BENCHMARK GREEN IT

2022

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SYNTHESIS

Repeated heat waves, forest fires, drought and crisis in the energy sector: by the unprecedented intensity of these crises, the summer of 2022 should mark a turning point in the awareness of the environmental consequences for our way of life, both for the environment and for our economy (increases in the wholesale price of energy multiplied by a factor of 4 to 10 throughout Europe).
In the IPCC's AR6[1] report published in March 2022, scientists warn of the need for *" rapid and deep and in most cases immediate GHG emission reductions in all sectors ".* They also note that *" Digital technologies can contribute to mitigation of climate change "* but that some of these gains *" gains can be reduced or counterbalanced by growth in demand for goods and services due to the use of digital devices."*

In addition to the IPCC's warnings, there are many other planetary limits that have recently been exceeded, including the water cycle in March 2022 (and its consequences on climate and biodiversity, but also the production of microprocessors in Taiwan) as well as ever-increasing tensions on abiotic resources that are resulting in an unprecedented shortage of electronic components affecting all sectors of activity and in particular the digital industry.

In this context, more and more organizations are seeking to quantify the environmental impacts of their information system to identify possible levers for action.

This 7th edition of the Green IT Benchmark shows that the challenge of this evaluation is crucial. In this study, the organizations' information system represents 426 kg of CO2 equivalent per user, i.e. 43% of the planetary limit for a European or 25% of the total greenhouse gas emissions that a French person can emit to comply with the Paris Agreements (i.e. stay below 1.5°C of global warming). IT also represents 12.8g SB equivalent (antimony) and 13,534 MJ per user per year, respectively 51% and 41% of the planetary limit for a European.

The effort to be made by organizations to fit within the framework of planetary boundaries (including the Paris Agreements) is still very important. This benchmark allows them to take a first step by assessing the environmental impacts of their information system and deploying a first action plan to reduce them.

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[1] IPCC, 2022: Summary for Policymakers. In: Climate Change 2022: Mitigation of Climate Change. Contribution of Working Group III to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [P.R. Shukla, J. Skea, R. Slade, To. To the Khourdajie, R. van Diemen, D. McCollum, M. Pathak, S. Some, P. Vyas, R. Fradera, M. Belkacemi, A. Hasija, G. Lisbon, S. Luz, J. Malley, (eds.)]. Cambridge University Press, Cambridge, UK and New York, NY, USA. two: 10.1017/9781009157926.001

ABOUT

GREENIT.FR

Created in 2004, the Green IT collective brings together the experts behind the approaches of **digital sobriety**, **green IT**, **responsible digital**, and **eco-design of digital service**, and **slow tech**. To structure these approaches we propose methodologies, evaluation systems, benchmarks of good practices, and other tools that have become, over time, reference tools. As experts, we support public authorities and large organizations and produce reference studies. www.greenit.fr

CLUB GREEN IT

The **Green IT Club** is the club of digital sobriety and responsible digital. It brings together public and private organizations that wish to quantify and sustainably reduce the environmental, economic and social impacts of their information system. Created in 2014 by GreenIT.fr, the Club has already supported dozens of public and private organizations in their skills development on the subject. The club is also a place of consensus which, thanks to the expertise of GreenIT.fr and the eyes of the members, makes it possible to create repositories such as the "Green IT: the 74 key best practices" and the "responsible digital" certification, two reference tools. club.greenit.fr

ESPELIA

Created under the aegis of the Association of Mayors of France 25 years ago, Espelia is a consulting firm expert in the design and operational deployment of public policies in France and internationally. With its 150 consultants committed to defending the general interest, Espelia supports local authorities in all their public policies with a high level of mastery of consulting business expertise (strategy, organization, economy, finance, legal) and sectoral expertise. The Firm thus supports local authorities in their digital transformation and that of their territory (city and smart territory) with the concern for digital sobriety both in their internal functioning and in a territorial approach, as presented in the study "Digital sobriety and local authorities, what are the challenges". https://www.espelia.fr/

RESILIO

Resilio was born from a common desire of EPFL engineers and GreenIT.fr experts to combine their skills and experience to best support the transition to digital sobriety.

Based in Switzerland, Resilio offers a high level of technical and methodological expertise. She supports her clients on all aspects related to their responsible digital approach: training, consulting and assessment of the environmental impacts of digital services. https://resilio-solutions.com/

PUBLICATIONS

Studies

- Digital sobriety and local authorities: what are the challenges?, study carried out with Espelia, 2020, https://bit.ly/SobNumCollectivites (PDF, 2.5 MB)
- Digital Environmental Footprint in Europe, Study, 2021, https://www.greenit.fr/le-numerique-en-europe-une-approche-des-impacts-environnementaux-par-lanalyse-du-cycle-de-vie/
- Global Digital Environmental Footprint, Study, 2019, https://bit.ly/EENM2020

White Papers

- Digital and environment, collective (Iddri,, GreenIT.fr and WWF), 2018, https://bit.ly/LBNE2018
- WeGreenIT: what Green IT approaches in large French companies, GreenIT.fr with WWF France and Club Green IT, 2018, https://bit.ly/WeGreenIT2018 (PDF, 2 MB)

Books

- Green IT: the 74 key best practices, Editions du Club Green IT, 2022, https://club.greenit.fr/doc/2022-06-GREENIT-Referentiel_maturite-v3.pdf
- Tending towards digital sobriety, Actes Sud, 2021
- Digital sobriety: the keys to action, Buchet-Chastel, 2019, https://bit.ly/SobNum

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LICENCE

SCOPE OF THE STUDY

OBJECTIVES

- Quantify environmental impacts in absolute and relative terms;
- Understand the structure of these impacts;
- Assess the maturity of the participants;
- Build a quantified action plan on an objective basis for each participant.

PARTICIPANTS

- Amersport
- Interstis
- IAD Real Estate
- Groupe ESG
- Communauté de communes Maremne Adour Côte-Sud
- Malakoff Humanis
- Moët Hennessy
- PwC
- Réunion des Musées Nationaux – Grand Palais
- Grenoble Alpes Metropole

STUDY

The Green IT Benchmark 2022 is the seventh edition of this study started in 2016 at the initiative of GreenIT.fr. Initially reserved for members of the Green IT Club, the Green IT Benchmark has been open to all organizations since 2017. Several editions have been conducted with partners such as Cigref, the College of Sustainable Development Directors (C3D) and WWF France.

This collective operation aims to quantify the environmental impacts of the information system of the participating organizations as well as the maturity of the teams (i.e. their ability to implement good practices to reduce these impacts). The data of each organization is then compared with that of the other participants (benchmark) in order to create a scale (min, max, average) and position each participating organization on this scale. Deviations from the average and qualitative analysis of the responses provided by organizations ultimately make it possible to build a quantified action plan, specific to each organization, on an objective basis. This approach is unique in Europe.

For this 7th edition of the Green IT Benchmark, we compared 10 private and public organizations, located in France and abroad. These organizations operate in the following sectors of activity: administration, insurance, public services, consulting, culture, education, clothing, real estate, luxury, digital services.

