Communication and Multimedia Master’s degree. Researcher at CARISM, associate researcher at the Centre for the Sociology of Innovation (Mines-CNRS).

Tristan Nitot,
Entrepreneur, author and speaker on the subject of digital freedoms, founded and chaired Mozilla Europe.

Éric Pérès,
Secretary-General of FO-Cadres, member of the Economic, Social and Environmental Council (ESEC).

Antoinette Rouvroy,
Lawyer, FNRS researcher at the Centre de Recherche Information, Droit et Société (CRIDS) in Namur.

Henri Verdier,
French Ambassador for Digital affairs.

Nicolas Vanbremeersch,
Entrepreneur, President and Founder of Spintank, President of Renaissance Numérique.

Célia Zolynski,
Associate Professor of Private Law at the Sorbonne Law School - University of Paris 1 Panthéon-Sorbonne - Qualified personality at the CNCDH and the CSPLA, Member of the National Digital Ethics Committee.

MEMBERS OF THE CNIL

Bertrand Du Marais,
Councillor of State.

Valérie Peugeot,
A researcher in the Orange Labs social and human sciences laboratory.

The Innovation and Foresight Reports Collection

Within the CNIL's Technology and Innovation Department, the Innovation, Studies and Foresight team leads research projects and explores emerging topics related to personal data and privacy. Its work lies at the crossroads of innovation, technology, practice, society, regulation and ethics.

The purpose of the Innovation and Foresight reports is to present and share the work and foresight studies carried out by the CNIL. The aim is to contribute to multidisciplinary and open discussion in the field of Data Protection and to fuel debate on digital ethics subjects.

This is the ninth publication in the collection:

I&F REPORT No. 1 - Privacy towards 2020
Paroles d'experts.

I&F REPORT No. 2 - Bodies are the new smart object
From quantified self to m-health: the new territories of the data world.

I&F REPORT No. 3 - Data, muses and borders of creative arts
Reading, listening, watching and gaming in the age of personalisation.

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June 2023
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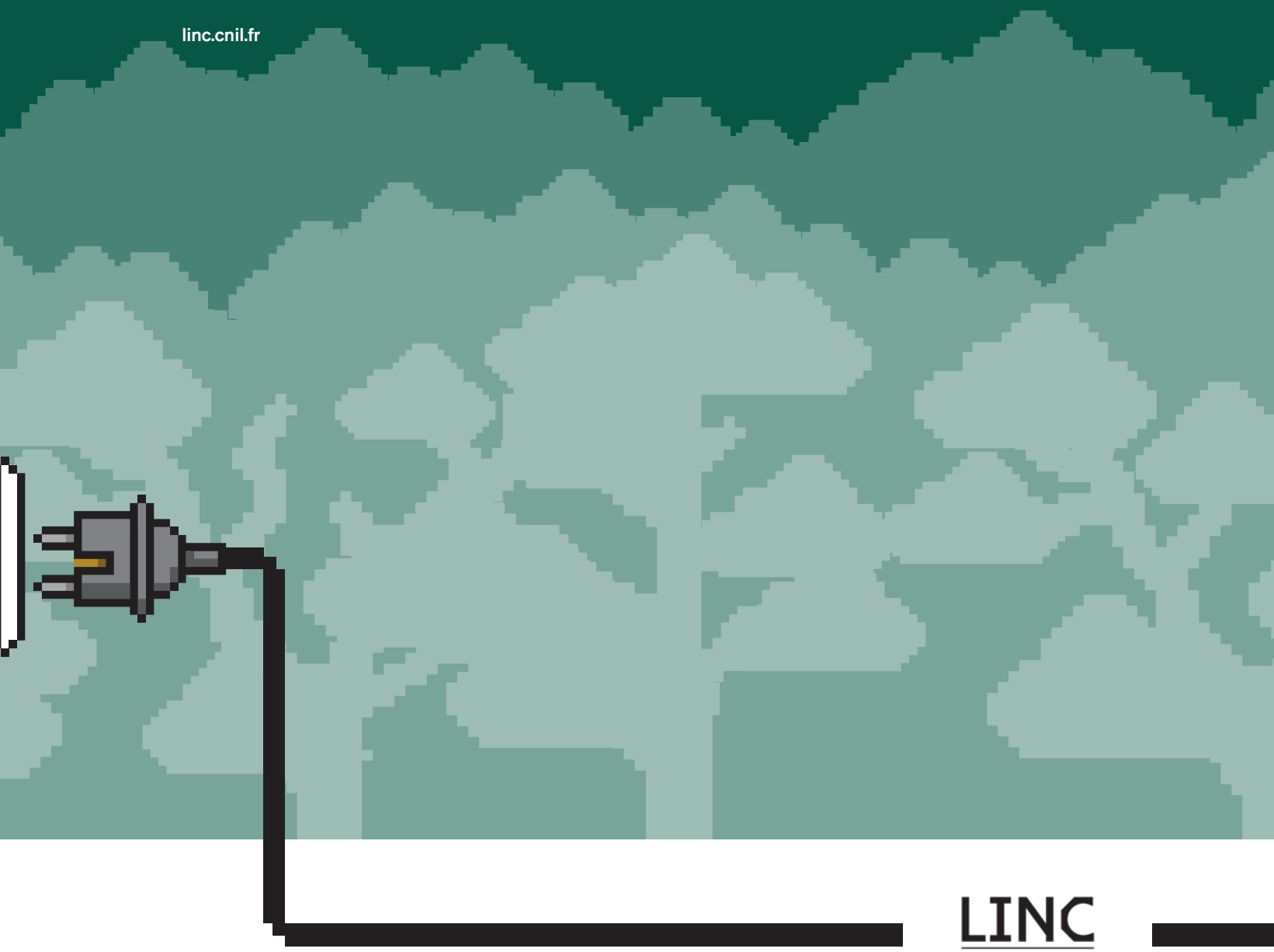

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