

**HIGH-LEVEL ADVISORY GROUP ON ACCELERATING  
THE USE OF SPACE IN EUROPE**

***Final Report***

*October 2021*

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*In June 2021, the ESA Director General called a group of independent, high-level advisors to assess the economic, societal and political role of space in an evolving global context and against emerging challenges. The mandate of the High-Level Advisory group was to advise the ESA Director General on directions and actions for ESA to realise ambitious goals, together with other stakeholders, serving the future of Europe and its citizens. The present report is a summary of our deliberations and our recommendations to the ESA Director General.*

## EXECUTIVE SUMMARY

In view of shaping new strategic directions, the ESA Director General has set up an independent, high-level group to advise him on ways to accelerate the use of space in Europe. The High-Level Advisory Group on Accelerating the Use of Space in Europe met at three occasions and agreed on the following recommendations.

While space has the potential to enable effective and resilient solutions to tackle major societal challenges, **it remains underutilised**. The ESA Director General should investigate options for increasing the societal and economic impact of space, **prioritising user-driven solutions** and leveraging commercialisation, through a new concept of action, **Accelerators**, building on ESA's programmatic capacities and acquired excellence.

**Accelerators** should innovate and implement space-enabled solutions to wider societal aspirations and challenges by **uniting various actors**, including public and private, under a shared umbrella and blending cash, in-kind contributions and other public policy measures.

From a set of proposals put forward by the ESA Director General, three priority streams replying to urgent societal challenges have been identified for immediate action through **Accelerators**:

- **ACCELERATOR 1 - RAPID AND RESILIENT CRISIS RESPONSE**, enabling security stakeholders to ensure rapid provision of information, and quick response to climate-induced and other crises facing Europe;
- **ACCELERATOR 2 - SPACE FOR A GREEN FUTURE**, using advanced space data, science & technology for sustainable life on Earth, and support society and decision makers to reach carbon neutrality by 2050;
- **ACCELERATOR 3 - PROTECTION OF SPACE ASSETS**, to ensure resilient availability and functioning of space infrastructure on which Europe's economy and society relies for day-to-day life.

The **Accelerators** require a **stepwise approach** in order to build-up consensus with the ESA Member States and potential partners to define common objectives and aggregate resources.

Looking further ahead and considering the potential for breakthrough developments in science and technology, the High-Level Advisory Group recommends the ESA Director General initiates preparatory steps towards a **sample return mission from icy moons of giant planets**.

The High-Level Advisory Group also recommends the ESA Director General investigates the technical, political, programmatic, and economic aspects of developing **Europe-made human space transportation** solutions.

To successfully deliver on these ambitions and tackle new challenges, ESA needs to pursue a transformational agenda that embeds:

- **Commercialisation**: Further steps should be taken to stimulate the European space economy, fully leveraging the innovation excellence of industry.
- **User-driven approach**: Putting users at the core is a key condition for success to properly define the services to be delivered as well as the supporting operations.
- **Human Capital & STEM**: Catalysing interest in STEM subjects amongst younger generations, investing in European Human Capital and transforming ESA to make it an attractive employer.

With a proven track record of successful **European Cooperation in space**, **Accelerators** provide an opportunity to combine strengths and resources of various actors in response to the most urgent societal challenges for Europe.

In international space cooperation, where ESA serves as **Europe's gateway to the world**, initiating partnerships to tackle global challenges will position Europe in a leadership role.

The High-Level Advisory Group recommends to the ESA Director General to immediately **take action and formulate proposals to initiate the Accelerators and implement a Transformational Agenda**, with ESA Member States and other partners, on the provided recommendations

# 1 RATIONALE AND FINDINGS

**Urgency to act:** During his address to the 76<sup>th</sup> Session of the UN General Assembly in 2021, the UN Secretary General called on the world to wake up as “*we are on the edge of an abyss, moving in the wrong direction and “our world has never been more threatened” while facing “the greatest cascade of crises in our lifetimes.”*”

**Imminent societal challenges:** Unprecedented societal, economic, and security challenges face Europe. Among these, **space is particularly relevant to the widespread consequences of climate change**, and multitude of adverse knock-on effects on the natural environment and society.

**Users not yet at the core of space solutions:** Initiatives addressing societal challenges need to be user-driven, and formal steps should be taken to ensure that user needs are key in driving programme development.

**Space is underutilised:** Space-based capabilities can make the difference in effectively tackling many of these issues, but are underutilised, falling short of their full socio-economic and strategic potential.

**The cost of not taking action:** Decision-making processes must take account of the potential costs of not addressing societal challenges in justifying space solutions.

