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CENTRE NATIONAL D'ÉTUDES SPATIALES

DECARBONIZATION ROADMAP OF THE FRENCH SPACE SECTOR

COSPACE

BEREC

25 09 2025

CONTENT

01

MANDATE

THE OFFICIAL REFERRAL

LE MINISTRE

Paris, le 17 NOV. 2023

Nos références : MEFI-D23-12998

Monsieur le Président Directeur Général,

De longue date, les systèmes spatiaux ont joué et continuent de jouer un rôle essentiel et indispensable pour soutenir la transition écologique de nos sociétés et de nos économies en documentant le changement climatique et ses effets à l'échelle de la planète. La France dispose d'une industrie spatiale innovante et mature dont les engagements environnementaux sont un différenciateur positif à l'échelle européenne et internationale qu'il convient d'encourager et de poursuivre. La consolidation des réflexions sur l'impact environnemental des activités spatiales reste toutefois à ce jour incomplet.

C'est en premier lieu le cas dans l'espace extra-atmosphérique et je me félicite de l'initiative précurseure de la France et du CNES qui a permis d'adopter au niveau international dès 2008 des lignes directrices sur la réduction des déchets spatiaux. Il est urgent de poursuivre l'effort pour que la communauté internationale se mobilise pour traiter collectivement des enjeux associés à la prolifération des débris spatiaux qui finissent par menacer la poursuite des activités spatiales.

Plus encore, si le CNES a veillé depuis plusieurs années à s'inscrire pleinement dans la démarche Service Public écoresponsable, l'impact environnemental terrestre des activités spatiales n'a pas, à ce jour, pas fait l'objet d'une évaluation à l'échelle de l'ensemble de la filière. Pourtant, malgré des spécificités indéniables, l'industrie spatiale se retrouve confrontée à des enjeux similaires aux autres secteurs industriels concernant sa décarbonation ou sa dépendance à des énergies fossiles. Dans un contexte de croissance sans précédent des activités de lancement, il est également urgent de mieux connaitre la pollution, notamment dans la haute altitude, générée par ces phénomènes.

De nombreuses initiatives en ce sens commencent à émerger. Dans le contexte de l'adoption du Pacte Vert, la Commission européenne s'est saisie de l'enjeu de cet impact environnemental. De la même façon, des initiatives de la société civile entendent alerter et porter ces sujets afin qu'ils soient pleinement intégrés dans les réflexions des décideurs publics et privés. La filière spatiale française gagnerait à faire davantage valoir ses atouts face à ces enjeux.

Dans ce contexte, alors que la France est l'une des premières puissances spatiales et soutient de longue date des politiques de développement durable ambitieuses, je vous demande de piloter l'élaboration d'une feuille de route commune à l'industrie spatiale française construite sur un état des lieux solide de l'impact environnemental de la filière. Dans un premier temps, vous proposerez ainsi à mes services, dans le cadre d'une concertation au sein du COSPACE, un diagnostic intégrant des éléments de comparaison avec les autres puissances spatiales. Dans un second temps, la contribution de la filière à l'atteinte des objectifs de neutralité carbone fixés par la France à l'horizon 2050 devra dans ce cadre faire l'objet d'une feuille de route que vous me remettrez en septembre 2024.

Je vous prie de croire, le Président Directeur Général, à l'assurance de ma considération distinguée.

Bruno LE MAIRE

GOUVERNANCE OF THE PROJECT

AIRBUS

ariane GROUP

cnes

ThalesAlenia Space

CNES working group

ThalesAlenia Space

COSPACE

MINISTÈRE DE L'ÉCONOMIE, DES FINANCES ET DE LA SOUVERAINETÉ INDUSTRIELLE ET NUMÉRIQUE

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Lot #1

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carbone4

Alcimed

- **Lot #2** — Assessment of the carbon footprint of the French space industry
- **Lot #3** — Identification and quantification of reduction levers
- **Lot #4** — Definition of decarbonization scenarios
- **Lot #5** — Definition of the implementation and monitoring system for the roadmap
- **Lot #6** — Drafting of the final report and presentation of the results

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02

ORGANIZATION OF WORK

STRUCTURING OF WORK

01 · Definition of perimeters

02 · Estimating the carbon footprint of the French space industry

03 · Defining the ambition for decarbonization

04 · Definition of levers and facilitating actions for reduction

05 · Definition of decarbonization scenarios

06 · Definition of the implementation, monitoring and governance system

07 · Publication of the roadmap

03

SCOPES

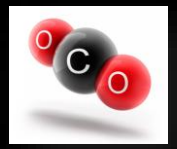
CRITIERIA FOR THE SCOPE

- "Environmental Footprint" method developed by the European Commission in 2021.
- Rules for quantifying the environmental impacts of products, goods, and services

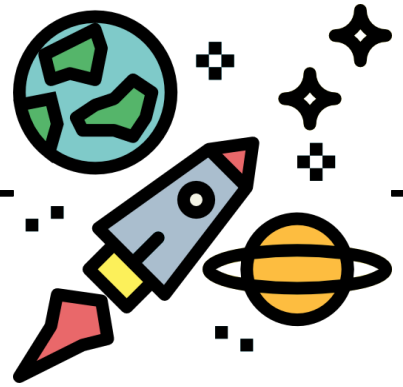
01	• Climate change
02	• Ozone depletion
03	• Water use
04	• Particulate matter
05	• Land use
06	• Ionising radiation
07	• Photochemical ozone formation
08	• Acidification
09	• Eutrophication - Fresh water
10	• Eutrophication - Marine
11	• Eutrophication - Terrestrial
12	• Ecotoxicity - Freshwater
13	• Resource use - Fossils
14	• Resource use - Minerals and metals
15	• Human toxicity - Non cancer
16	• Human toxicity - Cancer

⚠ The effects in the upper atmosphere are not included due to lack of data. They remain to be characterized later, in terms of impacts and levers.

CO_2 : Carbon dioxide



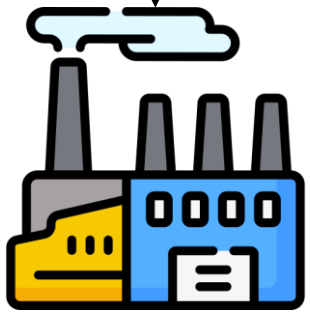
THE SCOPE: LIFE PHASES



Method
All phases of the GHG Protocol's life cycle were explored.

