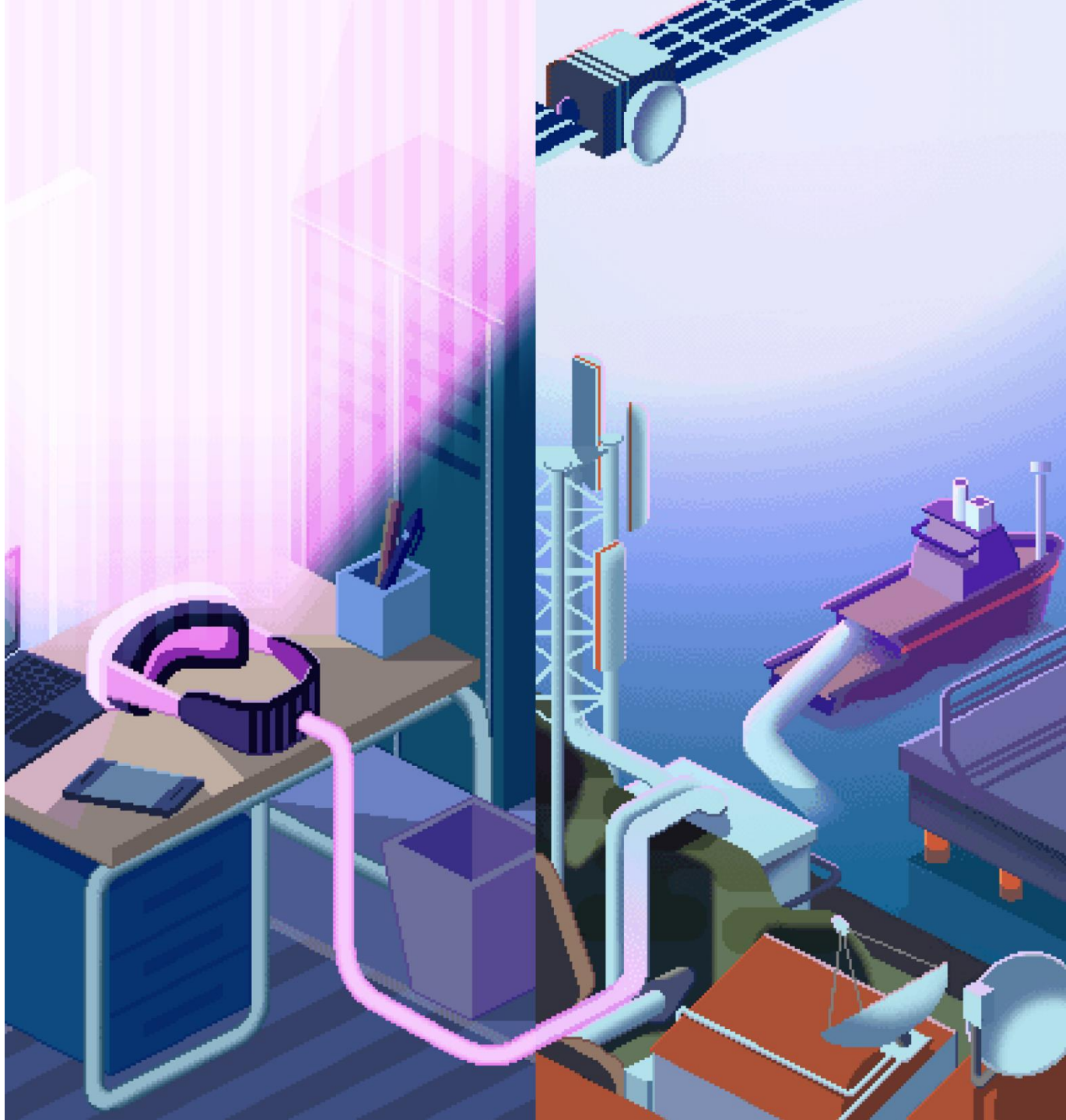
THE SHIFT PROJECT

Satellite networks: climate footprint and place in the digital system

BEREC Satellite Workshop

May 22th, 2024



SUMMARY

The Shift Project : The carbon transition think tank

A **think tank** advocating **the shift to a post-carbon economy.**

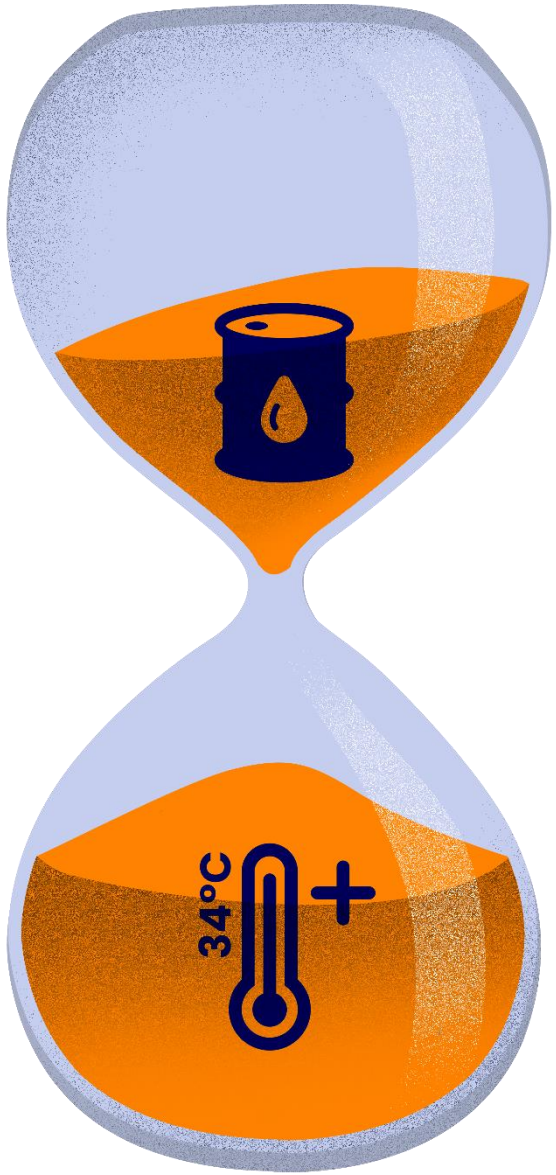
Since 2010, a non-profit organisation **committed to serving the general interest** through **scientific objectivity.**

We are dedicated to **informing** and **influencing** the debate on **energy transition in Europe.**

The Shift Project : Why ? The dual carbon constraint

CLIMATE

On one side, climate change requires us to **reduce our greenhouse gas emissions** to reduce its intensity.



ENERGY

On the other side, the inevitable contraction in oil supplies means that we need to anticipate it, and therefore **reduce oil consumption** before it falls sharply.

The Shift Project : Why ? The dual carbon constraint

CLIMATE

- Key Risk 1 : Mortality and morbidity of people and changes in ecosystems due to heat
- Key Risk 2 : Heat and drought stress on crops
- Key Risk 3 : Water scarcity
- Key Risk 4 : Flooding and sea level rise

