THE SHIFT PROJECT

THE CARBON TRANSITION THINK TANK

ENERGY & CLIMATE

LEAN NETWORKS FOR RESILIENT CONNECTED USES

Digital infrastructures adapted to the dual carbon constraint

SYNTHESIS - MARCH 2024

DIGITAL TECHNOLOGY, BOTH A TOOL AND A CHALLENGE FOR DECARBONISING THE ECONOMY

Digital technologies are not virtual tools but physical media.

Exchanging data is only possible thanks to devices (smartphones, computers, tablets, etc.), network infrastructures (terrestrial and submarine cables, mobile network antennas, fibre optics, etc.), servers, and data centres.

The digital sector's carbon footprint, which is growing at an average rate of 6% per year, already accounts for 3 to 4% of global emissions today (The Shift Project, 2021).

In France, it represents **at least 2.5% of the national footprint** (ADEME & Arcep, 2023).

Like other sectors of the economy, it must meet its decarbonisation target: **-45% by 2030 compared with 2020 at global level** (SBTi et al., 2020), which The Shift Project proposes to translate into a target of **-30% by 2030 for France.**

In a context of intense electrification of uses (mobility, buildings, industry, etc.), it is at the heart of planning and supply issues.

+6%

A YEAR

DIGITAL CARBON FOOTPRINT

-30%

COMPARED WITH 2020

DECARBONIZATION TARGET FOR 2030 FOR FRANCE

WHY
WORK ON
MOBILE NETWORKS ?

MOBILE NETWORKS ACCOUNT FOR BETWEEN

12 & 25-35%

OF THE GLOBAL DIGITAL CARBON FOOTPRINT (1)

EN FRANCE

5,5 %

according to the ADEME-Arcep study(2)

In France, the electricity consumption of the 4 main operators grew at an average rate of 6% per year between 2017 and 2021, reaching almost 4 TWh in 2021, 60% of which was for the mobile access network alone(3).

These network-specific dynamics are part of a **systemic rationale** : the deployment choices made at network level have an impact on the digital system as a whole, while also being the result of the overall trajectory given to the system and its uses.

THE MOBILE NETWORK **MODEL**

The Shift Project draws on the development of a new Energy-Carbon model for mobile networks

The quantitative simulations are carried out on French mainland territory, but **the model can be configured** to guide the thinking of public and private players in this field, in France and across Europe.
The model can be used to **quantify the energy-climate consequences** of deployment choices: technological suitability (throughput, latency, frequencies and bands, energy performance, etc.), coverage in terms of population and surface area, regulatory constraints (road coverage, minimum throughput, etc.), capacity requirements.

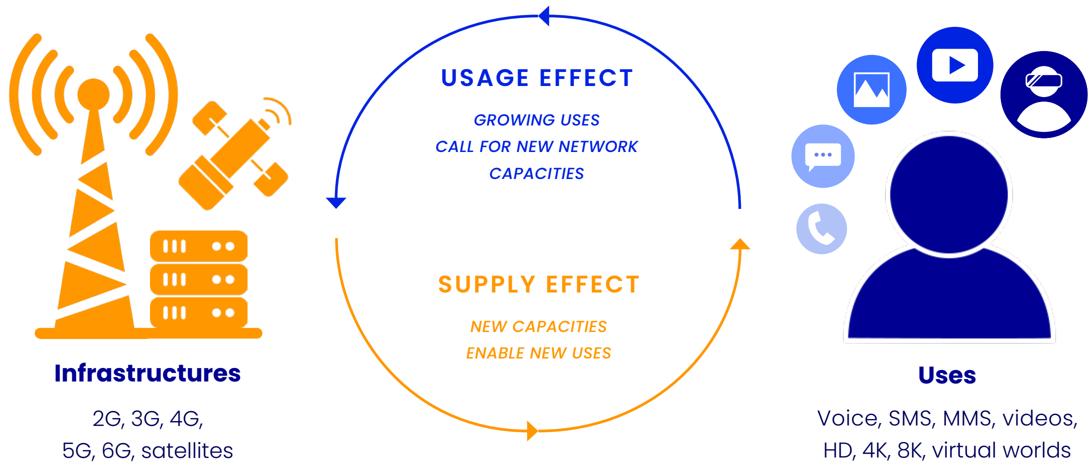
(1) Freitag C. et al., 2021; Malmodin J. et al., 2023; The Shift Project, 2021
(2) ADEME & Arcep, 2023
(3) Arcep, 2023

