What future for digital technology in a carbon-neutral world - prospective workshop based on ADEME's work

ECO-ICT day, October 8 2024

Summary

The kind speakers

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- LCA study in IT
- Environmental database

2023 — ADEME

- Methodologies to evaluate the environmental footprint of IT services
- LCA study in IT
- Ecodesign and digital sufficiency

- PhD in eco-design and operational research

2020 — ADEME / Nantes Université

- Consulting in digital transformation

2017 — CENTRALE NANTES

- Web development
- Web eco-design

What is ADEME in France ?

State operator under supervision :

- Ministry of Ecological Transition, Energy, Climate and Risk Prevention;
- Ministry of Higher Education and Research.

Areas of activity

- Climate change
- Air quality and mobility;
- Energy;
- Sustainable production;
- Urban planning;
- Agriculture and forests;
- **Circular economy;**
- Buildings;
- Behavior change.

Our missions :

- Amplify the deployment of the ecological transition;
- Contribute to collective expertise;
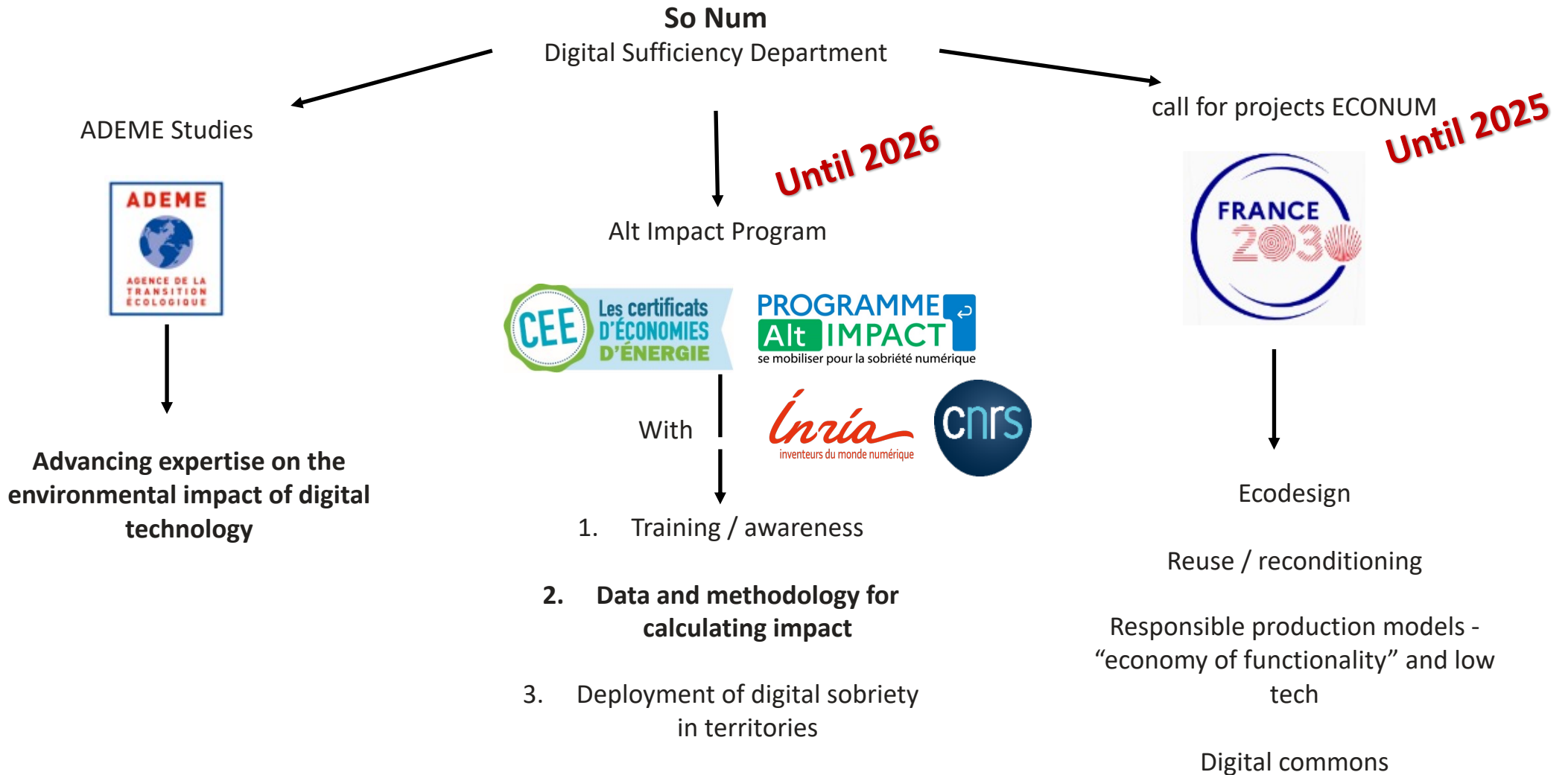- Innovate and prepare for the future.

How ?

- Tools and methodologies
- Animation
- Expertise
- Financing

https://agirpourlatransition.ademe.fr/
https://www.ademe.fr/

A department dedicated to digital sufficiency

So Num
Digital Sufficiency Department

ADEME Studies

call for projects ECONUM

Until 2026

Until 2025

Alt Impact Program

Advancing expertise on the environmental impact of digital technology

With

1. Training / awareness

2. **Data and methodology for calculating impact**

3. Deployment of digital sobriety in territories

Ecodesign

Reuse / reconditioning

Responsible production models - "economy of functionality" and low tech

Digital commons

Expertise on the environmental impact of digital technology

	Objectives	Examples
1	Produce environmental assessment studies	Impacts of digital in France, digital and metals, audivosiual services, IT4Green ...
2	Environmental database for digital	BASE EMPREINTE®
3	Methodologies for LCA of digital services	PCR* Digital service, Internet Service Provision, Datacenter and Cloud ...
4	Identification of measurement and evaluation tools	Many existing tools

Alt impact

*PCR : Product Categorie Rules

Digital responsibility or digital sufficiency?