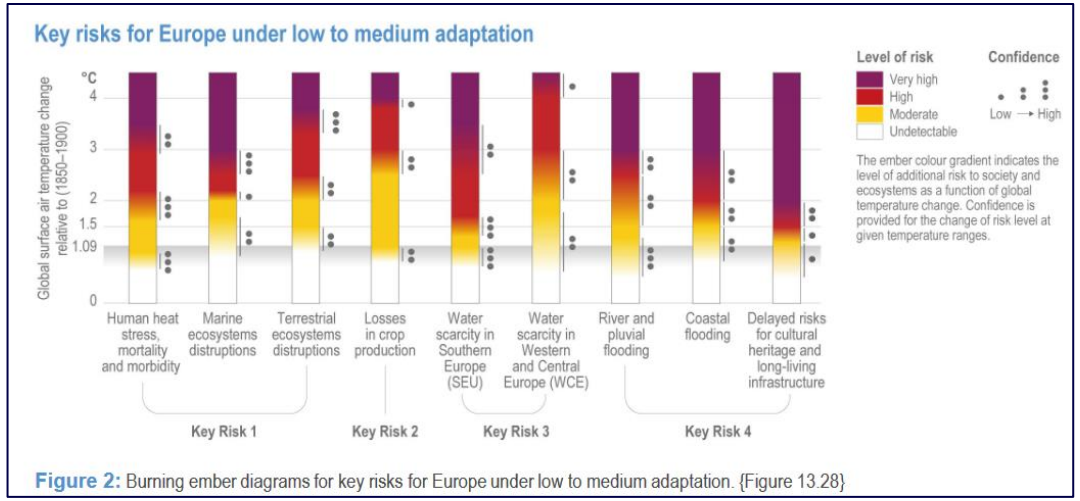


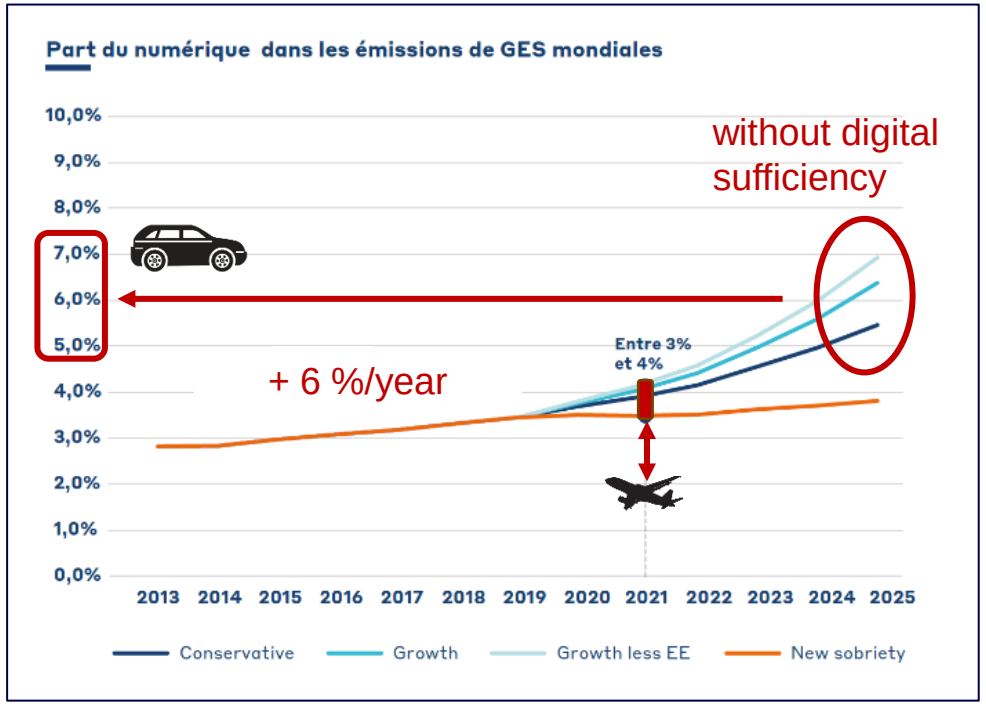
Figure 2: Burning ember diagrams for key risks for Europe under low to medium adaptation. {Figure 13.28}

Source : IPCC, AR6, WGII, Fact Sheet Europe

Digital sector & space sector : what energy-climate footprint ?