ENVIRONNEMENTAL
IMPACTS

The current dynamic is *cyclical*

Deployment decisions are aimed at **adapting infrastructures to the expected evolution of digital uses** (usage effect). Once the infrastructures have been deployed, **the uses develop according to new dynamics** (supply effect) until they reach new levels, thereby calling for new capacities and new needs.

OUR USES & OUR NETWORKS
are two facets of the same dynamic



Source : The Shift Project, 2024

We inherit our past deployment choices and their impacts. **The deployment trajectories endorsed in 2020** (5G specifications and regulations, deployment of the new generation, investment in new applications, etc.) **have confirmed the infrastructure's strengthening** : deployment of new 5G sites, coverage of motorways and roads, generalisation of increased performance (240 Mb/s). **Capacity requirements, in a second phase, will amplify the momentum created.**

LEAN NETWORKS

TOWARDS A LOW-CARBON AND RESILIENT COVERAGE

For a country like France, t**he undifferentiated deployment and widespread adoption of very intensive uses** (virtual worlds, IoT, IIoT, AI, etc.) could lead to a **20% increase in the total carbon impact of the mobile network compared with the reference scenario,** and an increase in its electricity consumption of **more than 4 TWh** (i.e. a 2.5-fold increase) **between 2020 and 2035.**

+4 TWH

INCREASE OF ELECTRIC CONSUMPTION

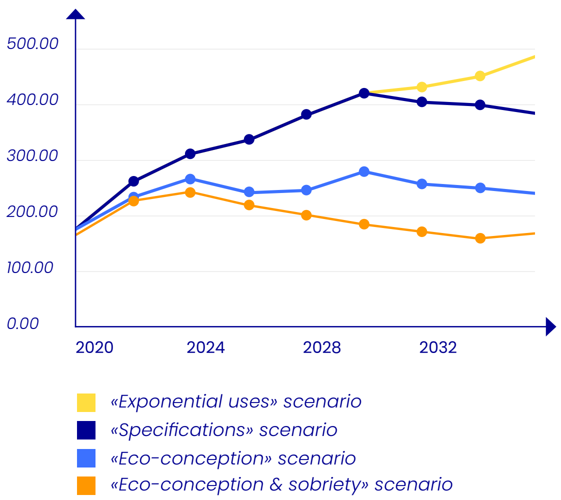
BEING ×2,5

BETWEEN 2020 ANS 2035

GREENHOUSE GAS EMISSIONS

Mobile networks in France

(in ktCO²e/year)



Source : The Shift Project, for the purpose of this report

HOWEVER, MOBILE NETWORKS CAN BECOME THE PIVOTAL POINT OF A LEAN AND RESILIENT DIGITAL FUTURE, by stabilising their footprint and basing their future deployment strategies (4G, 5G, 6G) on usage development scenarios that are compatible with the digital decarbonisation trajectory.

To achieve this, the players involved must jointly activate the «eco-design» and «sobriety» levers (extending lifetimes, improving energy efficiency, modifying regulatory constraints, sharing, designing a different type of 6G to help decarbonisation, managing usage growth).

Without a strategy to contain the growth in data traffic, it will be impossible to reap the benefits of eco-design efforts.

SATELLITE
NETWORKS

Despite a **limited number of users** (71 million), satellite networks are meeting **growing coverage challenges**, with some offering service levels (very high bandwidth, low latency) that are comparable to certain terrestrial networks.