R&D

Raw material extraction



Conception manufacturing

Transport

Use

End of life

THE SCOPE : ORGANIZATION

Launcher segment
Launcher
Propellants

Space segment

Ground Segment
Technical Center
Launch Base
Station Network
Control Center
Mission Center
Space Situational Awareness Ground Segment

User Segment
User Terminal
Data Center
Data Processing and Storage Center for Downstream Space Applications

Civil Activities, including man in space Military Activities, excluding missiles

SCOPES

Timeframe: Annual footprint

- For launcher and space segments: average for the period 2018-2023 (inclusive)
- For the rest: 2023

Decarbonization: 2024-2050

Operational scope: "footprint"

- French company established in France and abroad
- Launcher segment: manufactured by a French company or used to place a French satellite into orbit Space segment: manufactured by a French company or registered in France
- Ground segment: manufactured by a French company or operated by a French company
- User segment:
  - Data generated and stored by a French space segment
  - Data distributed by a French space segment
  - Data used by a first French user User terminal manufactured by a French company or used in France

OPERATIONAL OR GEOGRAPHIC SCOPE

Launcher segment

		carrying	
		France	Foreign
Manufactured by	France	☑	☑
	Foreign	☑	

Space segment

		Launched by or operated by	
		France	Foreign
Manufactured by Or registered in	France	☑	☑
	Foreign		

Ground segment

		Operated by	
		France	Foreign
Manufactured by	France	☑	☑
	Foreign	☑	

User segment

		Operated by or used by	
		France	Foreign
Manufactured by Or "Generated stored distributed valued by"	France	☑	☑
	Foreign	☑	

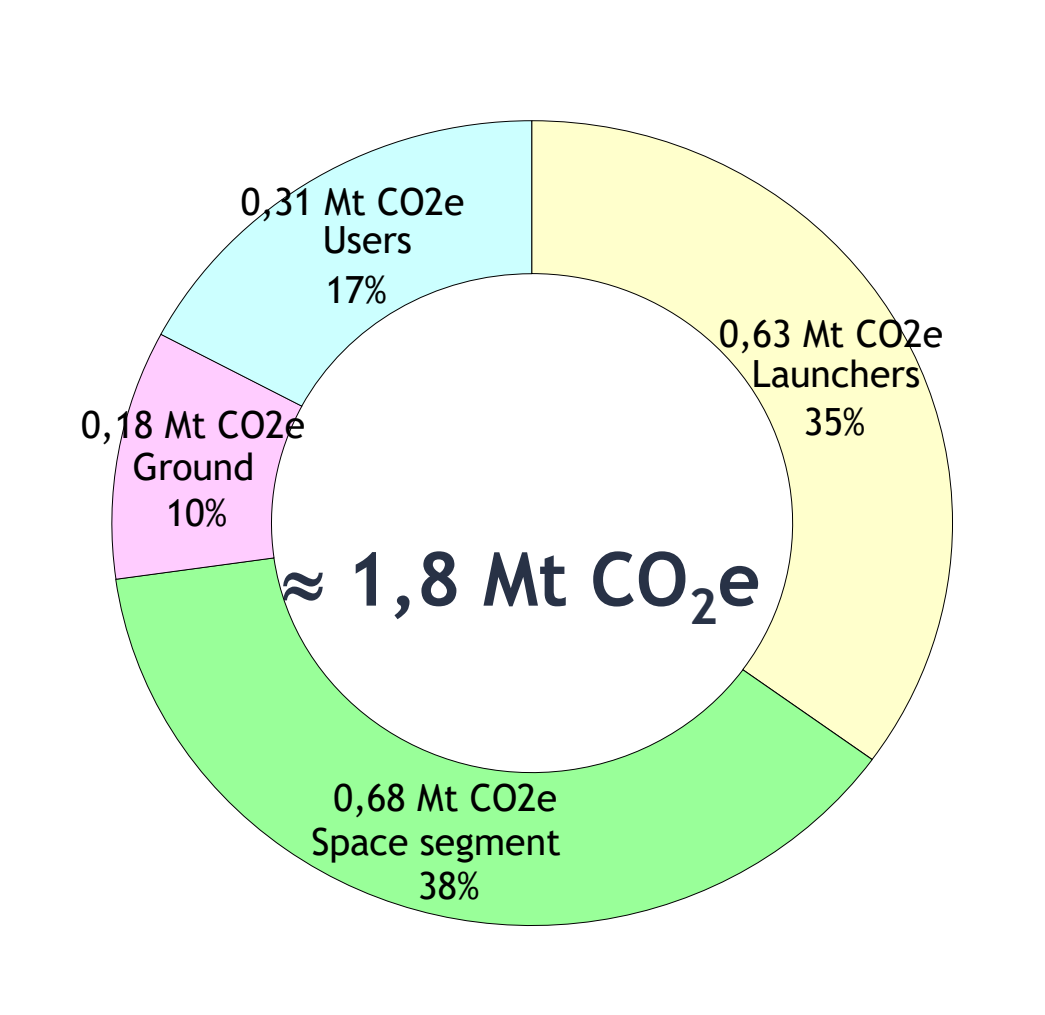
Utilisateur de 1er niveau

Source : Carbone 4

04

CARBON FOOTPRINT

CARBON FOOTPRINT 2023: FRENCH SPACE SECTOR



Carbon Footprint	
French annuel carbon footprint	620 Mt CO_2e
Per capita	10 t CO_2e

Monetary carbon intensity		
Space FR - turnover	2022	165 t CO_2e / M€
Agriculture FR - turnover	2019	219 t CO_2e / M€
Industrie FR - turnover	2019	326 t CO_2e / M€
France - GDP	2022	155 t CO_2e / M€
Germany - GDP	2022	247 t CO_2e / M€

This estimate is based on: The figures available in 2024
The various assumptions established in consultation with the industry