DIGITAL SECTOR

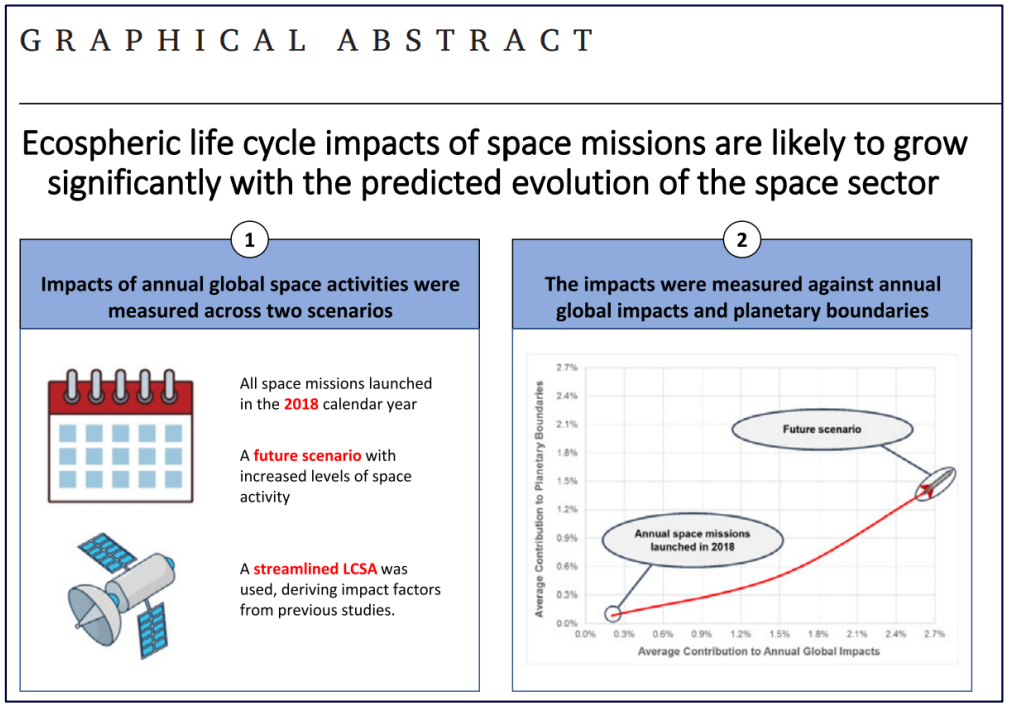
- World level : **> 2 $GtCO_2e$** in 2021 *(The Shift Project, 2021)*
- **Unsustainable** : On the way to 25 $MtCO_2e$ in 2030 *(ADEME-Arcep, 2023)*, 10 $MtCO_2e$ to 64 $MtCO_2e$ in 2050