SCOPE

The scope of the study is that of the organization's information system. The information system is structured in 3 thirds:

1. the user's working environment (workstation, telephony, printing);
2. networks (LAN and WAN);
3. data center (including cloud).

As we evaluate organizations of very different sizes and sectors of activity, in order to be able to compare them, we carried out the study on two complementary perimeters:

- a **complete scope** representative of the impacts associated with the entire information system, including the **components specific** to the organization's business;
- a **partial scope** representative of the impacts associated with the components of the information system **common** to all organizations participating in the Green IT Benchmark.

Unless specified, this report presents the results relating to the partial scope, i.e. orders of magnitude to which all organizations can refer on a

METHODOLOGY

The methodology chosen is that of simplified Life Cycle Assessment (LCA) screening type, defined by the following standards:

- ISO 14040: 2006 Environmental Management – Life Cycle Assessment – Principles and Framework
- ISO 14044: 2006 Environmental Management – Life Cycle Assessment – Requirements and Guidelines

Details of the methodology are given in the Annex

LIFE CYCLE

In this study, we looked at the following stages of the life cycle:

1. **Manufacturing** (Build): this includes the extraction and refining of raw materials, upstream transport and manufacturing and assembly processes
2. **Distribution** (Dist.): it includes the transport of equipment from the factory to the place of use
3. **Use**: it includes electricity used by digital equipment
4. **End of life** (EoL): this includes end-of-life processing of digital equipment.

common perimeter. This means that the average impact values should generally be increased by 1% to 10% depending on the indicator.

LIMITATIONS OF THE STUDY

INCLUSION

This study focuses on the information systems of the 10 participating organizations over the year 2021.

In order to be able to compare companies with each other and over time, we have chosen to establish a partial footprint, essentially corresponding to their management IS. On the other hand, participating organizations are invited to work on their total footprint, which represents their entire information system.

The following equipment and flows are taken into consideration:

- **IT Department**: Employee Travel and Service Purchases
- **User work environment**: smartphones, desktop and laptop computers, screens, etc. with the exception of video projectors;
- **Prints**: shared and personal printers, paper;
- **Local area** network: computer equipment linked to the local area network (LAN);
- **Wide area** network (WAN) and mobile network (2G/3G/4G);
- **Cloud**: VMs, storage
- **Data centers** : data servers, storage arrays, network equipment, etc.

EXCLUSION

The following are excluded from the environmental assessment:

- Flows related to R&D and industrial IS
- Hosting services offered to third parties by the organization
- The packaging of equipment and its end of life (as a reminder, terminals have their own sectoral rules), excluding packaging of equipment made available to users and their end of life;
- Broken or defective equipment;
- Construction and maintenance of infrastructure (building);
- Lighting, heating, sanitary facilities and cleaning of infrastructures (including DSI);
- Transport systems and infrastructures other than those dedicated to the IT department;
- The installation of equipment.
- Video projectors because they were present in very small quantities and for which there was no impact factor available.

All of the above are considered to fall outside the scope of the study.

ENVIRONMENTAL INDICATORS

CHOICE OF INDICATORS

Environmental footprints were calculated according to 16 environmental indicators. However, to make the results of this study as comprehensible as possible and to focus our recommendations on priority topics, we have selected the 7 mostimportant indicators to present in this report.

In addition to the 7 indicators opposite, the Cumulative Energy Demand Indicator (CED) has been calculated.

Be careful, however, the indicator "Water Use" should be taken with caution. Indeed, a problem of accounting for water flows in end-of-life (EoL) data forced us to exclude this part of the study. However, we have decided to keep this indicator to testify, even partially, to the tensions on this resource to which digital technology contributes.

The full description of the indicators is also presented in the Annex.

INDICATORS

- **GWP**: Climate change (kg eq. CO_2)
- **PM**: Particulate matter emissions (incidence of disease)
- **AD**: Acidification (mol eq. M+)
- **IR**: Ionizing radiation, human health (kBq eq. U235)
- **ADPe**: Resource Use, Minerals and Metals (kg Sb eq)
- **ADPf**: Resource Utilization, Fossile (MJ)
- **WU**: Water resources use (m3 eq)

DATA SOURCE

LCA calculations were performed from two types of data:

- Inventory. Data relating to the physical characteristics of the system studied (such as the number of smartphones, computers, printers, etc. as well as their lifespan, reuse rate, etc.). These data come from inventories carried out by the participating organizations with the support of GreenIT.fr and its partners.
- Impact factors. Data relating to the life cycle impacts of IT equipment (manufacturing, distribution and end of life) or energy flows (impacts of electricity production, impacts of kilometres travelled by IT department employees, etc.) that enter the system studied. This data comes mainly from the NegaOctet database and for very rare exceptions from the EcoInvent database.

INVENTORY

The inventory reflects the functioning of the information system in 2021.

- **10** Organizations
- **39,760** Users
- **2,690** EMPLOYEES of the IT department (including service providers)
- **16,359** m^2 of offices dedicated to the IT department
- **27** kms traveled by a CIO employee per day
- **206,475** digital devices

NEGAOCTET

Based on a simplified LCA screening methodology, calculations are made from secondary data from the NegaOctet database. NegaOctet is also based on the ISO 14040-44 methodology and the Product Environmental Footprint (PEF) methodology recommended by the European Commission.

NegaOctet is the only database of homogeneous and state-of-the-art impact factors in the world. These impact factors have also been critically reviewed (ISO 14071) by an independent public scientific research organization. This critical review guarantees the quality of the impact factors.

This 7th edition of the benchmark GreenIT.fr is based for the first time on the NegaOctet database. Comparing the results to previous years is therefore difficult.

TRENDS 2022

THE END OF THE FIXED OFFICE?

The sudden arrival of confinement during the pandemic has resulted in the emergency equipment of many employees with mobility tools. This has consequences for the management of computer equipment.

There is a sharp decrease in the number of desktops in favour of an increase in the number of laptops. In the same way, landline phones are decreasing in favor of softphones and smartphones (1 for 2 IS users).

The number of personal printers has been steadily decreasing for several years.

However, the fixed computer fleet has not been completely decommissioned because there is still more than one computer per person (fixed and mobile combined). The number of fixed telephony equipment is also expected to continue to decline in the coming years.

EVER LARGER SCREENS

If the equipment rate remains stable (around 1.2 screens per user), there is a significant increase in screen sizes from 22 inches to 24 inches or more. Organizations have massively swapped projectors for OLED screens larger than 50 inches or even 60 inches in their meeting rooms.

These 2 factors combined, increase in the size of screens and switch to OLED technology, significantly increase environmental impacts (factor 4 to 8), including greenhouse gas emissions, depletion of fossil resources (ADPf) and especially water consumption (x30 to x50).

There has also been no progress in terms of electricity consumption. Often mentioned to justify the migration of CRT and LCD screens to OLED screens, energy efficiency does not compensate for the increase in diagonals. In the end, the new screens deployed on workstations require 2 to 3 times more electricity than their predecessors.