In coverage black spots, geostationary satellites provide very high speed internet access; low orbit constellations provide low latency access. But the mechanisms underlying the carbon-energy impacts of satellite network deployment are completely different from those of the rest of the digital sector. During satellite launches and re-entries, particles are emitted with alarming and poorly understood effects on radiative forcing and ozone, known as «non-CO2» effects.

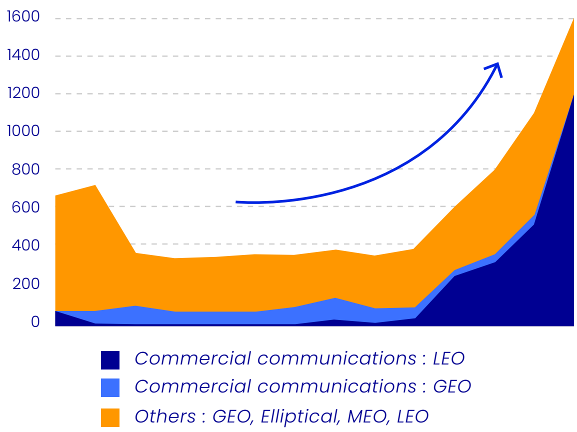
« Full coverage x very high speed x low latency » connectivity services are putting the space sector on an unsustainable trajectory:

- In 2022, the payload mass dedicated to these services (LEO commercial communications) became as large as the payload mass of all other space activities combined (see opposite).
- Between now and 2050, these services will increase the mass injected into orbit tenfold, making it impossible to control the environmental footprint of the space sector.

MASS OF PAYLOAD

placed in orbit between 2010 and 2022

(in t/year)



Aero Décarbo - The Shift Project for the purpose of this report, based on UCS (UCS, 2023) and Discos (ESA, 2024a).

- The annual footprint of a constellation like Starlink is estimated at over 1,600 ktCO2e/year, i.e. almost twice that of the French fixed and mobile networks in 2020 (ADEME & Arcep, 2023) for 2 million users to date. This footprint is not expected to decrease, as the infrastructure must be replaced every 5 years.
- A comparative study of several internet access solutions shows that the environmental cost is due to both the choice of a low latency, very high speed service, and to capacity deployment.