Digital Responsibility

Social
- Inclusion
- Accessibility
- Human Rights
- ...

Ethics
- Democratic Impact
- Discriminations
- Open source
- ...

Environment
- Carbon Impact
- Metals extraction
- Fresh water consumption
- ...

Digital Sufficiency

Digital responsibility in France

Legislators: MINISTÈRE DE LA TRANSITION ÉCOLOGIQUE ET DE LA COHÉSION DES TERRITOIRES, DINUM, afnor GROUPE

Supervisors

Driving and funding: arcep, Arcom, ADEME AGENCE DE LA TRANSITION ÉCOLOGIQUE

Research: Inria inventeurs du monde numérique, cnrs, EcoInfo

Work groups: INR Institut du Numérique Responsable, green it, Boavizta

Public structures: anct agence nationale de la cohésion des territoires, conseil national du numérique

Associations: AFNUM Alliance Française des Industries du Numérique, HOP HALTE À L'OBSOLESCENCE PROGRAMMÉE

Operators

Raising awareness   Ecodesign   Consulting   GreenIT industry   Service providers

Education and training   Datacenters   Networks   GreenIT tools   End of Life structures   Databases

Circular Economy Department / Digital Sufficiency Service

https://aelan.fr/posts/panorama-des-acteurs-numerique-responsable-1ere-edition

Legislative framework in France

Feb 2020	Feb 2021	Nov 2021	July 2023
Anti-waste law for a circular economy (AGEC)	Government roadmap "digital and the environment"	Digital Footprint Reduction Law (REEN)	The Ecoresponsible Digital Acceleration Strategy - France 2030

Feb 2020
- Repairability and durability index
- Environmental labelling for telecom operators
- Reconditioning
- ...

Feb 2021
- Study on the environmental impact of digital technology in France and action plan to reduce it
- ...

Nov 2021
- Observatory on the environmental impact of digital technology
- Responsible digital strategy for municipalities
- Ecodesign framework
- Recommendation on informing consumers about the impact of online video

July 2023
- Encouraging eco-design, AAP ECONUM
- Initial and continuing training in eco-design and digital sufficiency
- ...

What scope

The environmental impact of digital technology in France

Sept 2020: ADEME-ARCEP mission letter to work on assessing the env. footprint of digital technology in France

> Part 1: study methodology (life cycle assessment) :
   Multi-criteria: 12 environmental impact criteria (carbon footprint, consumption of metals and minerals, etc.).
   Multi-component: user devices, networks and data centers.
   Multi-stage: manufacture, distribution, use, end-of-life.

> Part 2: assessment of the environmental impact of digital technology in France in 2020.

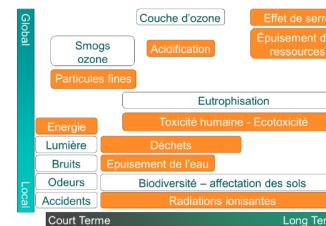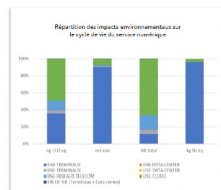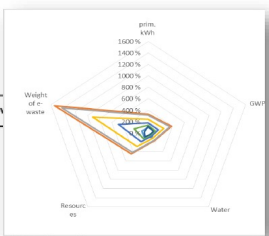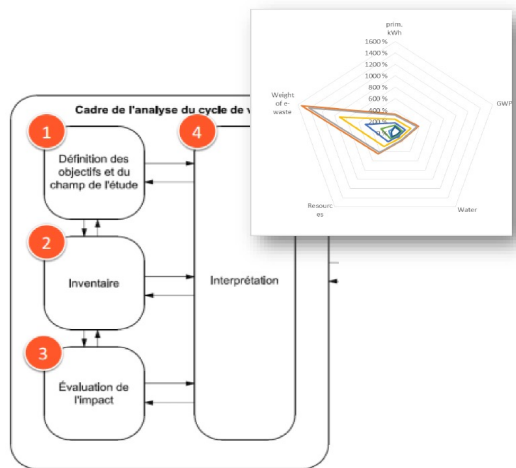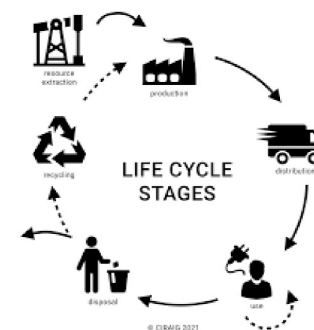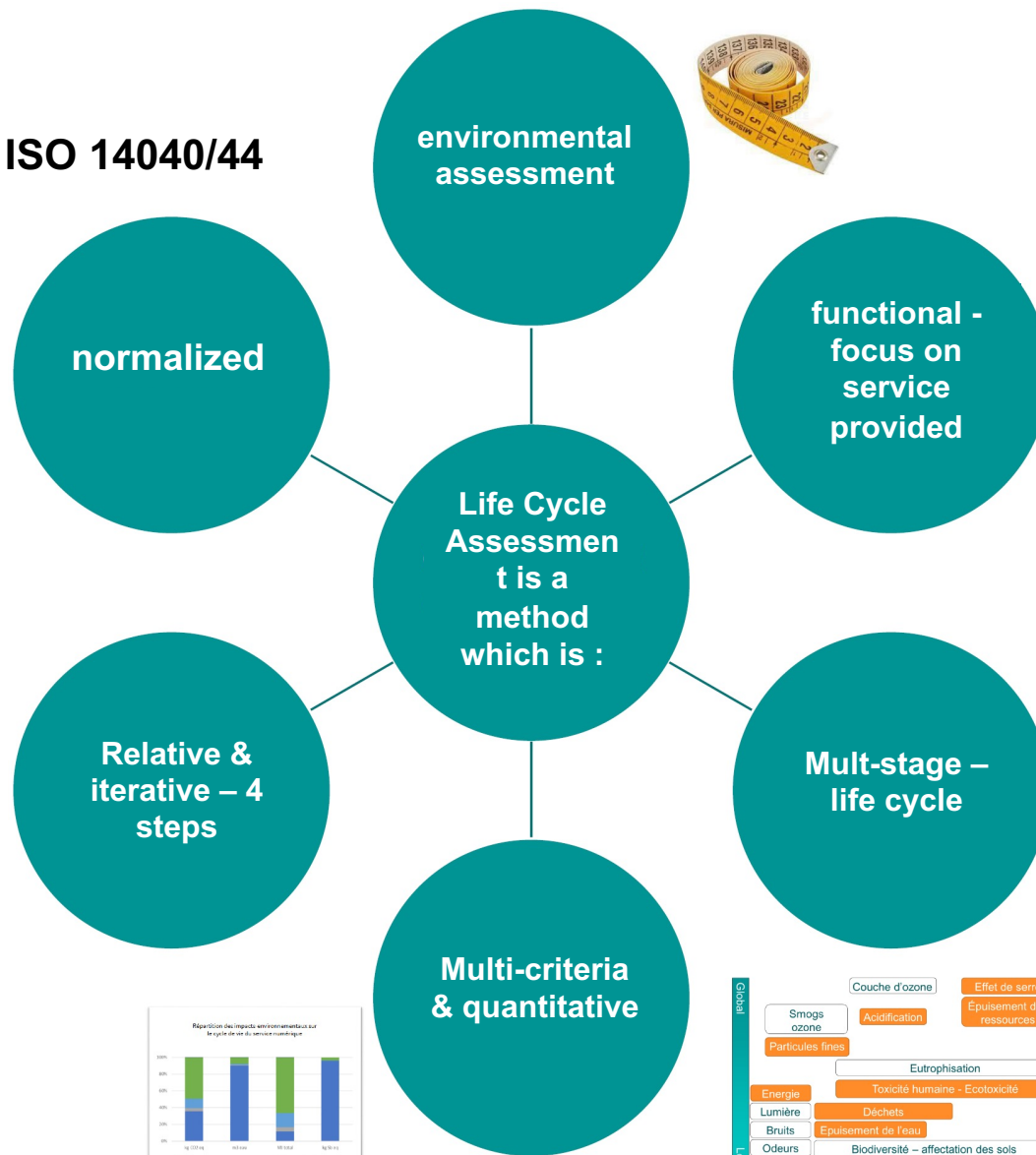**> Part 3: prospective analysis for 2030 and 2050.**