FROM DATA CENTERS TO THE CLOUD

"On-premise" or outsourced data centers are increasingly losing ground to cloud-type solutions, which are more flexible, but whose impacts are more difficult to quantify because of the lack of data from suppliers.

However, it can be noted that the location of the data centers hosting these services has an impact on the increase in the use phase in the environmental footprint. Indeed, the electricity mix of the country of establishment plays a lot on greenhouse gas emissions (GWP) and resource use (ADPe and ADPf) in the use phase.

FOOTPRINT 2022

The environmental impacts of the information systems studied are mainly concentrated in the working environment of users and at the level of data centers. The network is the third largest contributor to environmental impacts in this study.

The materiality of the information systems of the benchmark 2022, **each working day** is approximately:

- 42,000,000 litres of water (WU) or 700,000 showers or 17 Olympic-sized swimming pools;
- 77 tons of GHGs (GWP) or 438,000 kms by car, or 11 round-the-world trips.
- 6,000 tons of excavated soil (ADPe) (based on a clarke of antimony of 0.5 g / tonne)

Indicator	AP	GWP	IR	PM	ADPf	ADPe	CED	WU
Unit	mol eq. H+	kg eq. CO_2	kBq eq. U235	incidence of diseases	MJ	kg Sb eq	MJ	overall m3 eq
IT Department User	**22 816**	**5 418 488**	924 736	**1.56E-01**	81 101 428	**139**	86 162 955	**3 379 137**
Environment	**26 741**	**4 303 974**	**8 743 732**	**1.70E-01**	**127 071 841**	**347**	**135 245 769**	**3 336 346**
Print	7 779	985 959	759 451	4.18E-02	17 337 966	11	22 464 630	501 693
Telephony	3 272	550 538	301 107	1.93E-02	10 094 415	21	10 655 631	639 233
Local area network (LAN)	7 728	1 399 445	2 767 342	6.16E-02	57 602 938	38	65 607 719	333 929
Internet and Wide Area Network (WAN)	508	87 507	197 267	3.46E-03	3 486 907	4	3 848 377	22 222
Cloud	9 892	1 900 116	2 533 684	7.33E-02	61 198 548	26	11 509 262	404 588
Datacenters	12 246	2 289 712	**8 108 544**	9.06E-02	**180 375 058**	62	**196 778 039**	716 945
Total scope	**90 982**	**16 935 740**	**24 335 863**	**6.16E-01**	**538 269 101**	**647**	**532 272 381**	**9 334 092**
Per user	2	426	612	1.55E-05	13 534	0,016	13 383	235

Table 1 - Total Environmental Impacts, by User and Not Indicator

“

The benchmark allowed us to acquire best practices for sustainable digital, particularly in the management of computer equipment: inventory consolidation, life extension, refurbished purchases, repair.
He also contributed to raising awareness and questioning is stakeholders when choosing a solution for any new digital project.

The opinion of the participants : David Valet, Grenoble-Alpes Metropole

BREAKDOWN BY IS DOMAINS

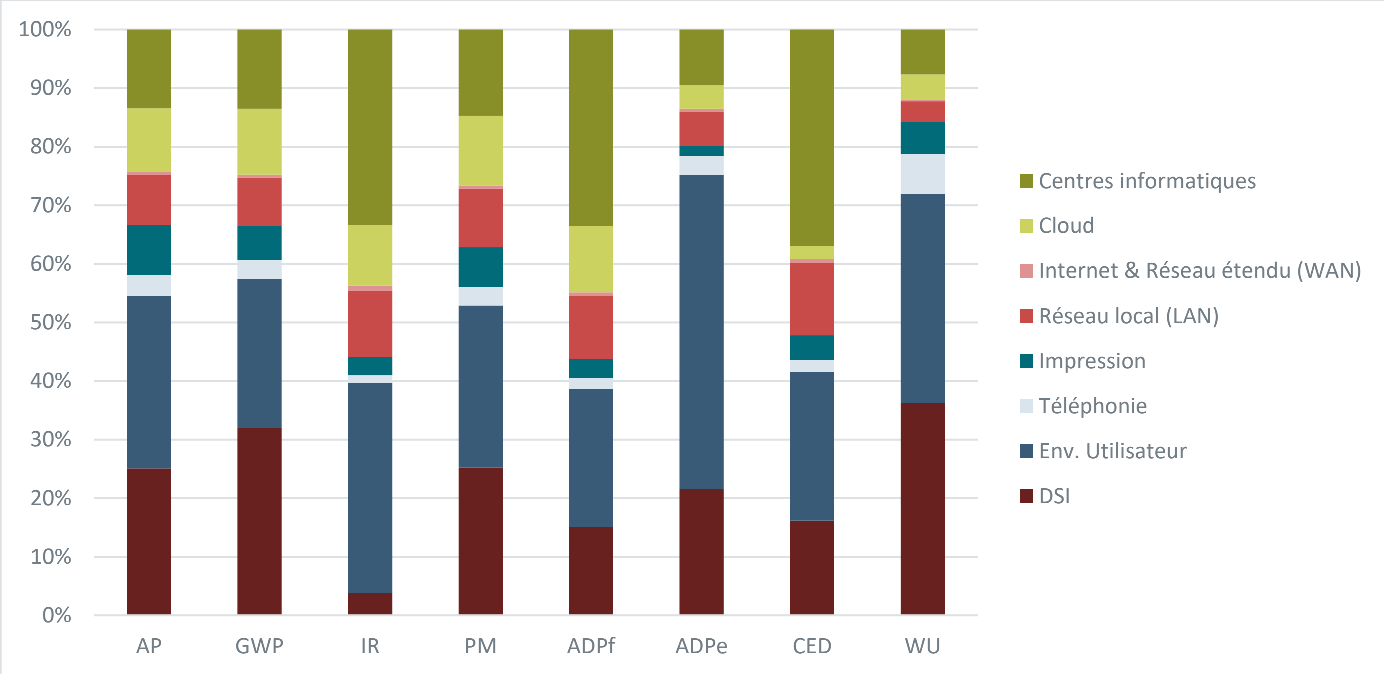

Figure 1 - Distribution of impacts by major IS areas

IS Domain	AP	GWP	IR	PM	ADPf	ADPe	CED	WU
IT Department	25%	32%	4%	25%	15%	22%	16%	36%
User environment	29%	25%	36%	28%	24%	54%	25%	36%
Telephony	4%	3%	1%	3%	2%	3%	2%	7%
Print	9%	6%	3%	7%	3%	2%	4%	5%
Local area network (LAN)	8%	8%	11%	10%	11%	6%	12%	4%
Internet & Wide Area Network (WAN)	1%	1%	1%	1%	1%	1%	1%	0%
Cloud	11%	11%	10%	12%	11%	4%	2%	4%
Data Centers	13%	14%	33%	15%	34%	10%	37%	8%

Table 2 - Distribution of environmental impacts by area of the information system

CIOS AND SERVICE PROVIDERS: A VERY STRONG IMPACT OF PROFESSIONAL TRAVEL

The men and women without whom the information system would not function constitute the "IT department" also known as the "CIO". To assess their environmental impacts, we take into account the kilometers traveled by the employees of the IT department and its service providers, equipment, etc. The IT department has a significant environmental impact ranging from 4% of ionizing radiation emissions to 36% of the water consumption of the information system. It is therefore crucial to take this source of impacts into account in the environmental balance of the information system.