Source : The Shift Project, 2021

SPACE SECTOR

- World level : **6 $MtCO_2e$** in 2018 *(Wilson, 2022)*
- **Unsustainable** : x20 in 2050 (Wilson, 2022)



Source : Wilson, 2022

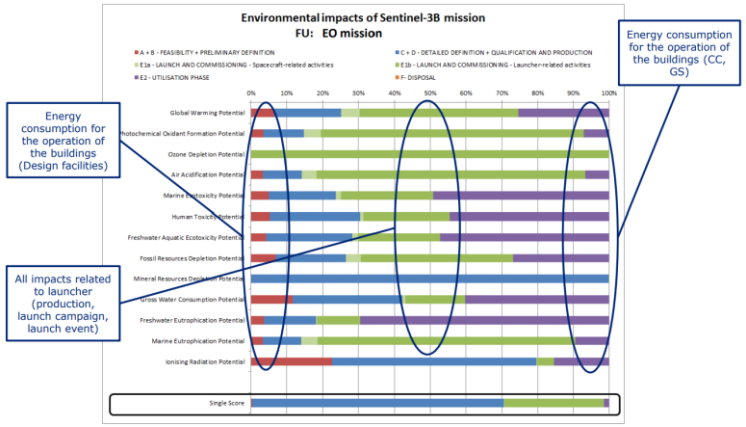
Digital sector & space sector : what energy-climate footprint ?

DIGITAL SECTOR

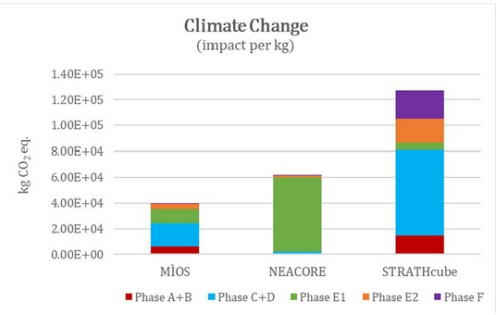
- Distribution of impacts between use / production :
  - World level : ~ 60% / 40%
  - French level : ~ 20% / 80%

SPACE SECTOR

- GHG emissions all along the lifecycle :



Source : Chanoine, Deloitte Sustainability, 2017



Source : Wilson, 2023

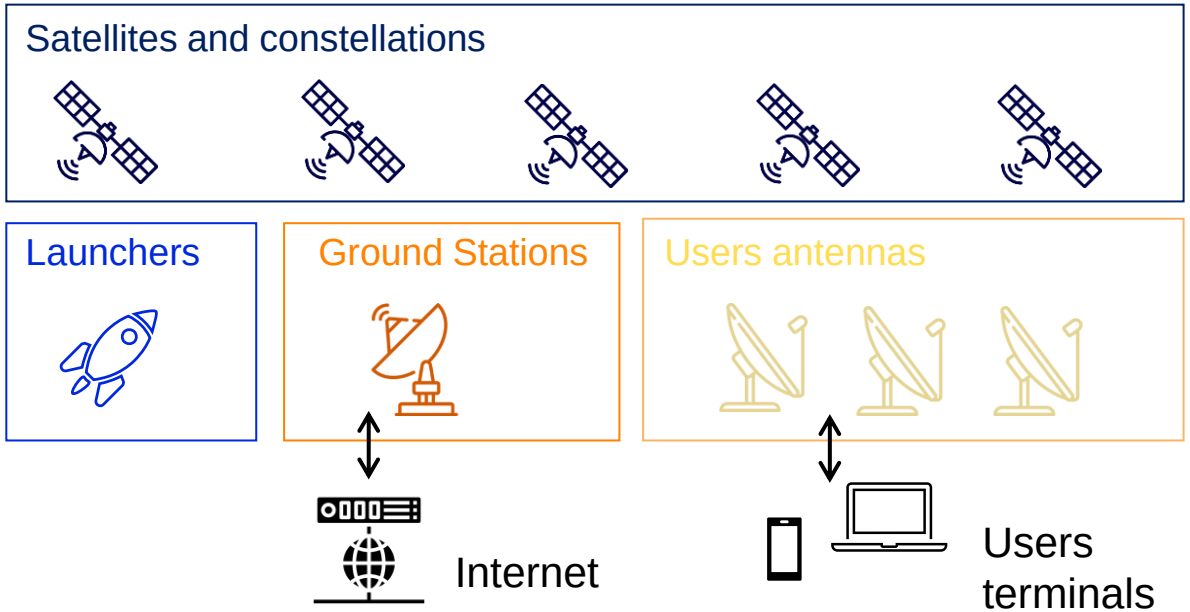
Space sector challenges in terms of climate footprint : preliminary elements