Source : Carbone 4

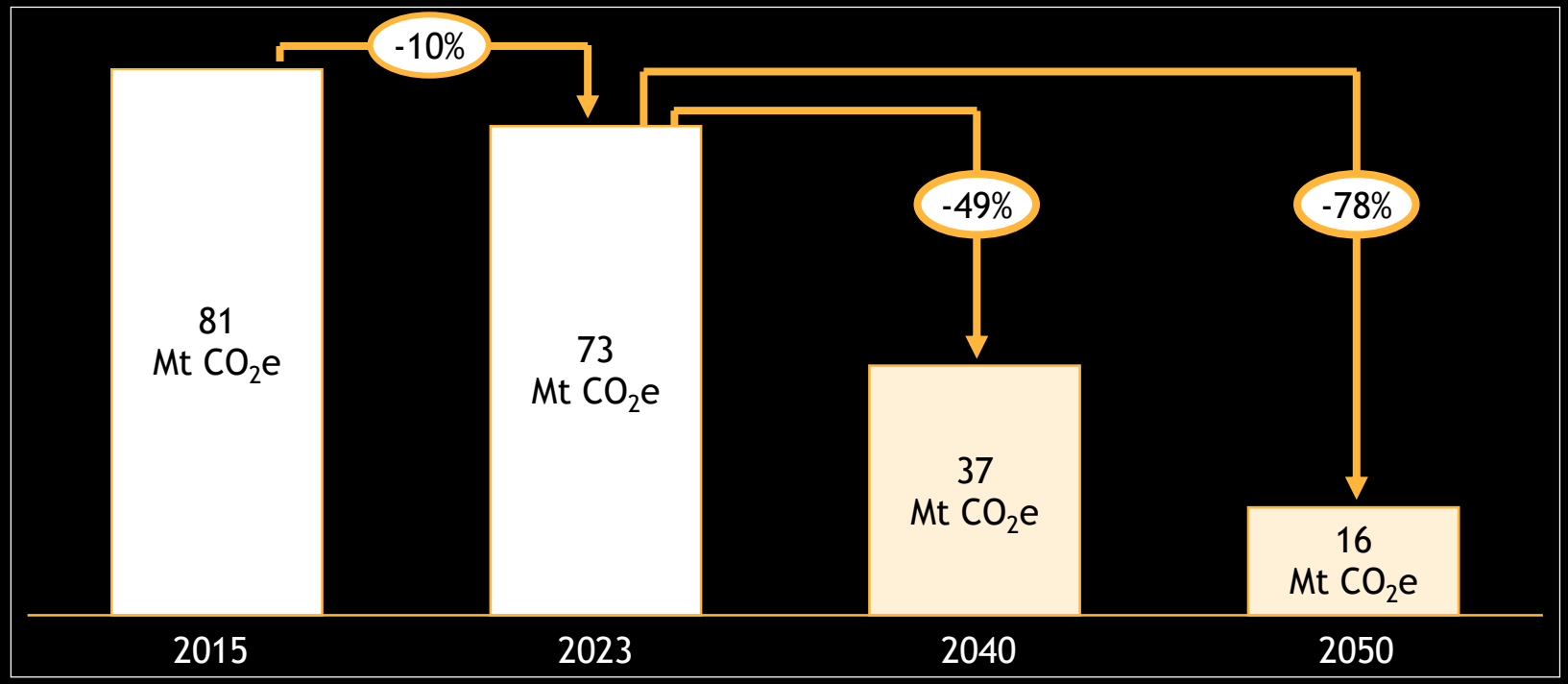
05

AMBITION

AMBITION APPLICABLE TO THE SPACE SECTOR: SNBC

History: Reduction of emissions from French industry (CITEPA)

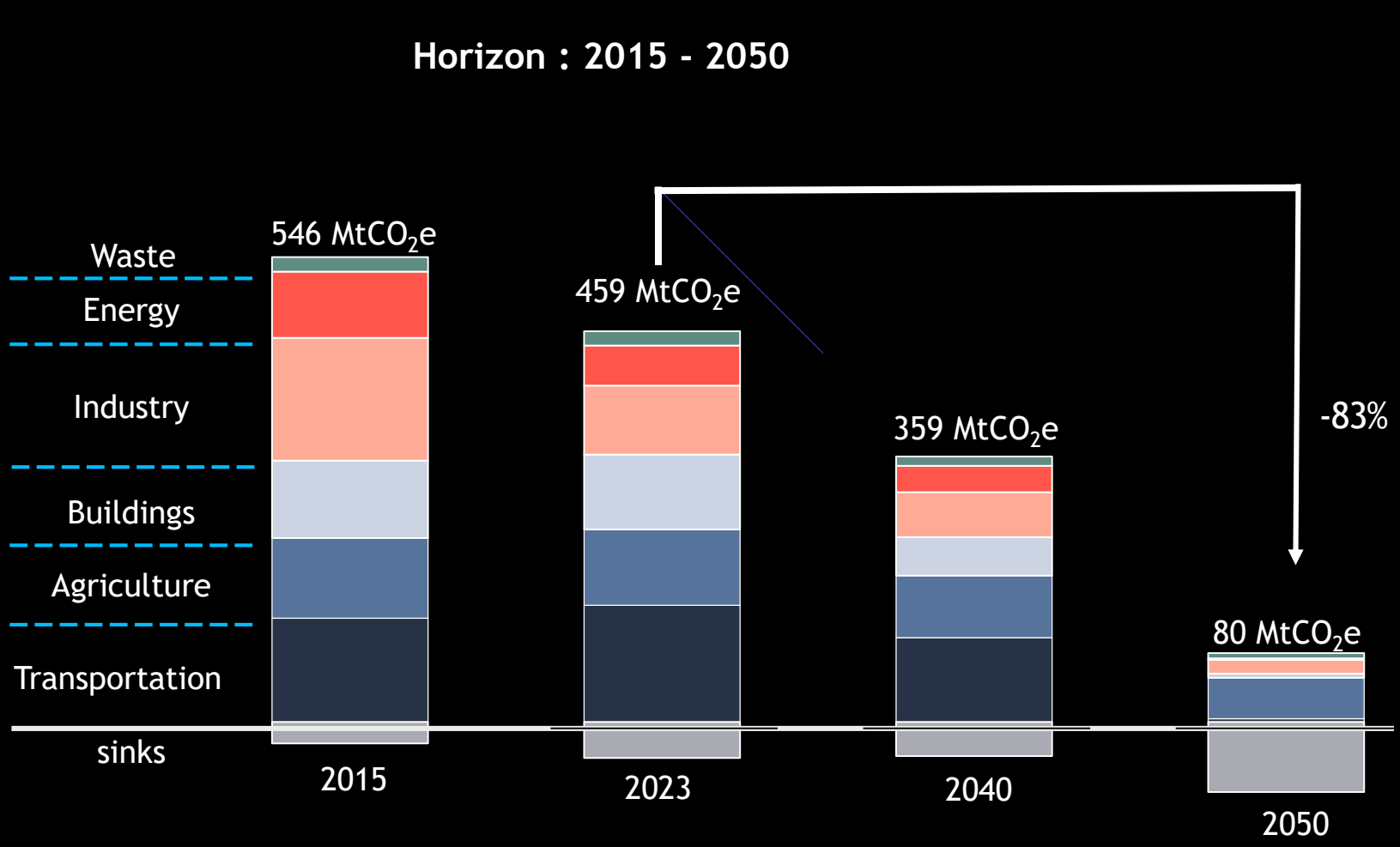
Ambition: Reduction of emissions from French industry (SNBC)



Source : Carbone 4

AMBITION RELATED TO THE REDUCTION OF THE CARBON FOOTPRINT

	Reduction
Wastes	- 66 %
Energy	- 100 %
Industry	- 81 %
Buildings	- 94 %
Agriculture	- 46 %
Transportation	- 100 %



Stratégie nationale bas-carbone

06

LEVERS AND FACILITATING ACTIONS

LEVERS & FACILITATING ACTIONS: STRUCTURATION

Levers

- Quantifiable
- Contribute to scenarios
- Characteristics:
  - Desired impact
  - Action to be taken
  - Proposal for changes to public policies
  - Carbon reduction potential