MAKING SATELLITE NETWORKS A RELEVANT BUILDING BLOCK OF A LEAN AND RESILIENT DIGITAL SYSTEM

1

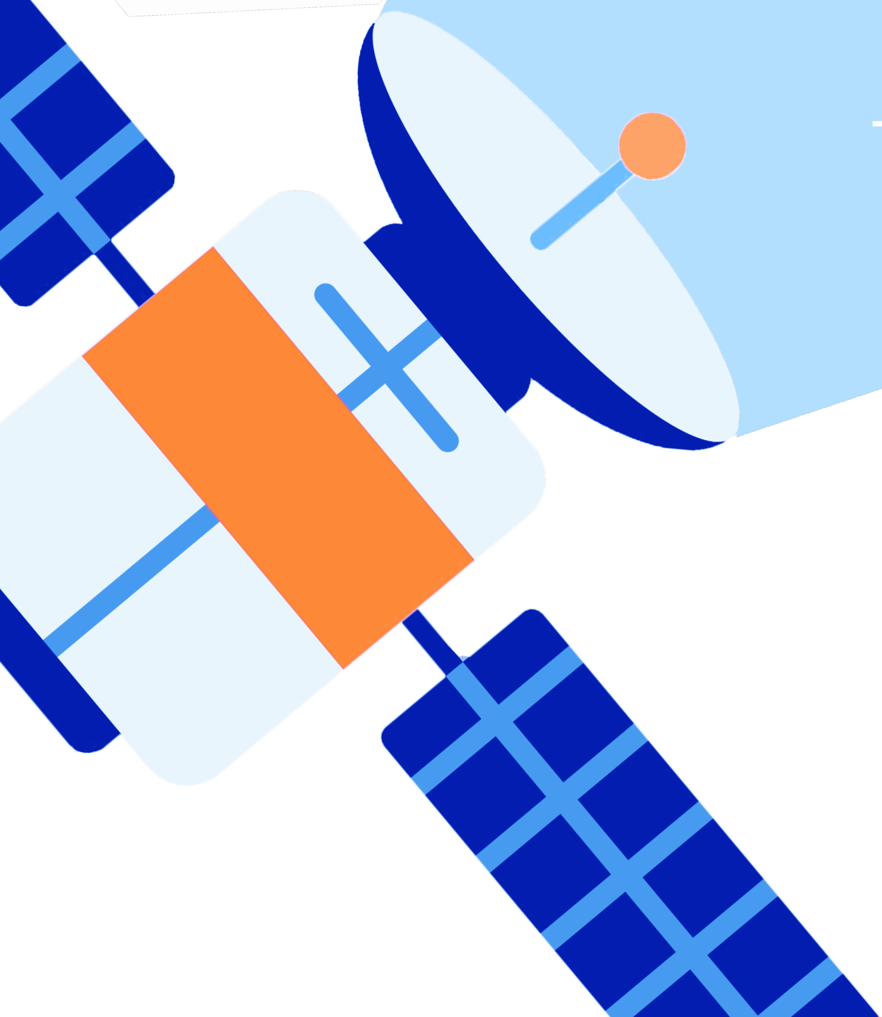
Alongside a medium-term reduction in uncertainties about the effects

of particles emitted during the launch and re-entry of satellites on both the climate and ozone, decision-making as a result of these academic gaps.

2

A reflection on possible decarbonization trajectories possibles

and the sector's role in achieving the carbon neutrality objectives set by France for 2050, leading to an in-depth review of the range of telecommunications missions carried out.



3

Reconsidering the connectivity strategy

for the full « coverage x very high speed x low latency triptych », since replicating a Starlink-type solution to ensure truly global internet access would be an environmental dead end.

RECOMMANDATIONS

FOR ADAPTING INFRASTRUCTURE TO THE DUAL CARBON CONSTRAINT

Measurement and transparency 1

Provide a quantitative reference framework (trajectory, indicators, monitoring) for steering the digital sector to redirect digital strategies towards compatibility with the double carbon constraint, i.e. towards a target of -45% by 2030 compared with 2020 at global level and -30% by 2030 for France.

Optimisation 2

Optimise deployment strategies and technological strategies to reduce electricity consumption in the operational phase while limiting the embedded carbon footprint (lifespan, energy efficiency, technological suitability, etc.).

Collective reorganisation towards sobriety 3

Curb the inflation of data-intensive uses to ensure controlled growth in data volumes (targeted deployment of 5G, design of services that promote sobriety, design of 6G to promote decarbonisation, etc.).

Training and skills 4

Train all stakeholders in order to achieve the level of understanding of the issues at stake and the technical expertise that is needed to implement lean and resilient infrastructures.

CONCLUSION

The key challenges of mobile and satellite network deployment strategies in the face of the dual carbon constraint must be **reintegrated into a systemic vision** : at the scale of network infrastructures as a whole, of digital technology as a whole, and within the usage systems upon which it is entirely interdependent.

The sustainability of our essential usages will only be guaranteed by **by adapting the digital system to the dual carbon constraint** which involves keeping our equipment volumes and data volumes under control.

Positioning our technological choices towards digital sobriety is not just a response to physical constraints, but an opportunity to set a new direction around which to structure **a genuine European digital ecosystem** for the 21st century.

THE SHIFT PROJECT

The Shift Project is a think tank working towards a post-carbon economy. As a non-profit organization recognized as being in the public interest and guided by the demands of scientific rigor, our mission is to enlighten and influence the debate on the energy transition in Europe. Our members are large companies that want to make the energy transition their priority.

www.theshiftproject.com

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