Life cycle assessment - definition

- Life cycle assessment is the most advanced tool for the global, multi-criteria evaluation of environmental impacts. This standardized method assesses the quantifiable effects of products or services on the environment.

- Life Cycle Assessment (LCA) identifies and quantifies the physical flows of materials and energy associated with human activities, throughout a product's life cycle. It assesses potential impacts, then interprets the results obtained according to its objectives

Source : https://expertises.ademe.fr/economie-circulaire/consommer-autrement/passer-a-laction/dossier/lanalyse-cycle-vie/comment-realise-t-acv

What is Life Cycle Assessment?
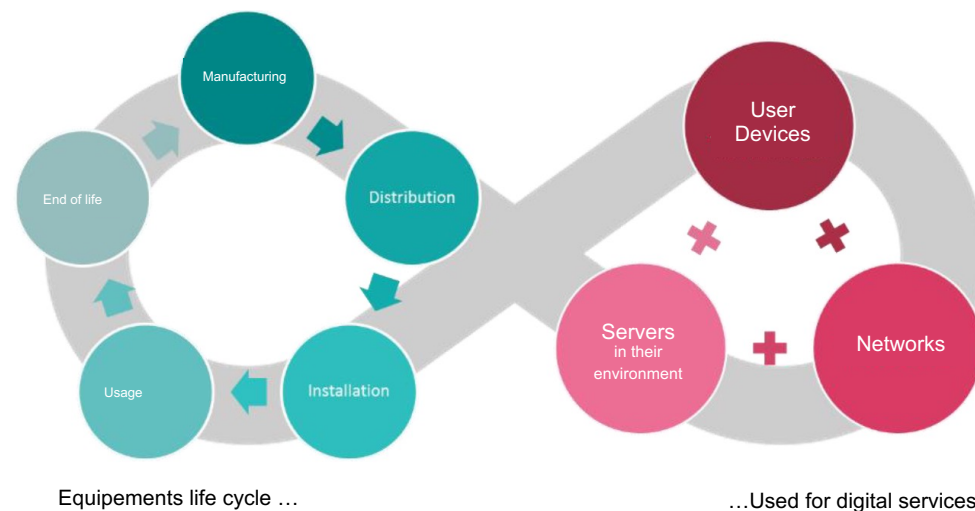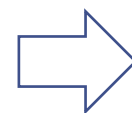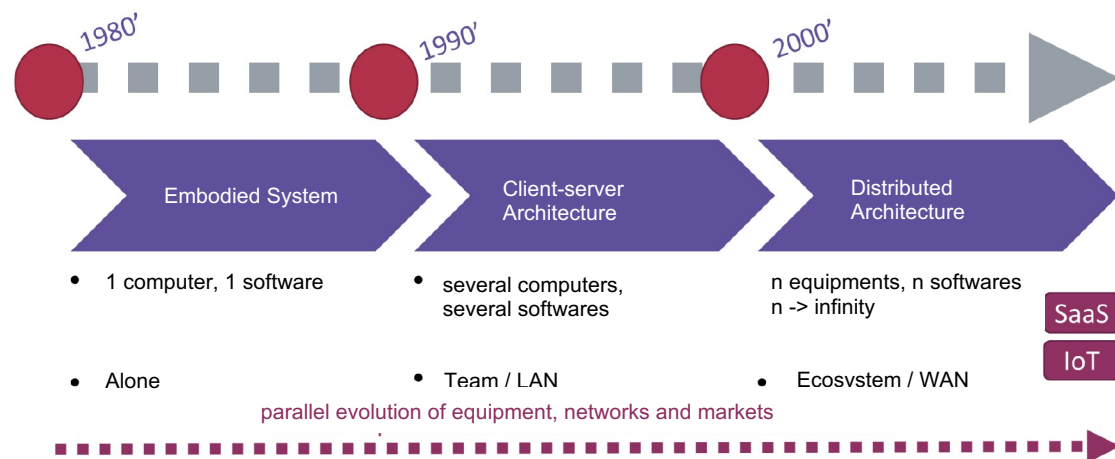
ISO 14040/44