Facilitating actions

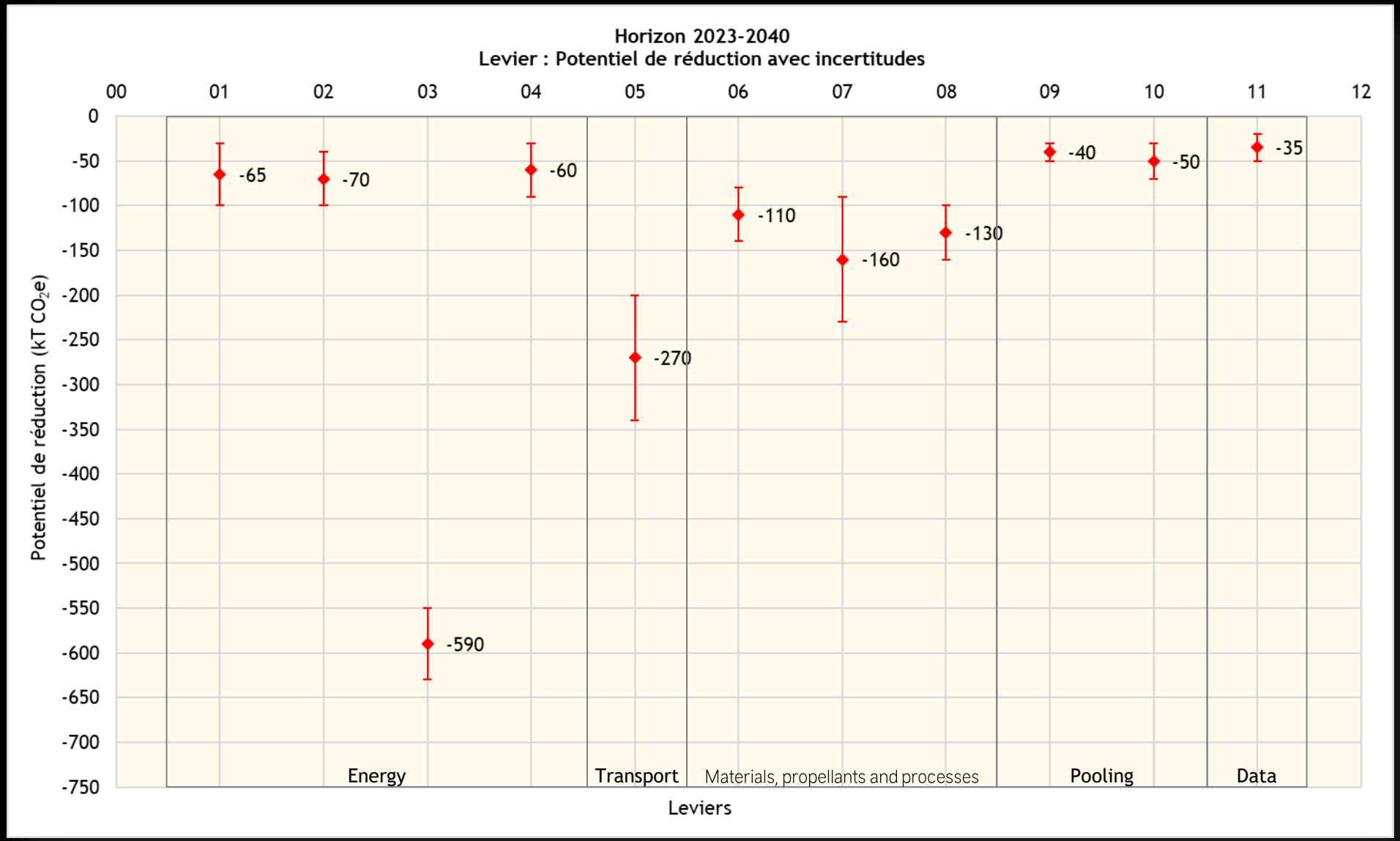
- Non-quantifiable Support and facilitate the implementation of the roadmap

LEVERS

Themes	#	Content	Segment impact
Energy	L01	Reduce energy and object consumption in the development, qualification and manufacturing phases	
	L02	Optimizing energy consumption of ground segments	
	L03	Use low-carbon energy to operate the sector's industrial resources (including suppliers), for the production of propellants and for ground segments	
	L04	Optimizing the energy consumption of user terminals	
Transport	L05	Optimize the transport of people, launchers, satellites and parts across the entire supply chain on Earth	
Materials, propellants and processes	L06	Develop and use low-carbon materials and processes for the manufacture of launchers, satellites, ground segments and industrial resources in the sector	
	L07	Develop and use low-carbon propellants for launchers and satellites	
	L08	Reduce the material impact of user terminals	
Pooling	L09	Promote and support the pooling of industrial tools in the sector	
	L10	Pool and standardize launch bases, launcher and satellite control and mission centers and ground stations	
Data	L11	Optimizing the generation, storage and processing of scientific and Earth observation data	
Upper atmosphere	UA	Reduce the proportion of materials and propellants with high radiative impact and/or ozone depletion, for the powered phase and atmospheric re-entry of launchers and satellites	*The effects in the upper atmosphere are not integrated due to lack of data. They must be* characterized.

HORIZON 2040 - LEVERS: REDUCTION POTENTIAL AND UNCERTAINTIES

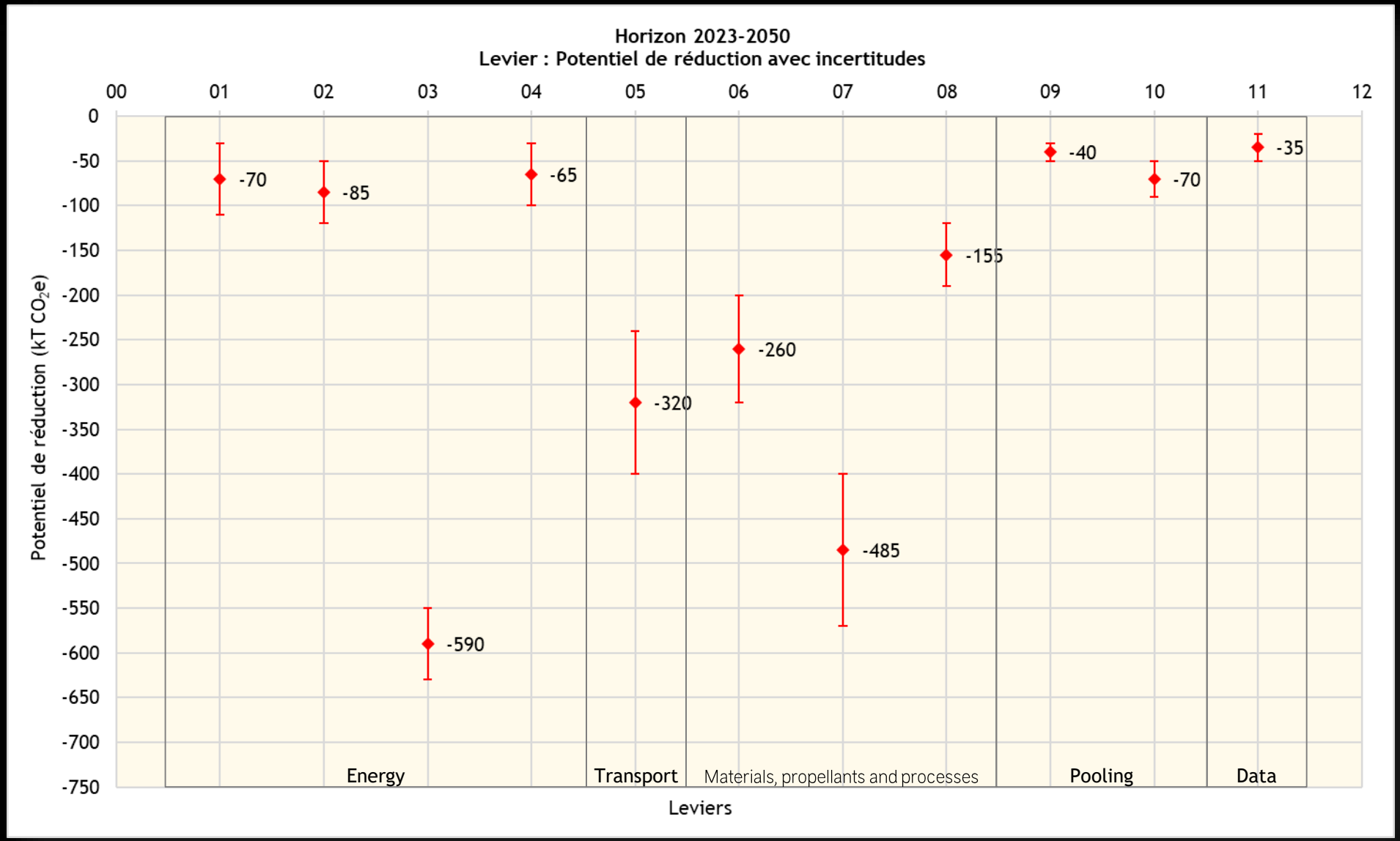
#	Libellé
L01	Energy consumption programs
L02	Energy consumption ground segment
L03	Low carbon energy consumption
L04	Energy consumption user segment
L05	Transportation optimization
L06	Use of low-carbon materials, propellants and processes
L07	Low carbon propellant
L08	Reduction of terminal footprint
L09	Poolling
L10	Pooling of operations centers
L11	Data rationalization
HA	Upper atmosphere