**Space - the integrator:** Space needs to be embedded in wider policymaking ambitions and considered as a key tool, used in a transverse manner. In this respect Europe needs a “Putting-Space-To-Work policy” to leverage unique capabilities offered by space.

**European excellence and strategy under pressure:** New policies and actors have emerged, increasingly pressing institutions across the whole of Europe to reassess their long-term strategic approach (see **Annex A**). Space faces a similar challenge to information technologies in the 1990s, where Europe failed to convert an abundance of raw talent into creating the world’s largest companies. **In space this can only be avoided today if urgent action is taken to face the fierce competition from the United States and other parts of the world.**

**Embracing Commercialisation:** Europe needs to more strongly embrace the commercialisation of space taking place world-wide, taking full advantage of service-oriented procurement and new contracting schemes to develop new sectors of the economy, stimulate innovation, and serve public and societal needs more effectively.

**Driving enthusiasm and inspiration:** Pioneering space missions and solutions to global challenges reinforce the role of space as an ambassador of excellence, sparking inspiration through scientific and engineering achievements, demonstrating the essential role these disciplines will play for our common future.

**The race for talent:** The space sector needs to attract the best and brightest talent by **clearly presenting the transformative impact that space has upon society** and catalyse the development of STEM skills in parallel to managerial and political expertise.

**Expanding to new partners:** Building on its wide experience of cooperation, ESA shall address new partners and innovative applications using an integrated approach to communications and stakeholder engagement, to build credibility and confidence, making use of all relevant channels to engage with decision and policymakers as well as the general public.

**A new concept of action:** By focusing on users and targeting wider European policy ambitions, **a completely new model of conception, funding and execution is needed**, aggregating public and private resources, in **full synergy** with ESA’s activities and programmes.

With a view to shaping new strategic directions, the ESA Director General has set up an independent, high-level group to advise him on ways to accelerate the use of space in Europe. The High-level Advisory Group advises the ESA Director General to consider the above findings in the further steps towards elaboration of his proposals to ESA Member States.

*Consistent with the ESA Agenda 2025, the Agency should adapt and initiate the necessary transformation to provide Europe with effective tools to face future challenges where space has a major role to play. This implies user-driven missions implemented through new categories of programmes and adequate investment in its Human Resource strategy to attract the best talent.*

## 2 URGENCY TO ACT ON MAJOR SOCIETAL CHALLENGES

Unprecedented societal, economic, and security challenges face Europe. Space has enormous untapped potential to play a key role in tackling pressing current and future challenges and crises, while simultaneously providing new impulse for the European space sector.

### Climate crisis requiring urgent action

The persistent worsening of global climate indicators is the most urgent challenge faced by humanity and requires immediate action. Climate change is “*everyone’s problem*”. The extreme events, heatwaves, flash floods, wildfires of the summer of 2021 have demonstrated to citizens what scientists have been warning about for decades, namely that the climate crisis is taking place *now*.

In addition, the impacts of climate change go far beyond effects on the environment. A higher frequency of extreme weather events, droughts and desertification have dramatic knock-on effects on society.

In particular, unprecedented safety and security challenges face Europe, characterised by unpredictability, rapid progress, and intensified impact, and require immediate response.

### Space as an enabler of effective and resilient solutions

Leading climate assessments (e.g. the Intergovernmental Panel on Climate Change Assessment Report) recognise the unique evidential value offered by space technologies. Satellite data underpins more than half of the essential climate variables, identified by the Global Climate Observing System.

However important it is, there is more at stake than monitoring. Any sustainable solution to climate change, related challenges and mitigating natural disasters, must be based on five elements: monitoring, understanding, modelling, predicting, and acting.

Space is a crucial enabler and makes essential contributions to **all of these. Space is increasingly poised to foster effective action on climate-induced and other crises.**

In crisis situations around the world, satellites provide immediate operational information and relief when existing ground infrastructures are unavailable.

Space is uniquely positioned to make a difference in tackling the threats and challenges faced by humanity, providing an articulate response. **Further upgrading space-enabled capabilities**, in particular with regard to reliable forecasting and rapid response, will bring **invaluable benefits to society at large.**

### Resilience in and from Space

As our dependence on space-based services and ground assets grows, these must be better protected from an increasing number of natural and human-made hazards.

Increasing amounts of space debris, and the greater impact of natural phenomena such as space weather requires an urgent response. Systems capable of timely and accurate warnings of threats and support effective reaction are needed.

#### Concrete recent cases in which satellites played a major role in mitigating major crises

- Haiti – Earthquake, 2011
- Syria – Civil War, 2012
- Puerto Rico – Hurricane Maria, 2013
- Mediterranean – Migration crisis, 2015
- Indonesia – Tsunami, 2018
- Germany – Flooding, 2021
- Spain – Volcanic eruption, 2021

## Enhancing European leadership for a better world

These pressing challenges require Europe to safeguard the environment, sustain positive socio-economic development for its citizens, and bolster Europe's strategic position in a changing geopolitical environment.