- environmental assessment
- functional - focus on service provided
- normalized
- Life Cycle Assessment is a method which is :
- Mult-stage – life cycle
- Relative & iterative – 4 steps
- Multi-criteria & quantitative

Challenges of LCA applied to the digital sector

Increasingly complex systems...

1980' 1990' 2000'

Embodied System → **Client-server Architecture** → **Distributed Architecture**

- 1 computer, 1 software
- Alone

- several computers, several softwares
- Team / LAN

- n equipments, n softwares
  n -> infinity
- Ecosystem / WAN

SaaS
IoT

parallel evolution of equipment, networks and markets

Equipements life cycle …

Manufacturing
Distribution
Installation
Usage
End of life

User Devices
Servers in their environment
Networks

…Used for digital services

... requiring a multi-dimensional lifecycle approach

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The environmental impact of digital technology in France

The carbon footprint of the digital sector in France

17.2 Mt CO2 eq. or 2.5% of the national footprint

Energy consumption: carbon footprint, ionizing radiation and depletion of abiotic fossil resources
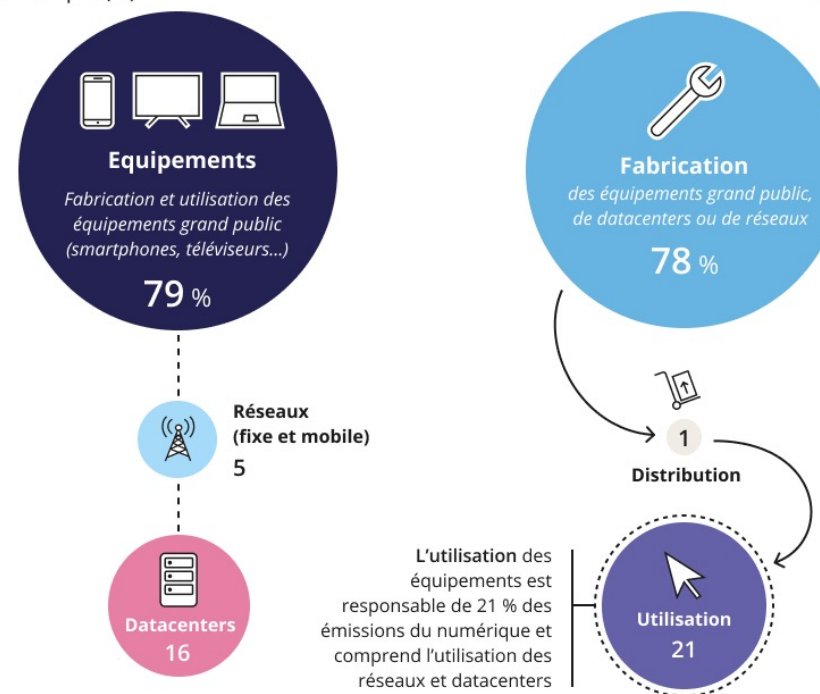
10% of French electricity consumption, i.e. 48.7 TWh per year

Depletion of natural abiotic resources (minerals & metals): represents around **27% of the environmental impact** of digital technology, and is equivalent to the extraction of 21 tonnes of gold.
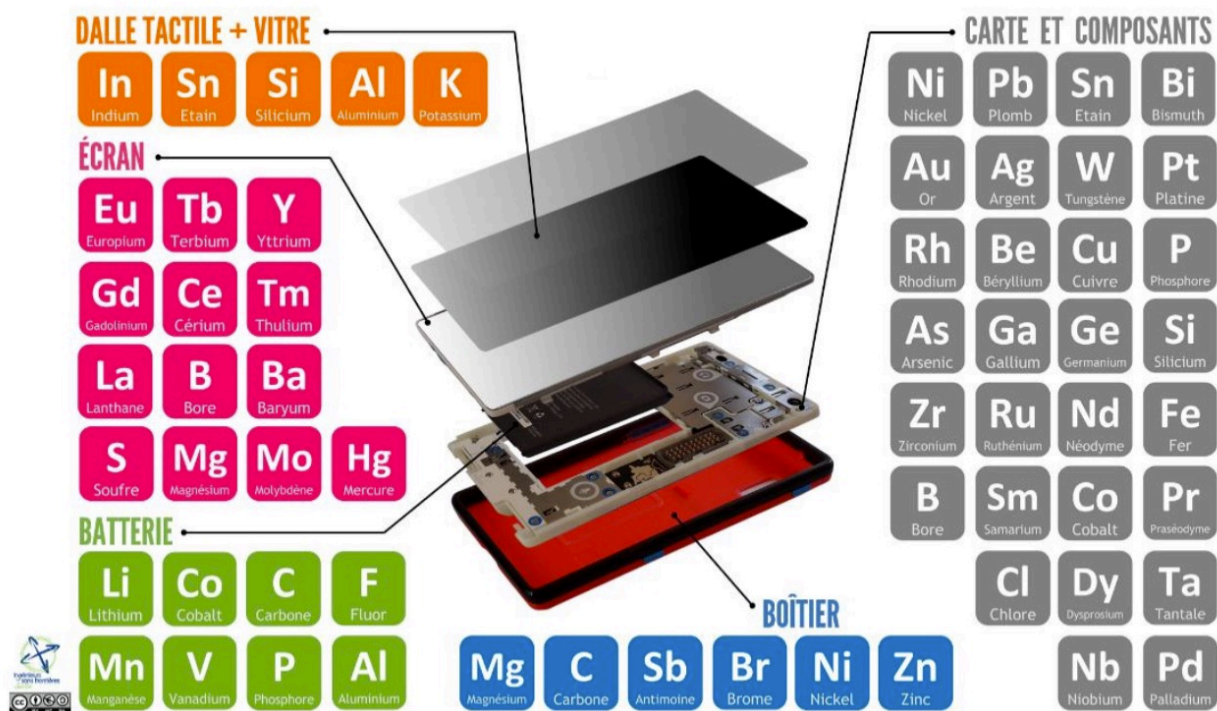
L'empreinte carbone du numérique dépend essentiellement des équipements et de leur fabrication