Source : Carbone 4

HORIZON 2050 - LEVIERS : POTENTIEL DE RÉDUCTION ET INCERTITUDES

#	Libellé
L01	Energy consumption programs
L02	Energy consumption ground segment
L03	Low carbon energy consumption
L04	Energy consumption user segment
L05	Transportation optimization
L06	Use of low-carbon materials, propellants and processes
L07	Low carbon propellant
L08	Reduction of terminal footprint
L09	Poolling
L10	Pooling of operations centers
L11	Data rationalization
HA	Upper atmosphere



Source : Carbone 4

FACILITATING ACTIONS

#	NAME OF ACTION
F01	Initiate demonstration programs on the carbon optimization of launchers and satellites
F02	Initiate research and development work on “decarbonized space systems”
F03	Initiate research & development work on satellite circularity
F04	Define shared objectives within the sector for improving the carbon intensity of launchers and satellites
F05	Integrate environmental and societal impact criteria into investment programs
F06	Define common carbon criteria at the sector level in supplier specifications
F07	Promoting good environmental practices in space at national, European and international levels
F08	Raise awareness and train academics, engineers, politicians and French space stakeholders as well as their suppliers on the environmental issues of space
F09	Promoting transparency of the environmental impact of space services among end users

07

SCENARII

GROWTH OF THE SPACE MARKET

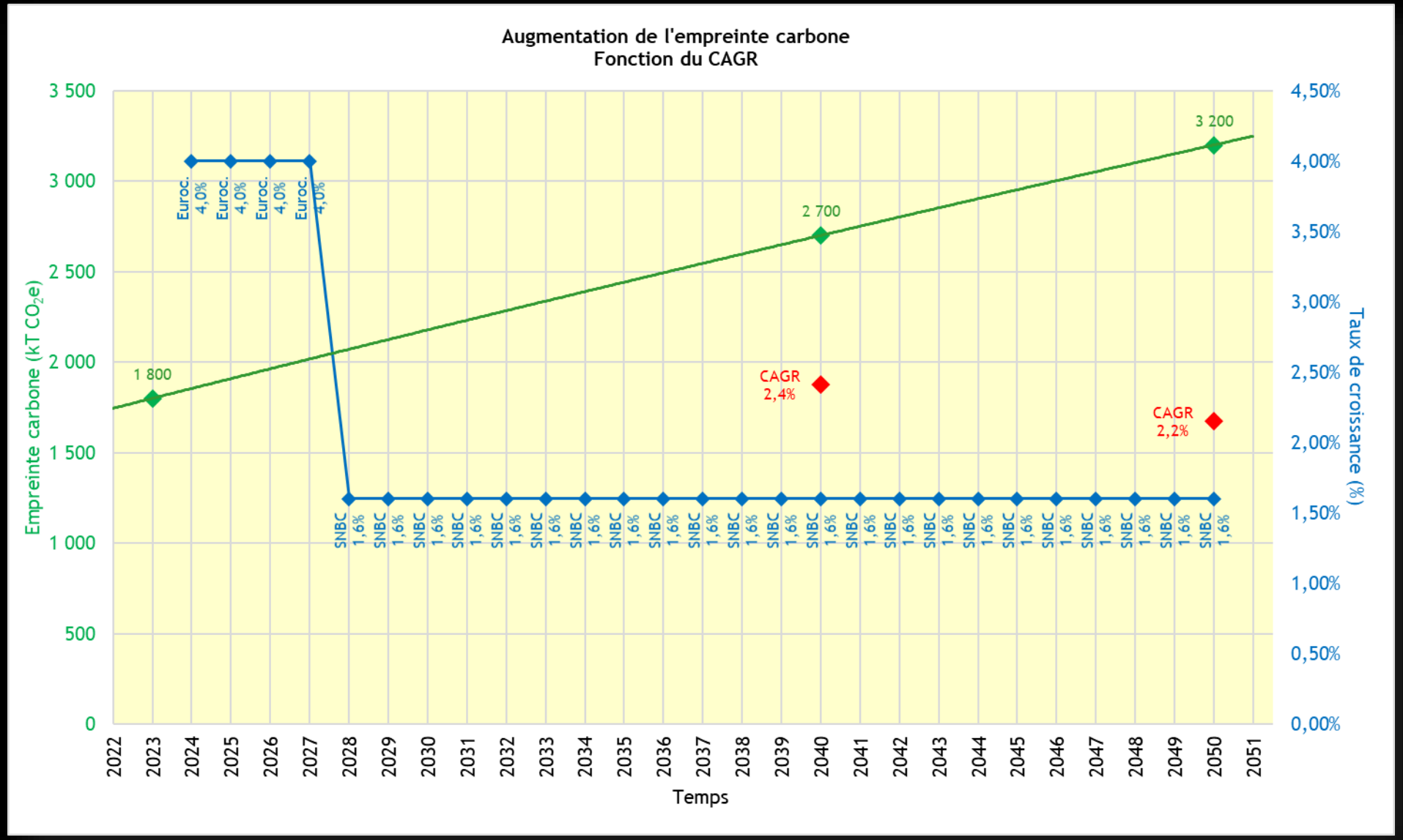
Sources:

For the period 2023-2027: Euroconsult, including adjustments for the user segment (Eutelsat) For the period ≥ 2028: SNBC