In 2021, the IT department represents the 1st source of impacts of the information system for

- water consumption (36%), far ahead of data centres (8%);
- greenhouse gas emissions from the information system (32%), far ahead of data centres (14%) and printing (6%).

IMPRESSIONS DECREASE SHARPLY

Prints are clearly no longer a source of major impacts, including for water (papermaking requires a lot of water). The decrease in the rate of personal printer equipment, a greater pooling of networked printers as well as the various

lockdowns and the progression of teleworking have caused paper consumption to fall from 13 pages / day / user in 2019 to less than 3.
However, this study could not take into account the number of pages printed by employees working from home. The 3 pages per day per user are therefore probably underestimated.

DATA CENTER AND CLOUD

Many companies have migrated all or part of their infrastructure into cloud services. This results in a sharp increase in GHG emissions and primary energy consumption due to server location. Indeed, outside the France, the production of electricity requires proportionally a greater amount of fossil primary energy (oil, coal, gas, etc.) which also emits more greenhouse gases per kWh of electricity produced.

LOCAL AUTHORITIES HAVE A SPECIFIC FOOTPRINT

The GreenIT Benchmark 2022 confirms the findings of the previous edition: the partial footprint of local authorities is smaller than that of private actors (the reasons identified last year remain effective). In general, the lifespan of user equipment has increased, but good practices such as *Bring your own device* "BYOD[2]" (and reverse BYOD) or the ecodesign of digital services are still projects to be invested. Finally, governance issues remain central to successfully passing a real course. Beyond internal governance, which does not yet seem to have stabilized (in terms of comitology, job description, budget line, referents, monitoring indicators, etc.), it is the articulation of digital sobriety with other digital strategies that will quickly become an obstacle. Without an integrated vision of digital issues internally crossing IT department, territorial digital strategy, digital inclusion strategy, digital sobriety, etc., local authorities risk ending up with a patchwork of digital strategies/recommendations designed separately to answer specific questions and whose posteriori articulation exercise will be relatively complicated. It is like an assembly of pieces of the same puzzle that do not fit together: the recommendations of digital sobriety resulting from the action plans imposed by the REEN law that would come up against strategies for the deployment of sensors for the smart city for example.
Finally, their ultimately rather low needs in computing power to deliver public services that consume little compute seem to contribute to reducing the footprint of the date center domain while compensating for the fragmentation of the physical sites of communities.
Historically, local authorities have been less reactive than some large companies in implementing good practices. However, they have caught up, particularly in anticipation of the REEN law.

[2] BYOD refers to the use of personal computer equipment in a professional context.

BREAKDOWN BY THIRD PARTIES

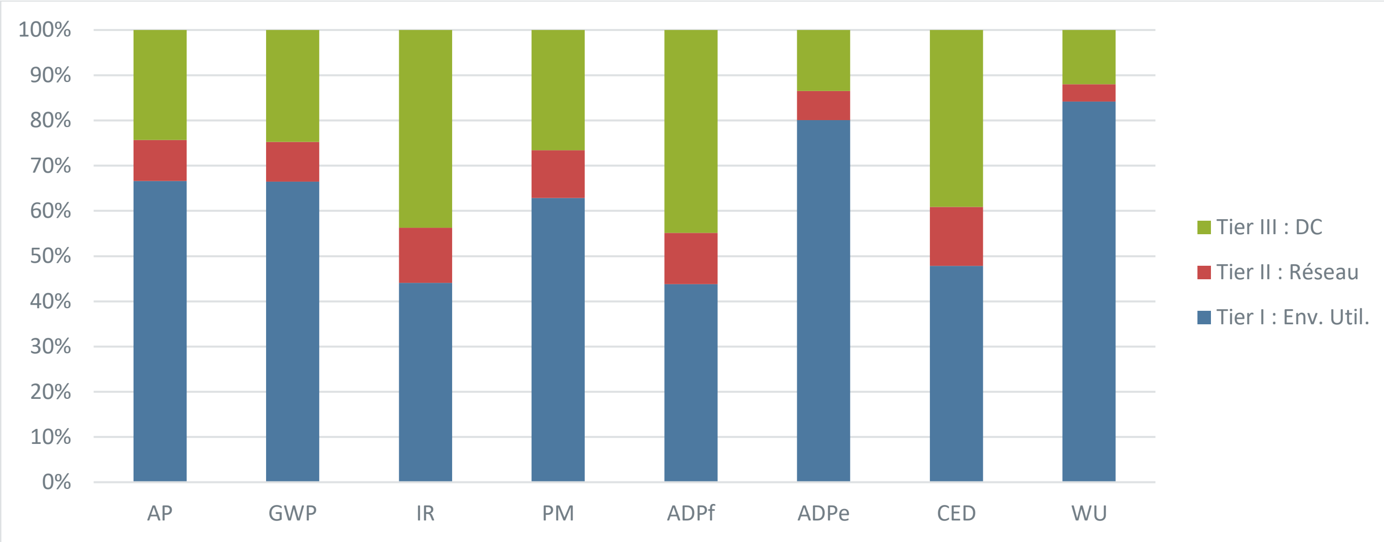

Figure 2 - Distribution of third-party impacts of the information system

Users (computers, screens, etc.) and the data center are two-thirds that concentrate environmental impacts.

The impact structure is not the same for these two positions:

- Tier I: The majority of the impacts of the information system are concentrated on Tier I containing the travel of IT employees and the manufacture of user equipment.
- Tier III: The power consumption of data centers concentrates many impacts. This is due to both the amount of electricity consumed and the nature of the electricity consumed. Indeed, we have taken into account several data centers located outside France, especially in North America or Asia, which use a high-carbon electricity mix.

BREAKDOWN BY LIFE CYCLE STAGE

Figure 3 - Distribution of impacts by life cycle stage

Stage	AP	GWP	IR	PM	ADPf	ADPe	CED	WU
Manufacture	50%	51%	34%	39%	23%	69%	26%	52%
Distribution	6%	2%	0%	5%	1%	0%	1%	0%
Usage	42%	47%	66%	55%	76%	31%	73%	48%
End of life	2%	1%	0%	1%	0%	0%	0%	0%

Table 3 - Distribution of Impacts by Life Cycle Stage

Distribution and end-of-life have very little impact. This is an observation in line with other studies on digital technology. The manufacture and use of the information system are therefore the two stages of the life cycle that concentrate the impacts.

The strong representation of the use phase can be explained by 2 factors:

- The longer life of equipment in companies than in homes, which cushions the manufacturing phase over a longer period of time
- The greater number of employees and data centers outside France, especially on the North American and Asian continents. The electricity mix being more impactful, the use phase is strengthened.