Conventional solutions to provide satellite internet access

Geostationary orbit (GEO)
Satellite « fixed » above the same earth position

Low Earth orbits (LEO)
Constellations of satellites streaking accross the sky

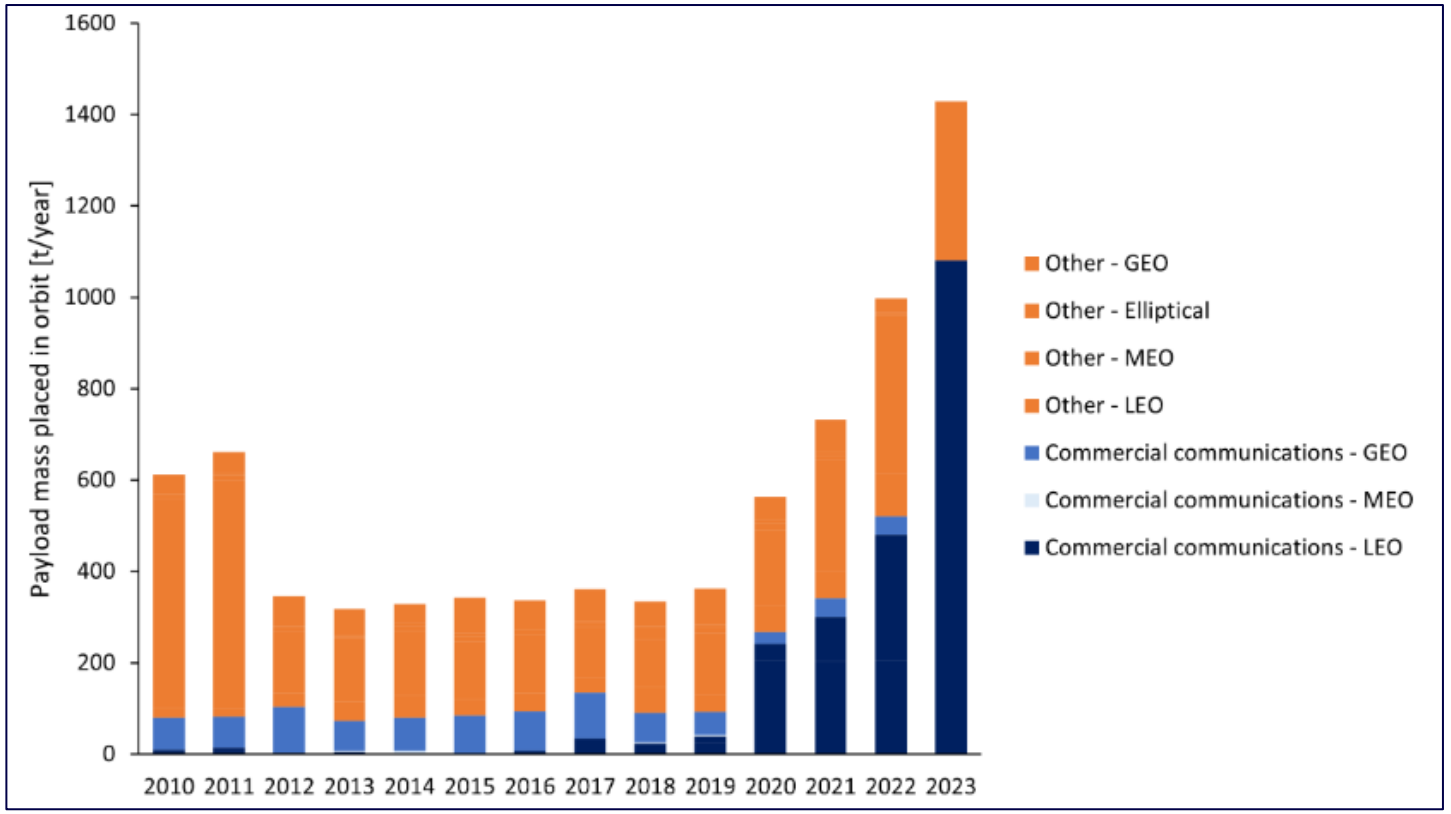
Scope



Space sector challenges : The rise of low earth orbit constellations and the « non CO_2 » effects

Low-Earth Orbit connectivity services are putting the space sector on an unsustainable trajectory

- In 2022 : constellations represent as much as the rest of space activities :
  - Of which 94% due to Starlink + OneWeb