Compound Annual Growth Rate CAGR

- CAGR 2023-2040 : 2,4 %
- CAGR 2023-2050 : 2,2%

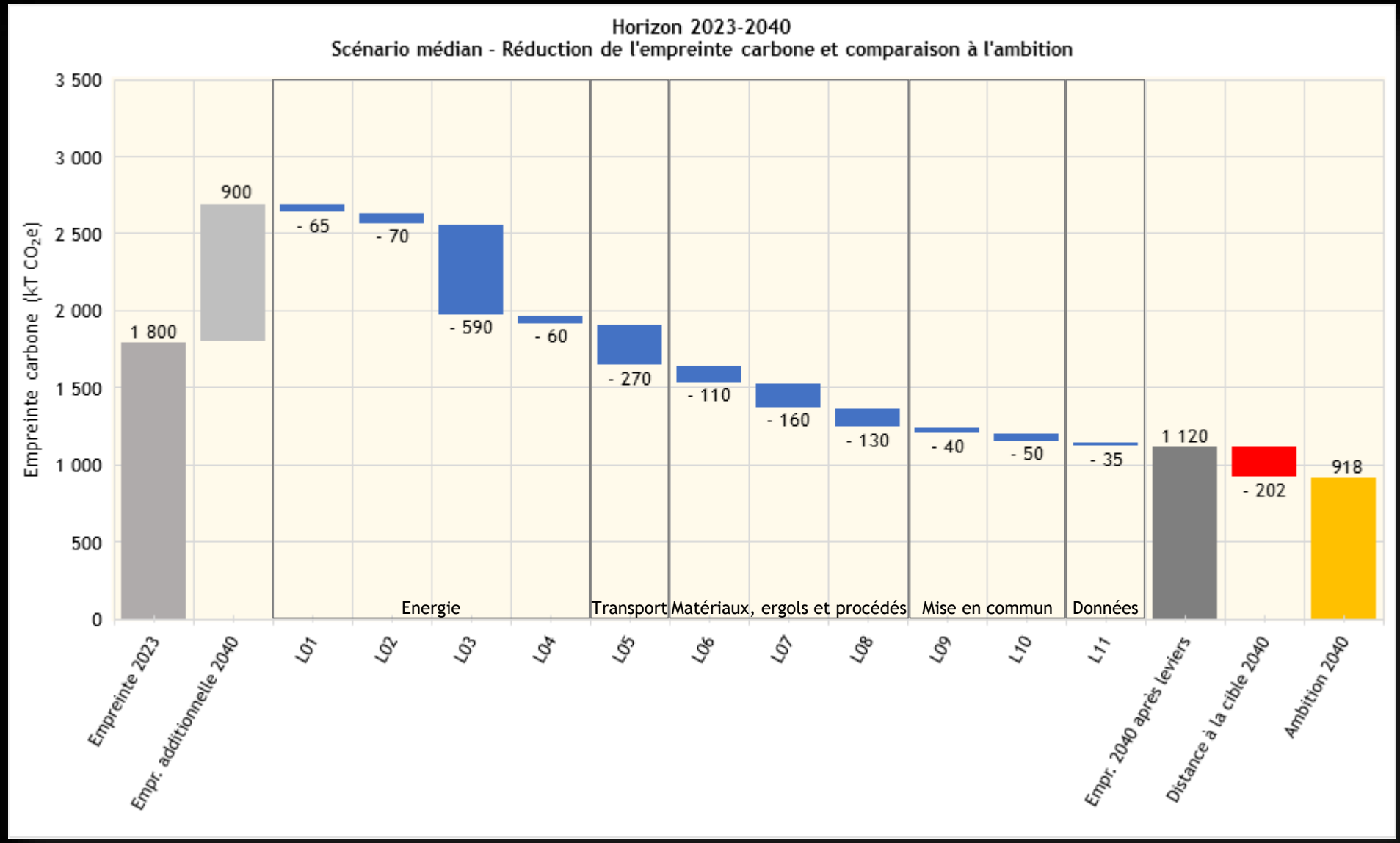
$$\text{CAGR} = \left(\frac{\text{Valeur}_{\text{Fin}}}{\text{Valeur}_{\text{Début}}}\right)^{\frac{1}{(\text{Date}_{\text{Fin}} - \text{Date}_{\text{Début}})}} - 1$$



Source : Carbone 4

HORIZON 2023-2040 – MÉDIAN SCENARIO

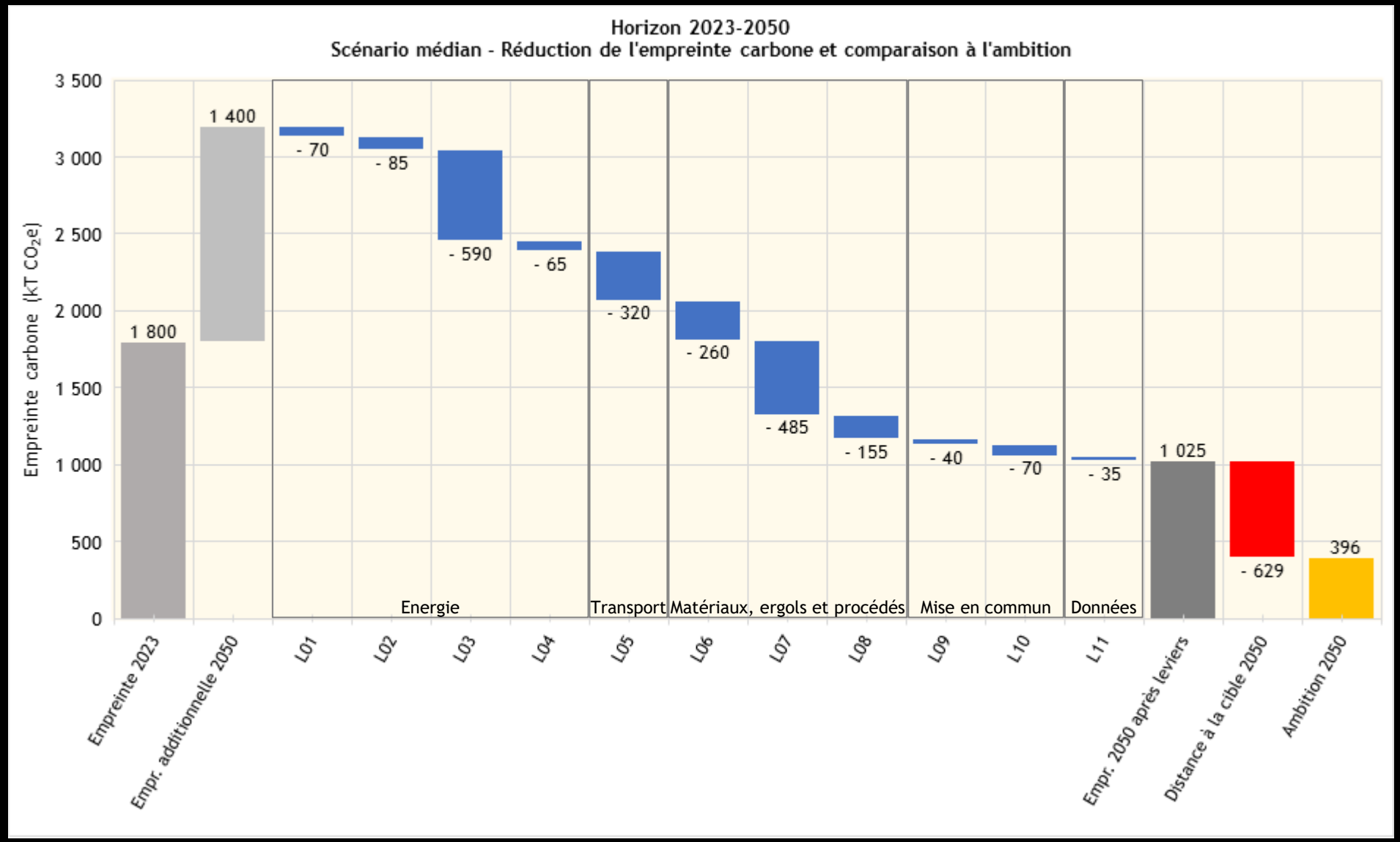
#	Libellé
L01	Energy consumption programs
L02	Energy consumption ground segment
L03	Low carbon energy consumption
L04	Energy consumption user segment
L05	Transportation optimization
L06	Use of low-carbon materials, propellants and processes
L07	Low carbon propellant
L08	Reduction of terminal footprint
L09	Poolling
L10	Pooling of operations centers
L11	Data rationalization
HA	Upper atmosphere