ELECTRICITY PRODUCTION, A PREPONDERANT ELEMENT OF THE BALANCE SHEET

Electricity generation is responsible for 73% of primary energy expenditure. The presence of many out-of-France data centers and the systematic use of the cloud increase the impact of power consumption in the overall footprint. As the electricity mixes of the North American or Asian territories are 6 to 11 times more emitting greenhouse gases than the French electricity mix, servers, " on Premise " or cloud, located on these continents increase the quantities of greenhouse gases emitted (GWP) and depletion of fossil resources (ADPf) and contribute to an increasingly important demand for primary energy.

BREAKDOWN BY DOMAIN AND LIFECYCLE STAGE

Domaine du SI	AP				GWP				IR				PM			
	BLD	DIS	USE	EOL	BLD	DIS	USE	EOL	BLD	DIS	USE	EOL	BLD	DIS	USE	EOL
DSI	57%	0%	42%	1%	56%	0%	44%	1%	19%	0%	81%	0%	33%	0%	66%	0%
Environnement utilisateur	73%	5%	19%	3%	73%	3%	22%	2%	64%	0%	36%	0%	67%	5%	26%	2%
Téléphonie	86%	2%	11%	1%	85%	2%	13%	0%	52%	0%	48%	0%	81%	2%	16%	1%
Impression	50%	45%	3%	2%	82%	10%	5%	3%	82%	0%	18%	0%	49%	44%	5%	2%
Internet et réseau étendu (WAN)	32%	3%	63%	2%	28%	3%	68%	1%	38%	0%	61%	0%	26%	2%	70%	1%
Réseau local (LAN)	26%	1%	71%	1%	24%	2%	74%	0%	24%	0%	76%	0%	18%	1%	80%	0%
Cloud	11%	1%	88%	0%	10%	1%	90%	0%	15%	0%	84%	0%	8%	0%	91%	0%
Centres informatiques	28%	1%	70%	1%	26%	1%	73%	0%	6%	0%	94%	0%	21%	1%	78%	1%
	50%	**6%**	**42%**	**2%**	**51%**	**2%**	**47%**	**1%**	**34%**	**0%**	**66%**	**0%**	**39%**	**5%**	**55%**	**1%**

Domaine du SI	ADPf				ADPe				CED				WU			
	BLD	DIS	USE	EOL	BLD	DIS	USE	EOL	BLD	DIS	USE	EOL	BLD	DIS	USE	EOL
DSI	46%	0%	54%	1%	7%	0%	93%	0%	43%	0%	56%	1%	7%	0%	93%	0%
Environnement utilisateur	41%	1%	57%	1%	96%	0%	4%	0%	39%	1%	59%	1%	93%	0%	7%	0%
Téléphonie	63%	1%	36%	0%	96%	0%	4%	0%	61%	1%	37%	0%	98%	0%	2%	0%
Impression	73%	7%	18%	1%	94%	0%	6%	0%	78%	6%	15%	1%	98%	0%	2%	0%
Internet et réseau étendu (WAN)	12%	1%	87%	0%	83%	0%	17%	0%	11%	1%	87%	0%	40%	0%	60%	0%
Réseau local (LAN)	8%	1%	91%	0%	71%	0%	29%	0%	12%	1%	88%	0%	35%	0%	65%	0%
Cloud	4%	0%	95%	0%	43%	0%	57%	0%	33%	2%	65%	0%	16%	0%	84%	0%
Centres informatiques	5%	0%	95%	0%	48%	0%	52%	0%	5%	0%	94%	0%	31%	0%	69%	0%
	23%	**1%**	**76%**	**0%**	**69%**	**0%**	**31%**	**0%**	**26%**	**1%**	**73%**	**0%**	**52%**	**0%**	**48%**	**0%**

Table 4 - Distribution of impacts by IS domain and life cycle stage

Legend: BLD = manufacture, DIS = Distribution, USE = Use, EOL = end of life

The analysis of the sources of impacts highlights two main contributors: the working environment of the users and the data centers. Classically, the user's working environment concentrates impacts associated with manufacturing (ADPe, GWP, WU) while the power consumption of data centers concentrates other impacts on the use phase (GWP, AP, IR, PM, ADPf).

However, the WU indicator "Use of water resources" should be taken with caution. Indeed, a problem of accounting for water flows in end-of-life (EoL) data forced us to exclude this part of the study.

PLANETARY BOUNDARIES

	AP	GWP	IR	PM	ADPf	ADPe	WU
Planetary boundary	2%	43%	1%	21%	42%	51%	1%

Table 5 - Share of the IS footprint within planetary boundaries

The Paris Agreements have set a target of 2 tonnes per French people to hope to limit global warming to +1.5°C. A French person today emits an average of 9 tonnes of CO_2 equivalent.

The European Commission's JRC[3] working group has defined a greenhouse gas emissions budget of 985 Kg eq CO_2 per European in order to remain within sustainable global limits.

In this study, a user of the information system therefore consumes 43% of this sustainable GHG budget.

Similarly, the JRC defines a budget of 3.18^{E-02} kg SB eq to respect planetary boundaries. A user of our study therefore consumes 51% of his budget in abiotic resources.

[3] https://publications.jrc.ec.europa.eu/repository/handle/JRC113607

LIFESPANS AND EQUIPMENT RATES

Equipment	2017	2020	2021
Computer - Central Unit (desktop)	5,5	6,2	5,95
Laptop	4,7	5,9	4,98
Screen	6,3	7	5,33
Wi-Fi access point	5,3	6,2	5,69

Table 6 - Evolution of the service life of equipment (in years)

These average values include the second life

There is a slowdown this year in the increase in the life of the equipment on the sample studied. Organizations have communicated rather pessimistic lifespans, especially large companies and multinationals, due to a lack of knowledge of the data from their broker.

The use of repackaging channels is also less widespread outside France.

Present on several sites and / or several regions of the world, large companies have sometimes been able to notice differences in maturity between their entities. The subject of the environmental footprint of digital technology is little discussed and little known outside Europe. This was felt in particular on the lifetimes of the equipment with a low knowledge of the future of the equipment after use in the company. Refurbishing channels are not established all over the world.

> Several differentiation criterias that make the GreenIT approach unique: expertise of the team, multiple environmental KPIs, maturity assessment, benchmark, simulations, best practices sharing with our peers. No one but GreenIT offers a such large range of skills and 360 analysis. Many thanks for your help

The opinion of the participants: Gaëlle Floch, Moët Hennessy

MATURITY

THE MATURITY OF ORGANIZATIONS IS STAGNATING

After a decline in 2020 and 2021, the maturity of organizations is on the rise in several areas such as governance (38%), desktop management (56%) and its tools and uses (51%). Overall maturity, however, stagnates at 45%

Maturity - average score	2022
1. Responsible Purchasing	41%
2. Lifespan and end of life	55%
3. Governance	38%
4. Workstation	56%
5. Telephony	42%
6. Printing	49%
7. Tools and uses of the workstation	51%
8. Software	48%
9. Digital Services and Business Applications	42%
10. Data Centers	36%
11. Network	34%
	45%

Table 7 - Maturity Level by Information System Domain

DATA CENTERS DECREASE SHARPLY

On the other hand, the maturity for data centers drops to 36%.
This decrease is explained by the presence, in the sample of this study, of computer centers located on industrial sites with little or no optimization and also by the strong outsourcing of hosting which makes the organization lose control of monitoring indicators.