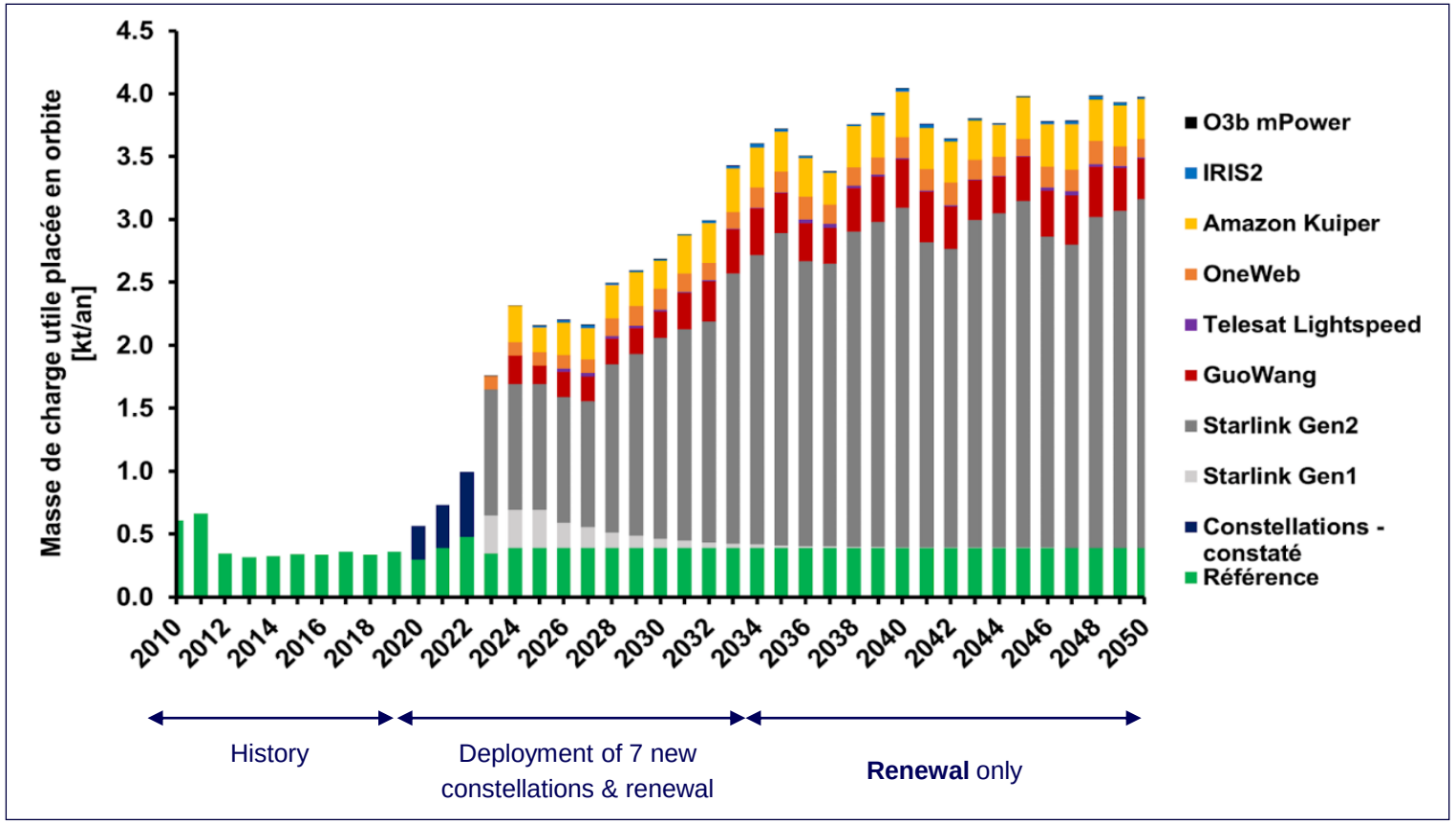


Evolution of satellite mass put in orbit each year (history 2010-2023) (Aéro Décarbo - The Shift Project 2024)

Space sector challenges : The rise of low earth orbit constellations and the « non CO_2 » effects

Low-Earth Orbit connectivity services are putting the space sector on an unsustainable trajectory

- In 2022 : constellations represent as much as the rest of space activities :
  - Of which 94% due to Starlink + OneWeb
- This historic trend is only the beginning, since the forecasts for 2021-2050 are: x 9



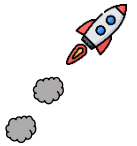
Evolution of satellite mass put in orbit each year (forecast in space sector 2023-2050) (Aéro Décarbo - The Shift Project 2024)

Space sector challenges : The rise of low earth orbit constellations and the « non CO_2 » effects

Low-Earth Orbit connectivity services are putting the space sector on an unsustainable trajectory