Source : Carbone 4

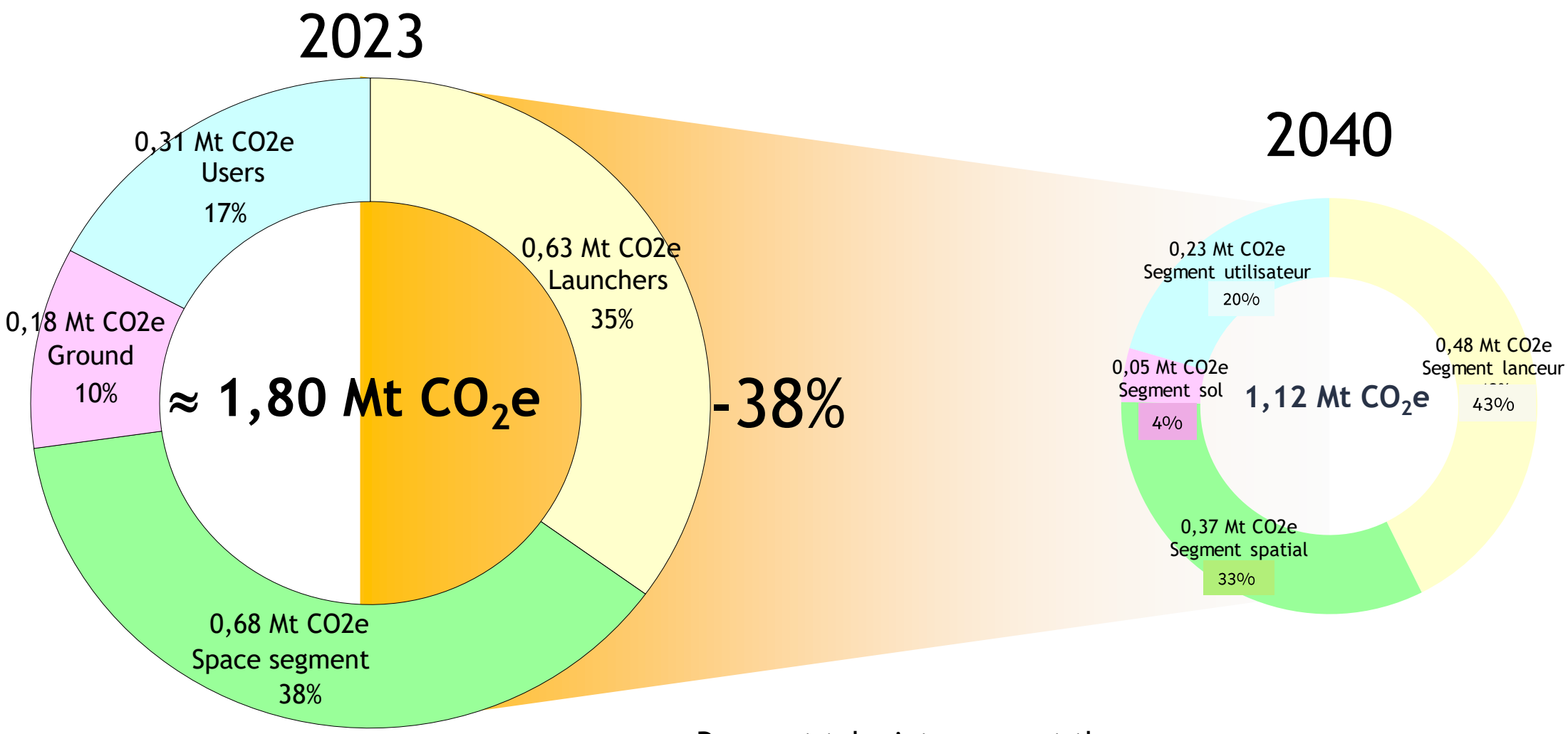
HORIZON 2023-2050 – MEDIAN SCENARIO

#	Libellé
L01	Energy consumption programs
L02	Energy consumption ground segment
L03	Low carbon energy consumption
L04	Energy consumption user segment
L05	Transportation optimization
L06	Use of low-carbon materials, propellants and processes
L07	Low carbon propellant
L08	Reduction of terminal footprint
L09	Poolling
L10	Pooling of operations centers
L11	Data rationalization
HA	Upper atmosphere