SIGNIFICANT DIFFERENCES FROM ONE ORGANIZATION TO ANOTHER

On the other hand, the differences remain significant from one organization to another. They are particularly marked regarding software (installation, maintenance, etc.), telephony, computer centers and practices related to the responsible purchase of hardware and IT services.

GOVERNANCE IMPROVES

The area that is progressing slower than the others is governance, with an average maturity of 38% compared to 45% for all areas. However, there is some progress compared to last year. To date, not all organizations have a full-time Green IT manager to organize all actions and monitor their impact over time, but for some the position was created during the year 2022 and is therefore not considered in this study concerning the year 2021. It is hoped that this area will continue to make progress in the coming years.

THE NETWORK, A NEW FIELD STUDIED

Unsurprisingly, the network domain, added this year in the best practices repository, is immature with a score of 34%.

REFERENTIAL

The maturity assessment is based on the third edition of the Green IT best practice framework developed by GreenIT.fr as part of the Green IT Club and published in March 2022, as well as on the associated evaluation system (score out of 100). https://club.greenit.fr/outils.html

CMMI

The evaluation system is based on a standardized scale from 1 to 5 and on a weighting system according to the importance of each of the good practices implemented:

1. **Initial** : The action is not yet applied or in an unpredictable, unorganized or controlled way.
2. **Reproducible** : the good practice is beginning to be mastered and has been initiated on part of the scope.
3. **Defined** : Processes are clearly identified and defined.
4. **Mastered** : KPIs measures performance from a quantitative and/or qualifying point of view.
5. **Optimized** : In continuous improvement.

BENCHMARK

The interest of this study is to allow companies to position themselves on a common scale to detect the main potential areas for improvement.

We propose in this part the measures observed on the 7 main environmental indicators monitored for this report as well as the flow indicator on primary energy consumption.

Indicator	AP	GWP	IR	PM	ADPf	ADPe	CED	WU
Unit	mol eq. H+	kg eq. CO_2	kBq eq. U235	incidence of diseases	MJ	kg Sb eq	MJ	global m3 eq
Minimum	0,71	112	317	4.48E-06	5234	8.36E-03	5697	51
Average	2,58	474	866	1.84E-05	18588	1.70E-02	18706	236
Maximum	4,39	853	3199	3.58E-05	66060	3.08E-02	72049	468

Table 8 - Benchmark of organizations by indicator

There are again strong disparities between organizations. Public organizations are rather below average and organizations with data centers outside France or with a lot of *cloud* are well above average.

The analysis of the impact of the Cloud will have to be continued and refined in the coming years because many organizations, public and private, are now massively using it. However, its environmental impact seems far from negligible while reducing the control of technical teams over the infrastructure data necessary to run the service.

> Participation allows the community to follow the evolution of its approach and to accentuate certain points according to the different feedbacks. In addition, as a community, it allows us to communicate and develop certain projects.

The opinion of the participants - Fabien Zaccari, Communauté de communes MACS

RECOMMENDATIONS

Given the main results of this study, here are our key recommendations to reduce the environmental impacts of an organization by major area of the information system

WORK ENVIRONMENT

PRIORITY ★★★
IMPLEMENTATION ⚙⚙

ATTENTION TO SCREEN TECHNOLOGY

The second external display is a disaster from an environmental point of view if it is a LED/OLED technology. On the other hand, the impact of the second screen is much less if it is an LCD screen. When an employee is equipped with a laptop and two external 24-inch LED/OLED screens, the screens contribute about 2/3 to 3/4 of the environmental impacts of the workstation (depending on the impact indicator observed). It is therefore crucial to avoid generalizing the second screen, *especially* LED / OLED, except when absolutely necessary. The difficulty lies in the fact that almost all screens sold today are based on LED technology.

PRIORITY ★★★
IMPLEMENTATION ⚙

DO NOT RENEW SCREENS WHILE THEY ARE WORKING

Given the impact of making a screen, the most effective approach is to renew them only when they fail. With an aggressive policy of this type, some organizations easily reach more than 10 years for some screens and averages 8 to 9 years for the entire park. Obviously, this practice will be all the more effective if we do not generalize the 2nd screen (or to a lesser extent that we limit its size), otherwise it barely allows to cushion this bad practice.

PRIORITY ★★★
IMPLEMENTATION ⚙⚙

SYSTEMATIZE THE SECOND LIFE OF EQUIPMENT

The equipment rate and the life of the equipment are the two main parameters that determine an employee's digital footprint. It is therefore necessary to massively reuse the reconditionable equipment that leaves the organization. On average, 80% of the equipment that leaves the company still works and can be reused. The systematization and industrialization of reuse requires taking this strategy into account from the purchase of new equipment and defining a sufficiently short first life to maximize their residual value both economic and use. In general, companies are based on the warranty period of 3 or 5 years of depreciation period. To systematize reuse, it appears necessary to identify a serious partner to refurbish the equipment.
Organizations working internationally will have an additional evangelistic effort to make for countries that are not familiar with refurbishing channels.

PRINTING

PRIORITY ★★★
IMPLEMENTATION ⚙

PROMOTE RECYCLED BLUE ANGEL OR FSC PAPER

Although the field of printing is not the most impactful in the footprint, due to the sharp decrease in equipment and printing, the rate of recycled paper is rather down (41%). The choice of paper has an effect on freshwater consumption as well as on other impact indicators related to the pollution of aquatic ecosystems (eutrophication, etc.). To reduce the impact, the purchase of 100% recycled unbleached blue angel or FSC eco-labelled paper is recommended. In 2022, quality recycled paper no longer poses any technical problems (powdering, tearing, etc.) for recent printers.

TELEPHONY

PRIORITY ★★★
IMPLEMENTATION ⚙

GIVING SMARTPHONES A SECOND LIFE

Telephony does not appear to be a major source of impact on the scale of a company's information system. On the other hand, the smartphone has become the symbol of planned obsolescence, but also of the fight against this practice with the growing success of reconditioning. It is therefore interesting to encourage users to take care of their professional smartphone so that it can have a second life.

PRIORITY ★☆☆
IMPLEMENTATION ⚙

DO NOT REPLACE LANDLINE PHONES

The decline in landline phones that began last year continues. It is now common to no longer deploy a fixed phone set and replace it with a softphone. This good practice limits the environmental impacts associated with manufacturing. It also brings more comfort to users. It is now necessary to decommission the fleet to the refurbishing channels.