While different initiatives have already been launched across the world and Europe is already a leader in the green agenda, the severity of contemporary global challenges calls for enhanced, transversal and synergetic action. **Resolute, legitimate and credible action can boost multiple facets of European international leadership and global influence, resulting in far-reaching positive consequences for European economies.**

*The societal challenges ahead of Europe are widespread, significant, and urgent - addressing them effectively will require bold decisions and dedicated efforts on multiple fronts. Space technologies, data and services are uniquely positioned to make a difference and provide a concrete response to present and upcoming challenges.*

### 3 THE CORNERSTONES OF ESA'S RESPONSE TO SOCIETAL CHALLENGES

The 2021 Global Risks report of the World Economic Forum says “no individual country will be perfectly equipped to address the mounting societal, economic and environmental risks the world faces.”

As the global community is called to action, we agree with ESA's Agenda 2025 in saying that “Most risks to our society and economy require space to be properly involved”, as space responds to the entire spectrum of needs – from capacity-building to monitoring, from understanding to acting, from simulating to transforming.

In this context, the High-Level Advisory Group believes that **space is currently underutilised**, with untapped potential to make a greater contribution to addressing societal challenges. Several factors are essential to take advantage of this moment of opportunity:

- Requirements must be more user-driven in order to solve concrete issues;
- Coordination among various actors and entities must be improved;
- Turnkey, in-the-field solutions, are needed;
- The full potential of space solutions must be recognised in public policymaking processes.

The European space ecosystem, leveraging knowledge and excellence developed throughout the past decades, could enable Europe to make *the* difference in addressing global challenges through bold decisions that clearly recognise the position of central role of space in doing so.

#### Designing Accelerators

Building on expertise, past investments and existing capacities, ESA has the unique potential to conceptualise advanced designs, coordinate their development and incentivise decision makers to support and join initiatives.

ESA's operational methods and processes need to evolve to realise this potential, and develop, **in full synergy** with existing activities and programmes, new dedicated tools: **Accelerators**.

Cooperation, coordination and support to European industry are in the DNA of ESA, and the Agency builds on over fifty years of European expertise in successful space missions and technology development. This underpins ESA's unique responsibility to assemble, coordinate and implement the **Accelerators**.

While ESA's founding principles remain relevant almost fifty years after its creation, the **Accelerators** envisage a transformational agenda:

- enabling new participatory architectures, and solutions,
- blending and scaling up existing infrastructure and applications,
- building on developed capabilities and attained technological excellence,
- aligning contributions of different partners and creating cooperative frameworks,
- creating synergies and enhancing the impact of existing efforts.
- aggregating diverse actors and associating various resources,

*Global challenges require precise identification of drivers, hazards and constraints, and the response needs to be supported by fast-paced decision-making and ambitious investment targeting clear objectives and creating inspiring narratives.*

Accelerators would build on but go beyond traditional ESA programme development, leveraging acquired excellence in existing application domains, shifting the focus towards transversal initiatives, engaging closely with users, acting in synergy with, and further stimulating, ongoing national and European efforts.

Accelerators would also innovate and implement space-enabled solutions to wider societal aspirations and challenges, unlocking ESA's transformational potential and making it fit for the future.



## Key Features of Accelerators

**Address urgent needs & deliver results for short-term action**

Fostering the role of space in addressing contemporary societal challenges requires **new impetus to design space capabilities** that target and provide added value in addressing urgent needs and deliver results that enable short term action.

**Demonstrate Societal Relevance & Connect multi thematic challenges**

New initiatives must meet interdependent societal needs and **match the full spectrum of space-based applications to terrestrial capabilities** in order to **respond in an agile way to real-time global developments**.

**Improve existing capabilities & Make a difference**

These initiatives must build upon, leverage and scale-up existing capabilities, programmes and expertise, with increased ambition to **affirm the role of space as a vital tool in facing global challenges**.

**Strengthen European Leadership**

Against clear policy direction set at both national and European level, **ESA can strengthen European leadership by catalysing technological and commercial innovation**, enabling the creation and scale-up of world-leading industries for a stronger Europe and a better world.

**Pave the way for innovation**

This will further position Europe at the forefront of technological leadership, embed anticipatory innovation, **create fertile ground for future-oriented space-based services and European industrial competitiveness**, and leverage emerging and future technological leaps.

**Associate varied funding sources**

Societal challenges are shared concern of a wide range of governmental and other actors who wish to contribute to addressing challenges beyond the reach of any individual player. **ESA should develop a new approach**, serving as a pivot, aligning objectives and pooling a variety of funding source including monetary and in-kind contributions, **through new models of collaboration**.