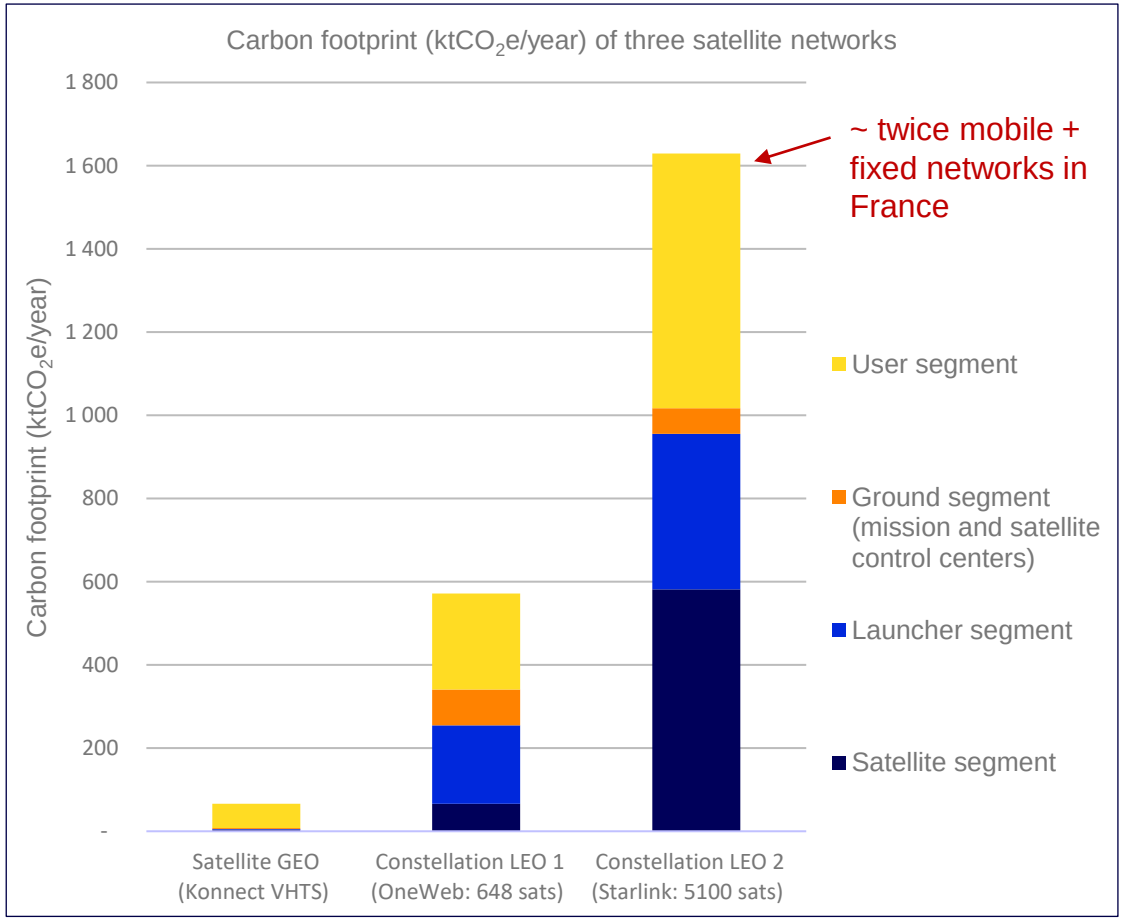
In addition to greenhouse gases, the "non-CO2" effects

- During launches and satellites reentries, particles are emitted into the atmosphere and have an impact on the climate (and on the ozone depletion)
- Studies with alarming results : 4-16mW/m^2 of radiative forcing on the stratosphere in 2019 with only hundreds of launches (Ross 2014, Ryan 2022)
- Few studies and uncontrolled impacts

		Climate impact	Impact On ozone
Emissions and post-combustion products from launch vehicles 	**Soots (methane, kerozene)**	Warming of the stratosphere via absorption of incident solar radiation Resulting effect on the troposphere complex	Accelerating the kinetics of ozone-destroying reactions by warming the stratosphere
	Alumine (solid propulsion)	Reflection of incident solar radiation and absoprtion of upwelling terrestrial radiation leading to a net warming ot the stratosphere	Accelerating the kinetics of ozone-destroying reactions by warming the stratosphere + supporting reactions
	Chlorine (solid propulsion)	Indirect via ozone depletion	Chemical destruction of ozone
	Water vapor (LH2 and+)	Warming	Negligible
	All		Emissions of ozone-destroying compounds
Emissions during reentries (satellites and stages) 	**Aluminium and metallic particles**	TBD	TBD
	Nitrous oxides	TBC	TBC