Répartition de l'empreinte carbone du numérique en 2020 par composantes du numérique (%)

Répartition de l'empreinte carbone du numérique en 2020 par phase du cycle de vie (%)

Equipements
Fabrication et utilisation des équipements grand public (smartphones, téléviseurs...)
79 %

Fabrication
des équipements grand public, de datacenters ou de réseaux
78 %

Réseaux (fixe et mobile) 5

Datacenters 16

1 Distribution

L'utilisation des équipements est responsable de 21 % des émissions du numérique et comprend l'utilisation des réseaux et datacenters

Utilisation 21

Focus: mining

A smartphone requires some fifty different metals

Liste des métaux présents dans un smartphone - Source : Ingénieurs Sans Frontières

→ Further reading: David Maenda Kithoko's lecture "Pour une écologie décoloniale du numérique" ("For a decolonial ecology of the digital age")
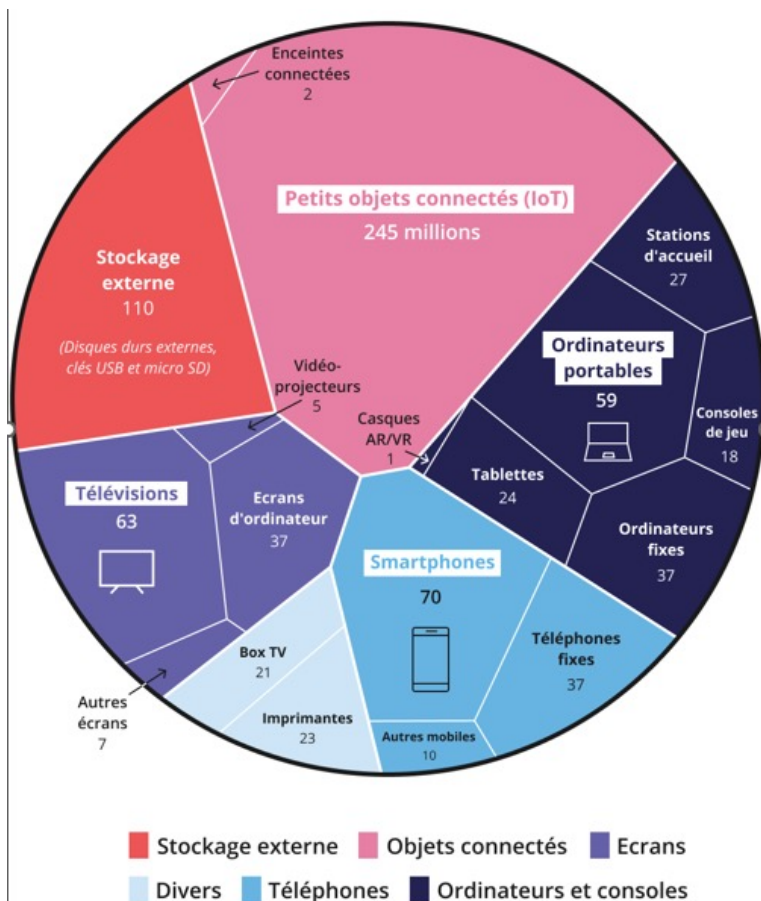

Palabora Mine - 4.1 million tonnes of copper
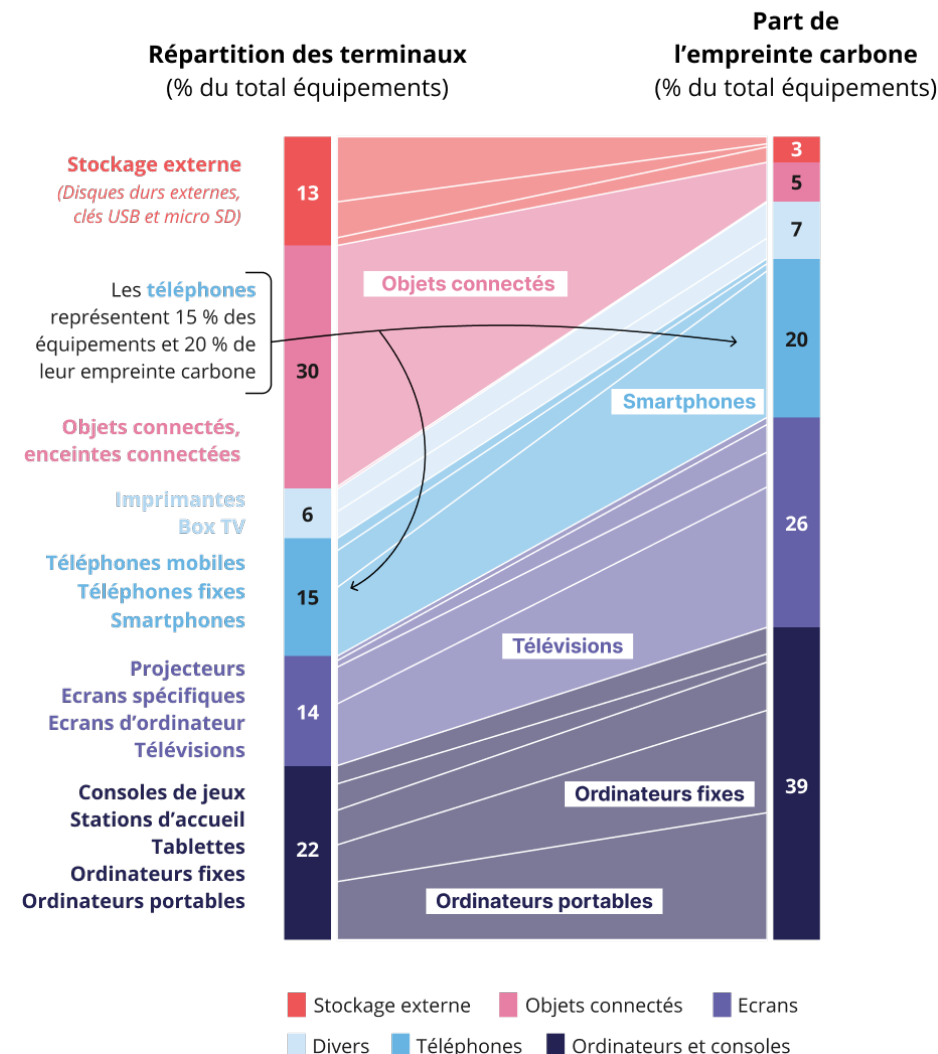*https://dillonmarsh.com/fwiw.html*