NETWORK

PRIORITY ★★☆
IMPLEMENTATION ⚙⚙

STANDBY NETWORK EQUIPMENT

The network will soon be the main unit source of electricity consumption of the information system, ahead of data centers. The systematic purchase of equipment that is easier to put into standby (Energy Efficient Ethernet) and its effective configuration could significantly reduce this electricity consumption and the associated environmental impacts (tension on fresh water, depletion of abiotic resources, etc.).

DATA CENTER

PRIORITY ★★★
IMPLEMENTATION ⚙⚙

GENERALIZE ASHRAE A3 & A4 CLASSES

The energy efficiency of the data centers of organizations, both private and public, has increased significantly over the last 15 years with a PUE (Power Usage Effectivness) often divided by 2. However, it is possible to make further progress by systematically deploying IT equipment that complies with ASHRAE class A3 to A4 requirements. It is then possible to raise the temperature at the setpoint input above 24 ° C and cool the equipment thanks to natural cooling (free cooling). However, this good practice requires that 100% of the equipment comply with these technical specifications. Its deployment is therefore easier when creating a new data center or a major equipment update.

IT DEPARTMENT

As we saw in the second part of this study, IT is a major source of greenhouse gas emissions and primary energy consumption.

PRIORITY ★★★

IMPLEMENTATION ⚙

SET UP A MOBILITY PLAN

Primary energy is mainly mobilized in the form of automotive fuel. This mobilization translates into significant greenhouse gas emissions. It is therefore not possible to reduce the GHG emissions of the information system without acting on the travel of IT employees. Setting up a Mobility Plan consists of playing on the quantity and quality of the kilometers traveled by the employees of the IT department and service providers. Two approaches are particularly effective: carpooling with more than 2 passengers per vehicle and public transport.

PRIORITY ★★☆

IMPLEMENTATION ⚙ ⚙

PROMOTING TELEWORK

Teleworking can bring more comfort to employees while reducing the impacts associated with travel. However, it is necessary to implement the technical conditions allowing it and ensure that it does not trigger a rebound effect (Increase in digital equipment, increase in personal journeys, overconsumption of energy at home, intensive use of videoconferencing ...) [4].

> Participation in the benchmark marks for me and our company the real launch of the sustainable digital approach that we want to lead. The audit phase allowed us to evaluate ourselves and the implementation of an action plan is now possible

The opinion of the participants - Nicolas Baudon, Interstis

[4] ADEME, 2020 : https://librairie.ademe.fr/mobilite-et-transport/3776-caracterisation-des-effets-rebond-induits-par-le-teletravail.html

ANNEXES

METHODOLOGY

Life cycle analysis is an environmental assessment method in the same way as Carbon Footprint or impact analyses, but it has specificities that make its holistic approach unique. Indeed, used since the end of the 19s90s and standardized in the series of ISO 14040:2006 and ISO 14044:2006, this method proposes to establish the ecological baggage of a product or service according to an approach:

- **Multi-criteria:** Several environmental indicators must be considered systematically through the global warming potential, the depletion of abiotic resources, the creation of photochemical ozone, water, air, soil pollution, human ecotoxicity, biodiversity. The list of indicators is not fixed but depends on the sectors of activity.
- **Life cycle:** in order to integrate the impacts generated during all stages of the life cycle of equipment, from the extraction of natural resources that are often not easily accessible to the production of waste, including energy consumption in the use phase...
- **Quantitative:** each indicator is qualified in a quantified way in order to be able to put on the same scale all the externalities of a product or service and to make objective decisions.
- **Functional:** the object of study is defined by the function it performs in order to be able to compare different technical solutions.
- **Attributional or consequential:** Life cycle analysis makes it possible to characterize in a traditional way the direct environmental impacts of a solution via the attributional life cycle analysis but also the indirect or systemic environmental impacts through the consequential life cycle analysis. As part of the ACVs conducted for NegaOctet, we remain in the field of attributional LCAs.

Refining the Life Cycle Assessment of an information system means restoring its materiality and environmental externalities. It is relevant to apply this method to:

- Establish a quantitative diagnosis of the direct environmental impacts of an information system
- Identify the most significant improvement levers to deploy a Green IT strategy
- Communicate objectively about performance and improvements
- Manage its Green IT strategy and integrate the digital services footprint into company reports

LCA is a powerful decision-making tool at the level of both state and corporate strategy.

Here the direct impacts are taken into account. Indirect, positive and negative impacts (such as direct or indirect rebound effects, substitution, structural changes), are not taken into account. This constitutes an attributional LCA.

QUANTIFICATION MODEL

Although LCA is initially more applied in the field of products, its scope of action has been expanded in recent years. First of all thanks to the ETSI 203 199 standard and today thanks to the many works carried out by professional telecommunications organizations such as the ITU, by the NegaOctet consortium for digital services or by the Ecodesign Pole for services in general. This work now makes it possible to feed into French regulations and in particular the implementation of Article 13 of the anti-waste and circular economy law which aims to force telecommunications network operators to communicate to the general public on greenhouse gas emissions from data transmission.[5][6][7][8][9]

Moving from a product to an information system means maintaining the multi-criteria and functional philosophy but moving from a circular approach (from cradle to grave) to a matrix approach integrating the life cycle of all the equipment constituting the three thirds (terminals, networks, datacenter) allowing the information system to work. Thus, such an environmental diagnosis makes it possible to avoid pollution transfers from one phase to another but also from one third to another of the information system.

ENVIRONMENTAL INDICATORS

Impact Category	Abbreviation	Model	Unit	LCA Method Recommendation Level
Climate change	GWP	GIEC 2013, GWP 100	kg eq. CO_2	I
Ozone depletion	ODP	World Meteorological Organization (WMO), 1999	kg of CFC-11 eq.	I
Particulate matter emission	PM	Fantke et al., 2016	Incidence of diseases	I
Acidification	AP	Posch et al., 2008; Seppälä et al. 2006	mol eq. H+	II
Eutrophication, fresh water	Epf	Struijs et al, 2009	kg P eq	II
Eutrophication, marine	Epm	Struijs et al, 2009	kg N eq	II
Eutrophication, terrestrial	Ept	Posch et al, 2008; Seppälä et al. 2006	mol N eq	II
Ionizing radiation, human health	And	Frischknecht et al. 2000	kBq eq. U235	II
Photochemical ozone formation, human health	POCP	Van Zelm et al., 2008, as applied in ReCiPe, 2008	kg eq. NMVOC	II
Human toxicity, non-cancerous	CTUh-nc	USEtox (Rosenbaum et al., 2008)	CTUh	III
Land use	Read	Soil quality index (based on Beck et al. 2010; LANCA, Bos et al., 2016)	pt	III
Use of resources, fossil fuels	ADPf	ADP for energy carriers, according to van Oers et al. 2002 as implemented in CML, v. 4.8 (2016)	MJ	III
Resource use, minerals and metals	ADPe	ADP for resources (minerals and metals), based on van Oers et al. 2002 as implemented in CML, v. 4.8 (2016)	kg Sb eq	III
Use of water resources	WU	AWARE 100 (from Boulay et al., 2018)	overall m^3 eq	III
Ecotoxicity, fresh water	Epf	USEtox (Rosenbaum et al., 2008)	CTUe	III/Interim
Human toxicity, cancerous	CTUh_nc	USEtox (Rosenbaum et al., 2008)	CTUh	III/Interim