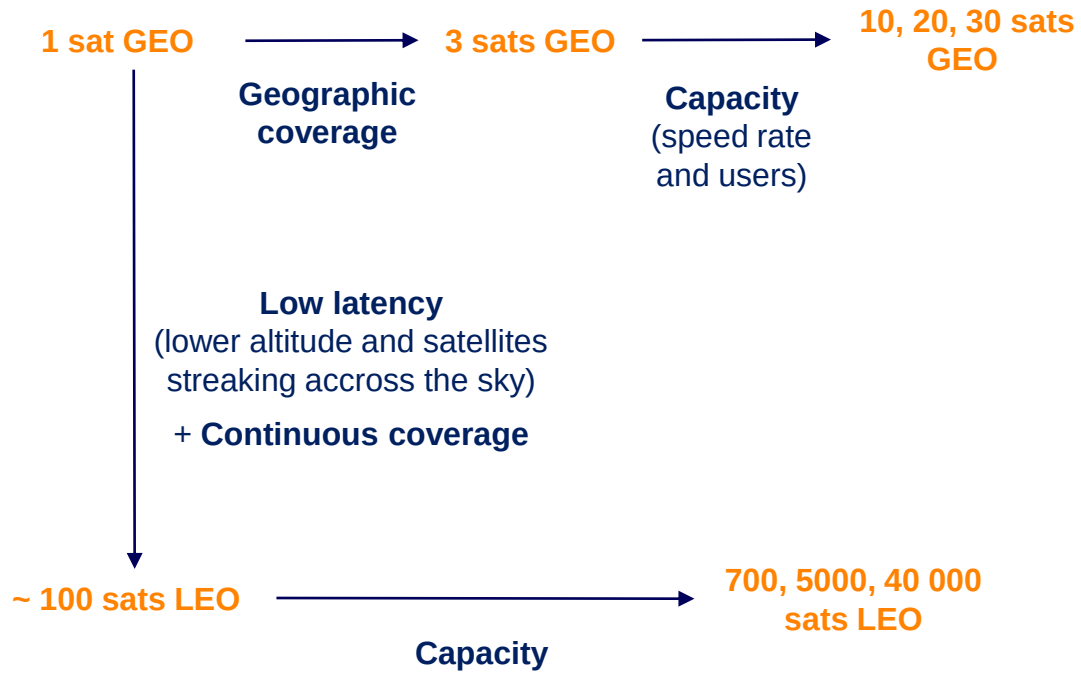
State of the art (march 2024) on laucnhers and satellite climate impacts (Aéro Décarbo – The Shift Project, 2024)

Internet access by satellite : Environmental costs of our services choices (latency, coverage, capacity) : « As is »



Annual carbon footprint of satellite networks (without the « non-CO2 » effect) (Aéro Décarbo – The Shift Project, 2024)

What mechanisms and service choices are behind these environmental costs ?



For a strategic vision of Internet access across all types of networks and taking into account the whole digital ecosystem

❑ **Should networks (fixed/mobile/satellites) be stacked or complementary?**

Do we have to pay a double environmental (and economic) cost especially because environmental infrastructure costs are important?

❑ **How to compare environmental costs of networks?**

In particular, because a service can be described by different KPI/KVI : speed rate, latencies, coverage, access, energy/emissions, …

- Example in France of terrestrial mobile vs fixed : ~ 2 times higher to transport 1 Go (ADEME, 2022)
- Example of constellations vs terrestrial mobile : 31-91 times higher (Osoro, 2023)

❑ **What are the strengths and weaknesses of each type of network?**

Satellites more interesting for coverage rather than capacity

❑ **And link the types of networks/satellites to the issues at stake : what development targets ?**

Coverage to provide internet access for 2 billion people or marginal services improvement for 1 million people, not necessarily in Europe ?

CONCLUSIONS & LINKS WITH REGULATORY CHALLENGES

Make the deployment of constellations conditional on climate impact studies in parallel **with work on reducing the uncertainties of "non-CO2" effects** and **slow down until we know the environmental impacts**

in the frame of precautionary approach

#other related competition, consumer and environmental issues (launch limitations? ground station authorizations?)

Make current connectivity strategies compatible with our carbon budgets

since replicating a “Starlink-type” (full coverage x very high speed x low latency) access to ensure truly global internet access would be an environmental dead end

#other related competition, consumer and environmental issues

#other regulatory issues associated with NTNs in the context of the extension of mobile/fixed communications networks

Carry out an in-depth review of telecommunications missions as part of discussions on decarbonisation trajectories for the space and digital sectors at European and world level

and think complementary and not stacked networks, think environmental externalities in relation to which development objectives (coverage or capacity ?)

#other regulatory issues associated with NTNs in the context of the extension of mobile/fixed communications networks

Thank you for your attention

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