User devices: 65 to 90% of environmental impact

La responsabilité des équipements sur l'empreinte carbone du numérique comparée à leur nombre

Répartition du nombre d'équipements en France et comparaison avec la répartition de leur empreinte carbone (sur tout le cycle de vie)

Prospective analysis for 2030 and 2050

- **Objectives:** assess the environmental impact of digital technology in different scenarios

- **Methodology:** Assessment of a trend scenario based on modeling of the 2020 impact.

Scenario-based approach to project developments that differ from observed trends and identify levers for improvement. It is divided into two exercises:

By 2030, with eco-design and sobriety scenarios combining actions that act on the main parameters of the model;

By 2050, with scenarios based on the **four social paths** proposed by ADEME in *"Transition(s) 2050"*.

How to achieve carbon neutrality in 2050?
ADEME has developed 4 "typical" pathways to feed the debate.

S1 FRUGAL GENERATION	S2 REGIONAL COOPERATION	S3 GREEN TECHNOLOGIES	S4 RESTORATION GAMBLE
Constraint frugality	**Sustainable lifestyles**	**Decarbonation technologies**	**Mass consumption**
Medium-sized towns and rural areas	Sharing economy	Biomass used	Urban sprawl
Low-tech	**Open governance**	Hydrogen	**Technologiesuncertain**
Massive renovation	Controlled mobility	**Green consumerism**	
New prosperity indicators	Environmental taxation	Minimum control	Globalized economy
Localism	**Cooperation between territories**	**Metropolises**	**Artificial Inteligence**
3x less meat	Targeted reindustrialization	Deconstruction / reconstruction	**Capturing CO2 from the air**
			Intensive agriculture

The ADEME scenarios all aim for carbon neutrality by 2050 and correspond to different societal choices.

Change compared with 2020	Terminal park	Lifespan	Unitary consumption	Usage
S4 Scenario « repairing bet » : Acceleration of current trends and digital headlong rush	↗ IoT x40	=	↘	↗↗↗↗ +25 %/an
S3 Scenario «Green technologies» : Continuing the trend : technologies bring the solutions	↗ IoT x15	=	↘	↗↗↗ +20 %/an
S2 Scenario « territorial cooperation » : Setting production and consumption habits and seeking efficiency	= Sauf IoT x3	+1 an	↘↘ ÷2	↗↗ +15 %/an
S1 Scenario « frugal generation »: Consumption as close as possible to needs and systematic eco-design	↘ Smartphones : -20 % IoT constant	+2 ans	↘↘↘ ÷3	↗ +10 %/an

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For ICT ?   📱 1   💻 1/home   🖥 \ ÷3   🖨 \ ÷3

S1 FRUGAL GENERATION

Same number of digital devices as in 2020

Fixed-line networks only use optical fiber

Datacenters are optimized

On average components require 3x less energy

No advertising screens

Mobile networks adopt sharing policy

- ✓ The principles of digital sobriety and eco-responsibility are the general norm
- ✓ Major changes in behaviour towards more sobriety
- ✓ Situations of shortages of essential raw materials
- ✓ Rise of low-tech products and services
- ✓ A clean break from current lifestyles
- ✓ Industries are reducing the use of all-connected systems by questioning the data feedback.
- ✓ The whole of society has access to the minimum of digital services for health, education, mobility, etc.
- ✓ Digital services are prioritized according to their usefulness to society
- ✓ Extensive communication on low-impact usage, in particular to limit rebound effects
- ✓ Hardware is optimized thanks to design efforts that extend the lifespan of equipments (servers, terminals), their reparability and without software obsolescence.

How to achieve carbon neutrality in 2050?
ADEME has developed 4 "typical" pathways to feed the debate.

For ICT ?

📱 1,1 💻 =2020 🖥 =2020 🖨 \ ÷2

REGIONAL COOPERATION
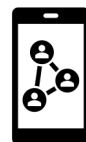
The number of connected devices is limited

Lifespan of devices is extended

Networks only use optical fiber

Datacenters are optimized
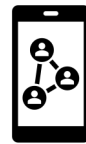
On average components require 2x less energy

- ✓ Production and consumption habits are close to those of 2020
- ✓ A global approach to limit environmental impacts through technological developments
- ✓ All types of territory are considered in the digital transition
- ✓ Equipment requirements are systematically analyzed prior to acquisition.
- ✓ The search for efficiency and responsiveness to needs is systematic.
- ✓ Digital services considered more useful to society are given priority
- ✓ Communication focuses mainly on eco-actions and sobriety
- ✓ Digital services are accessible to all
- ✓ Eco-design and sobriety principles are the norm with a less restrictive vision than S1
- ✓ The whole society is committed to finding solutions for responsible digital services.
- ✓ Focus on reuse and recycling

For ICT ?