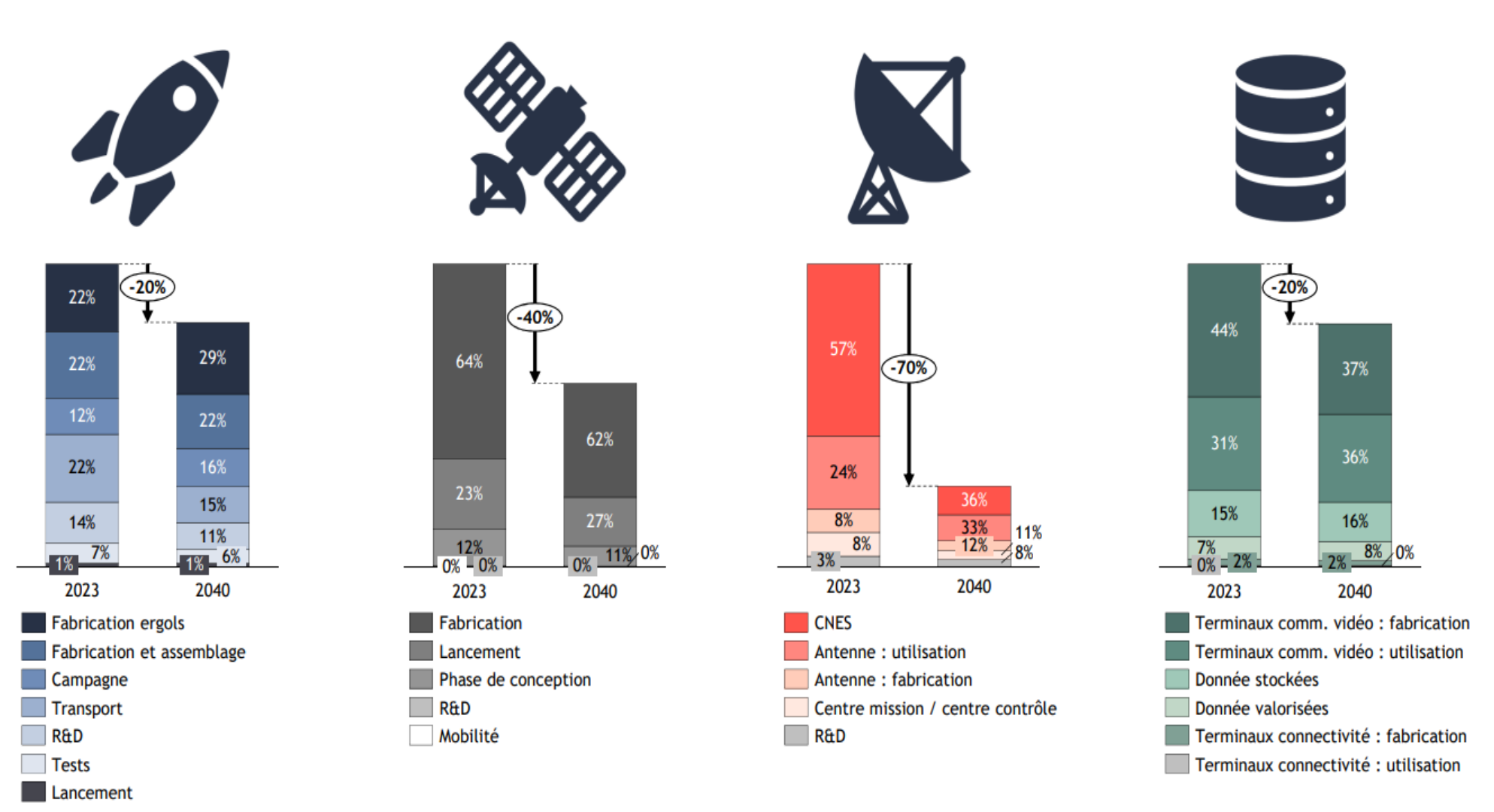
Source : Carbone 4

HORIZON 2023-2040 – MEDIAN SCENARIO – REDUCTION BY AREA



Does not take into account the cumulative carbon footprint over the period 2024-2040

MEDIAN SCENARIO, RESIDUAL EMISSIONS

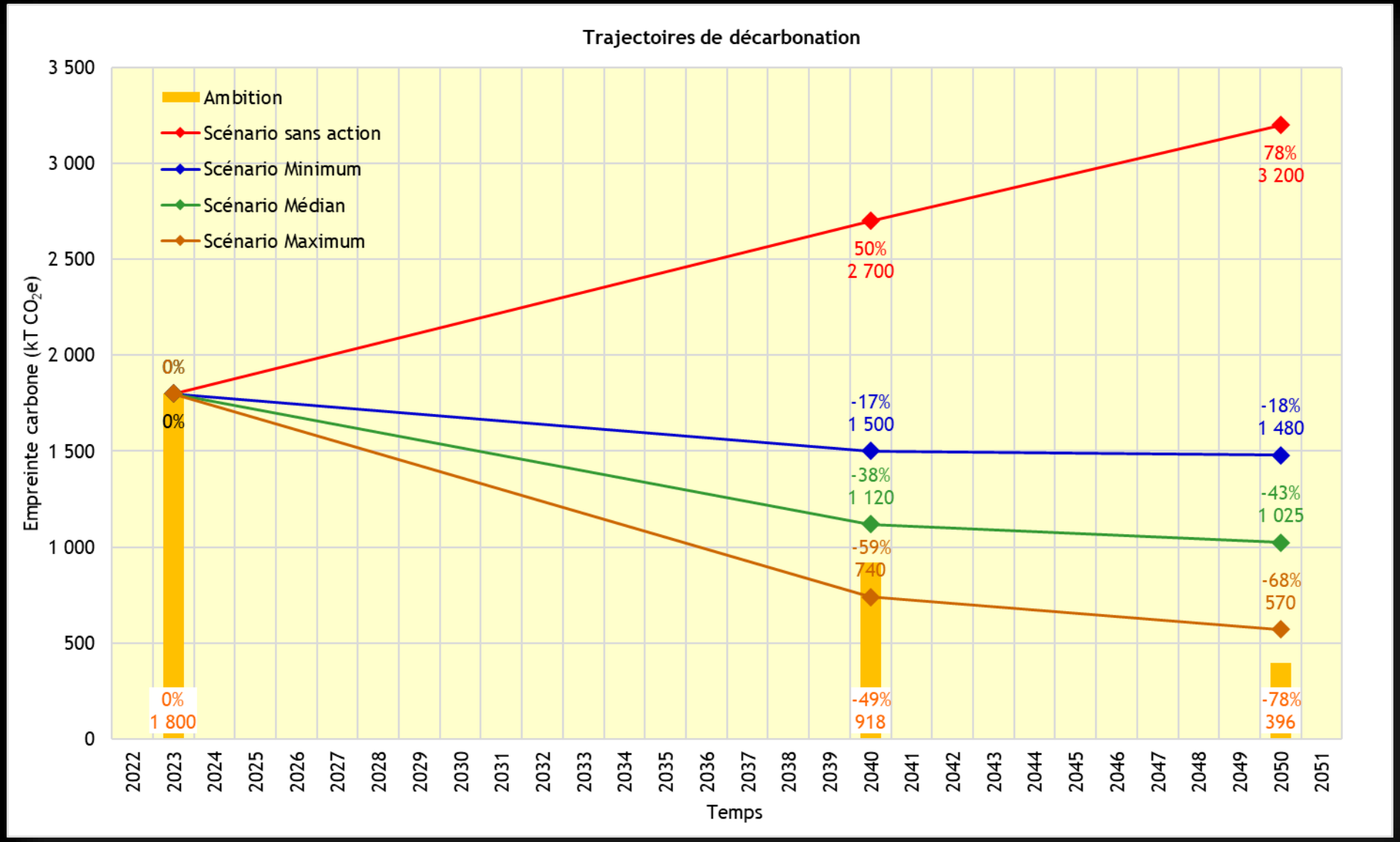


Source : Carbone 4

08

CONCLUSION

TRAJECTOIRES DE DÉCARBONATION PAR SCÉNARIO



Source : Carbone 4

AN AMBITIOUS ROADMAP ROOTED IN REALITY

- This proposed roadmap was developed in cooperation with all stakeholders in the space sector. This is a world first.
- Its implementation will take into account the preservation of competitiveness and support for innovation in the sector, thus placing the industry on a trajectory of transformation.
- It constitutes a lever for differentiation and transformation of the space industry, helping to ensure its long-term sustainability and excellence.
- Its implementation requires significant mobilization of the sector.
- It involves government support, the development of new skills, and changes in public policies.
- The work must continue, particularly by taking into account the effects of the upper atmosphere, which requires an update of the footprint assessment and the levers.

FOLLOW-UP WORK SCHEDULE

June :

Presentation during the Paris Air Show of the Executive Summary Report

From September :

Continuation of work in the WG and implementation Establishment of the monitoring and steering body

Update the roadmap to encompass environmental impacts beyond carbon Implementation in organizations, particularly at CNES