Table 9 - Indicators recommended by the PEF method

5 https://www.etsi.org/deliver/etsi_es%5C203100_203199%5C203199%5C01.03.01_60%5Ces_203199v010301p.pdf
6 https://www.itu.int/en/action/environment-and-climate-change/Pages/default.aspx
7 https://negaoctet.org/
8 https://www.eco-conception.fr/
9 https://www.legifrance.gouv.fr/jorf/id/JORFTEXT000041553759/

Depletion of natural resources (minerals and metals) • Indicator Type: Problem-oriented impact indicator (mid-point) • Abbreviation: PEF-ADPe • Unit: kg Sb equivalent (kgeqSb) • Evaluation Method: ReCiPe 2018 Industrial exploitation leads to a decrease in available resources with limited reserves. This indicator assesses the amount of resources (minerals and metals) removed from nature as if they were antimony.	**Climate change** • Indicator Type: Problem-oriented impact indicator (mid-point) • Abbreviation: GWP • Unit: kg C02 equivalent (kgeqCO2) • Evaluation Methodology: IPCC Method 2013 Greenhouse gases (GHGs) are gaseous compounds that absorb infrared radiation emitted by the Earth's surface. The increase in their concentration in the Earth's atmosphere contributes to global warming.
Use of water resources • Indicator Type: Impact Indicator • Unit: m3 • Abbreviation: PEF-WU • Unit: m3 world eq • Méthode d'évaluation : Available Water REmaining (AWARE) as recommended by UNEP, 2016 Impact related to freshwater consumption (lakes, rivers or groundwater);	**Emission of fine particles** • Indicator Type: Problem-oriented impact indicator (mid-point) • Abbreviation: PEF-PM • Unit: Disease incidence • Méthode d'évaluation : PM method recommended by UNEP (UNEP 2016) The presence in the air of fine particles of small diameter, especially those with a diameter of less than 10 microns - represents a human health problem, since their inhalation can lead to respiratory and cardiovascular problems.
Acidification • Indicator Type: Problem-oriented impact indicator (mid-point) • Abbreviation: PEF-AP • Unit: mol H+ eq • Valuation method: Accumulated Exceedance (Seppälä et al. 2006, Posch et al, 2008) Air acidification is related to emissions of nitrogen oxides, sulphur oxides, ammonia and hydrochloric acid. These pollutants turn into acids in the presence of moisture, and their fallout can damage ecosystems as well as buildings.	**Ionizing radiation** • Indicator Type: Problem-oriented impact indicator (mid-point) • Abbreviation: PEF-IR • Unit: kBq U235 eq • Evaluation method: Human health effect model as developed by Dreicer et al. 1995 (Frischknecht et al, 2000) Radionuclides can be released during a number of human activities. When radionuclides decay, they release ionizing radiation. Human exposure to ionizing radiation damages DNA, which can lead to various types of cancer and birth defects.
Depletion of abiotic resources (fossils) • Indicator Type: Problem-oriented impact indicator (mid-point) • Abbreviation: **PEF-ADPf** • Unit: **GM** • Evaluation Method: CML 2002 The indicator represents the consumption of primary energy from different non-renewable sources (oil, natural gas, etc.).	**Primary energy consumption** • Indicator Type: Flow Indicator • Abbreviation: CED • Unit: GM cumulative primary energy. Primary energy is the first form of energy directly available in nature before any transformation: wood, coal, natural gas, oil, wind, solar radiation, hydraulic or geothermal energy, etc.

Table 10 - Description of the impact indicators selected

LEXICON

- **Life Cycle Assessment** (LCA): standardized evaluation method (ISO 14040 and 14044) to achieve a multi-criteria and multi-stage environmental assessment of a system (product, service, company or process) over its entire life cycle.
- **WEEE** : Waste Electrical and Electronic Equipment. In the field of responsible digital, particular attention is paid to categories 3 (information technology and telecommunications) and 4 (consumer equipment).
- **Data** Center: The physical place where computer servers for processing and storing computer data are grouped together.
- **Ecodesign** : also, "eco-design". According to the international standard ISO 14062, "eco-design consists of integrating the environment from the design of a product or service, and at all stages of its life cycle".
- **IT Ecolabel** : Ecolabels are intended to promote the design, marketing and use of products and services with a lower impact on the environment at each stage of their life cycle.
- **Rebound effect** : The Jevons paradox states that as technological improvements increase the efficiency with which a resource is used, the total consumption of that resource may increase rather than decrease.
- **Grey** energy: Grey energy or "embodied energy" in English, is the sum of the energies needed to make a product or service.
- **EPEAT** : IT ecolabel that covers the entire life cycle of the equipment, from the design of the equipment, to its use, including its end of life. Site: EPEAT.net
- **End of Life** : The stage in the life cycle of an object from which it is no longer used. The end of life itself has different sub-stages: collection, sorting, reconditioning, depollution, recycling, recovery (incineration) and landfill.
- **GHGs** (Greenhouse Gases): Greenhouse gases are gaseous components that absorb infrared radiation emitted by the Earth's surface, contributing to the greenhouse effect. The increase in their concentration in the Earth's atmosphere is a factor suspected of being at the origin of global warming. Global warming contributes to climate change, which is reflected, among other things, in the collapse of biodiversity. There are about ten GHGs including methane (CH_4), carbon dioxide (CO_2), water vapor (H_2O), sulfur hexafluoride (SF_6), etc.
- **Green IT Governance**: Organization set up by a company to manage its Green IT action plan. Steering consists of defining objectives, financial and human resources, responsibilities, milestones and indicators of progress. The steering committee is responsible for the smooth running of the process(es) to achieve the set objective.
- **Green IT** : Continuous improvement approach that aims to reduce the environmental, social and economic impacts of digital technology. The official term in France (very little used) is eco-TIC.
- **IT infrastructure** : All third-party equipment, software, and services shared across an organization's information system. This term essentially includes the network (WAN/LAN) and data centers.
- **Kilowatt hour** (kWh): unit of measurement of an amount of energy. Alternative to Joule, ISO international unit. For example, the power consumption of a computer in kWh per year is measured.
- **Ecological backpack**: Also called "ecological ruck-sack" and translated as MIPS (Material Intensity Per unit of Service) in English, this indicator measures the resource intensity of the manufacture of an object. It compares the weight of raw materials needed for manufacturing with the weight of the finished product. The ratio is, for example, 16,000:1 for a computer chip compared to 54:1 for a car.

- **Virtualization** (of servers): This approach involves creating a software image of underutilized physical servers and running those virtual servers on a single physical server. Reducing the number of physical servers reduces the associated environmental impacts.

SOURCES OF THIS LEXICON:

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