GREEN TECHNOLOGIES

The number of connected device continues to rise

Networks only use optical fiber

Datacenters are optimized but not limited

Equipments are more efficient

✓ Based on widespread consumption of eco-designed digital productsMajor changes in behaviour towards more sobriety

✓ Limiting impacts through technological developments rather than behavioral changes.

✓ The digital revolution is taking place mainly in <u>urban areas</u>, where access to very high-speed broadband (fiber optics) is widespread.

✓ Digital uses are increasing considerably

✓ Sensors and IoT are widely used on a large scale but are designed to limitate and to optimize their usage.

✓ A focus on quality and performance limits over-equipment.

✓ Awareness of the environmental impact of digital technology and recycling

✓ High rebound effects

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How to achieve carbon neutrality in 2050?
ADEME has developed 4 "typical" pathways to feed the debate.

S4 RESTORATION GAMBLE
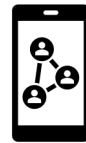
The number of connected device is exploding

6G

Huge datacenters and cloud services

Equipments are more efficient

Datacenters are optimized but not limited

For ICT ?

✓ Everything is digitalized, (autonomous vehicles, smart homes, smart cities, metaverse)

✓ New technologies are encouraged: smart grids, blockchain, metaverse, AI services

✓ The development of digital services is leading to a proliferation of equipment

✓ Server centers multiply in number and size with dedicated energy production systems

✓ Sensors and IoT are widely used on a large scale

✓ Awareness of the environmental impact of digital technology and recycling

✓ High rebound effects

✓ This radical vision is based on the need to master other technologies, in particular energy production and storage, as well as carbon capture and sequestration.

Workshop ! *(45 minutes)*

➤ Form 8 groups, 2 groups per scenario (5-6 per group, diversity is encouraged !)

Project yourself into one of ADEME's scenarios :
What might my job be like in France in 2050 (doctoral student, teacher, researcher, etc.)?

By yourself : 8 minutes

By pair : 7 minutes

Group : 15 minutes

Together : 15 minutes

Research topics

Administrative

Data and calculation management

International collaboration

Scientific watch

Teaching

Daily work organization

Local collaboration

Tips : focus on 2/3 topics per person

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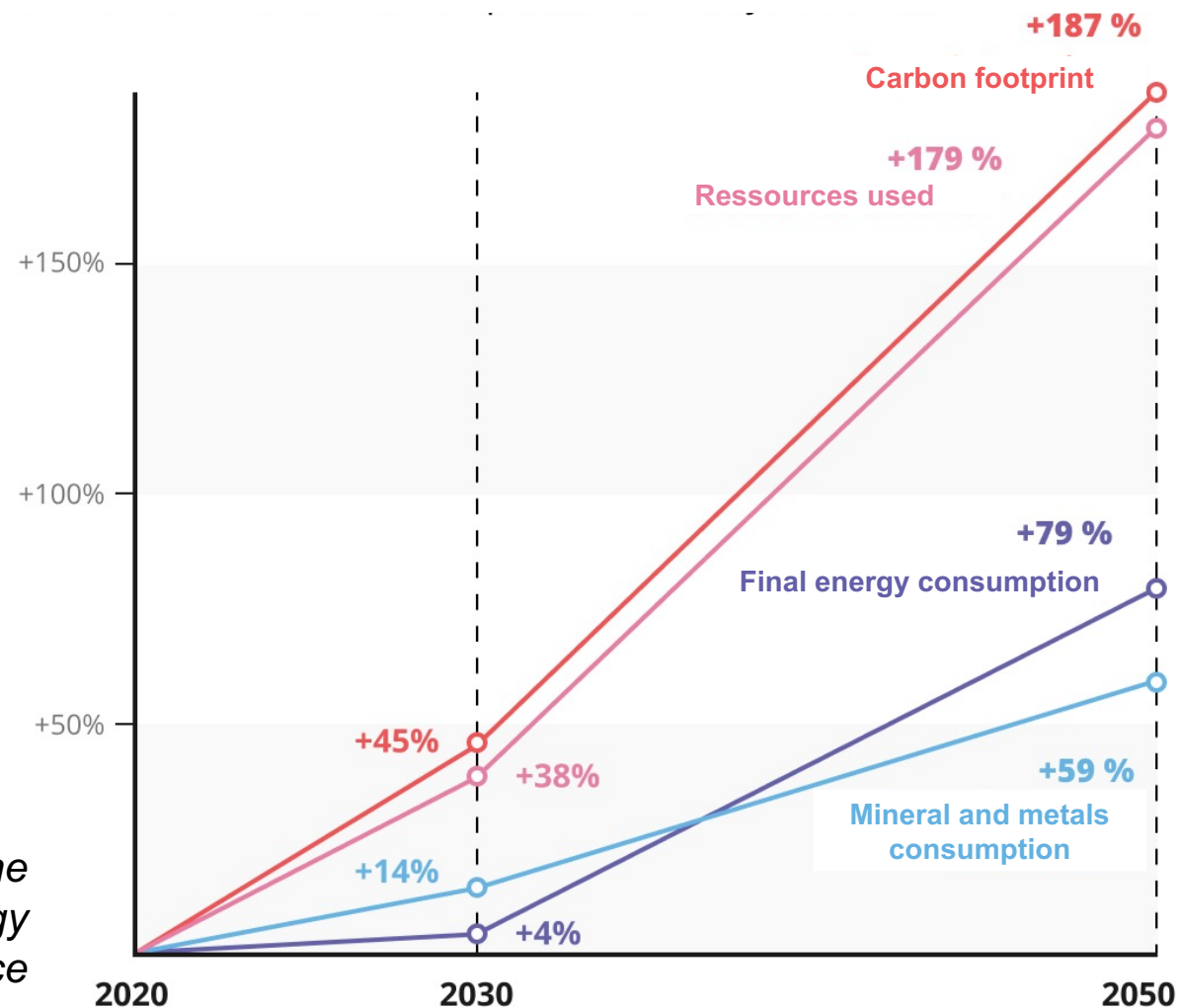*Liberté*
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How to achieve carbon neutrality in 2050?
ADEME has developed 4 "typical" pathways to feed the debate.

Without action to reduce it, the digital industry's carbon footprint could triple by 2050, while energy consumption could double.

Trends in four indicators of the environmental impact of digital technology in France
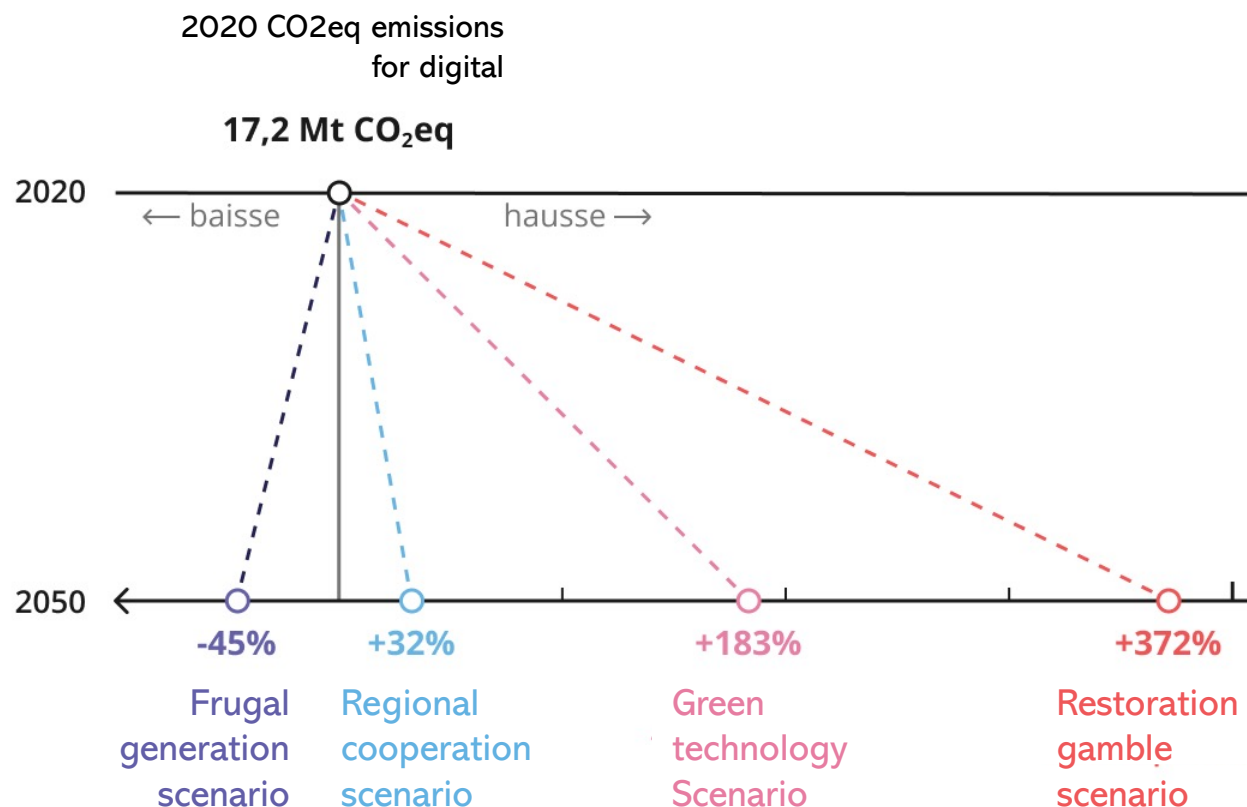

+187 %
Carbon footprint

+179 %
Ressources used

+150%

+100%

+79 %
Final energy consumption

+50%

+45%

+38%

+59 %
Mineral and metals consumption

+14%

+4%

2020   2030   2050

How to achieve carbon neutrality in 2050?
ADEME has developed 4 "typical" pathways to feed the debate.

Society choices: what carbon footprint for France in 2050?

For each scenario : Rate of change for CO2eq emissions from the digital sector in 2050 (over the entire lifecycle) compared with 2020.

2020 CO2eq emissions for digital

17,2 Mt CO₂eq

2020   ← baisse   hausse →

2050

-45%   +32%   +183%   +372%

Frugal   Regional   Green   Restoration
generation   cooperation   technology   gamble
scenario   scenario   Scenario   scenario

What solutions ?

Formation / awareness

Data and methodology for calculating impact

PROGRAMME Alt IMPACT
se mobiliser pour la sobriété numérique

Deployment of digital sobriety in territories

Low-tech

Accessibility

Education

Decision-making

Standardization

Legislation

Prioritization

Cross-disciplinary research

Caution

Ressources

Thank you !

To go further :

Librairie ADEME   https://librairie.ademe.fr/
Base Empreinte   https://base-empreinte.ademe.fr/

References (french versions) :

- *Evaluation du numérique en France et analyse prospective*, Etude ADEME Arcep, 2022
- *Empreinte environnementale du numérique mondial*, GreenIT.fr, Frédéric Bordage, 2019
- *Prospective – Transitions 2050 – Rapport*, ADEME, 2021
- *Référentiel méthodologique d'évaluation environnemental des systèmes d'information* , Référentiel 2023
- *Etude de l'impact environnemental du numérique en France* , Etude ADEME Arcep Arcom 2024

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