**Catalyse private investment**

**Contributions from private actors**, industry, equity funds, and capital markets through dedicated partnerships **will be a crucial differentiator from past approaches**, aligning various public and private efforts in a longer term perspective.

**Generate knowledge & inspiration**

These initiatives **must be accompanied by ambitious research, scientific and technology development priorities**, enabling Europe to maintain independent access to knowledge and technology, strengthen its position in global partnerships and provide a profound source of inspiration, catalysing increased interest in STEM education in the next generation.

ESA, especially in light of its unique set-up along four dimensions (Research & Development, Programme Management, Industrial Policy and Intergovernmental cooperation) and its flexible governance model, is well positioned to fuse resources to develop and implement projects aimed at pressing need. However, it currently lacks an optimal avenue to blend the required features under a single umbrella.

*Above-described features can be best addressed through **Accelerators**, allowing ambitious and targeted investment into future-defining technological developments and missions.*

## 4 CLIMATE CHANGE: URGENT NEED FOR ACCELERATORS TO MAKE THE DIFFERENCE

Global climate change is the single most challenging issue we face. Like a chain reaction, it fuels a range of other top-level challenges from food security to migration, biodiversity loss, the fight for resources, risks to human health, economic losses and threats to social peace.

**We must act now** and take full advantage of the huge untapped potential of space to make a difference, developing and bringing its contribution to global challenges up to the highest level. **New approaches – Accelerators - should be developed urgently** with the following key points in mind:



**Acting swiftly becomes increasingly crucial.** Considering the profound impact of climate change, Europe cannot afford to wait – there is no time to lose. Europe needs the ability and the tools to support Earth solutions to limit the effects of climate change or the impact of human activities, as well as tools to respond to crises in real-time, based on robust inputs.

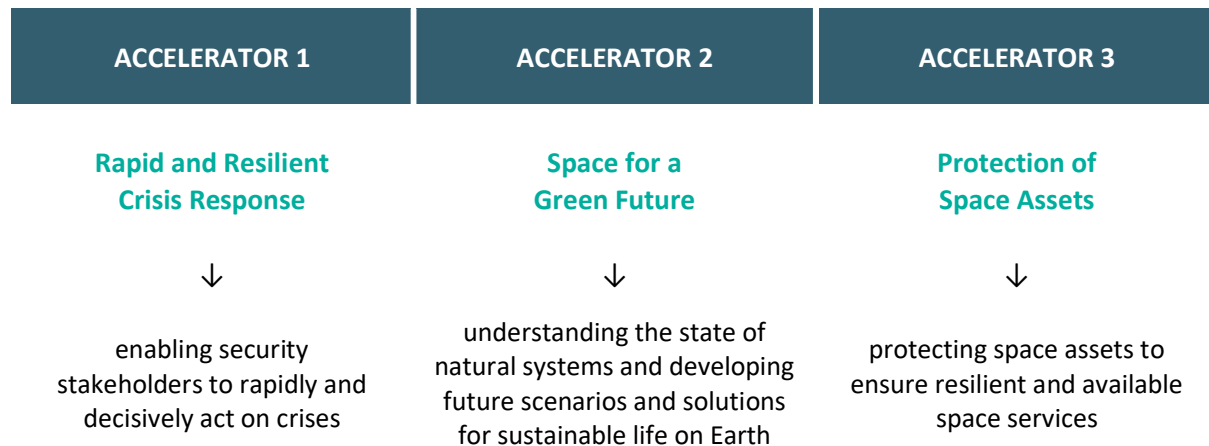


**Understanding the evolution of climate parameters** and turning this knowledge into actionable tools towards anticipating and modelling of impacts are essential tasks in support of bold European policy ambitions and provide a firm basis for decision-making.



**Space infrastructure is the backbone** to enable Europe to act and lead. However, increasing reliance on space infrastructure makes it necessary to safeguard European assets in orbit, while contributing to a sustainable space environment.

It is proposed that three **Accelerators** are initiated focusing on the following areas:



These **Accelerators** will play a critical role in addressing the pressing challenges facing us today. They will also spur on the growth of the European economy and space sector and support Europe in playing a leading role internationally.

The High-Level Advisory Group **advises the ESA Director General takes immediate action and further elaborates** the three **Accelerators** in line with the below-described key characteristics:

## Accelerator 1: Rapid and Resilient Crisis Response

**Rapid and Resilient Crisis Response** will enable security stakeholders to ensure a rapid provision of information, and quick response to climate-induced and other crises facing Europe.

### Urgent problem we need to solve

**Crises are becoming ever more frequent and impactful.** Summer flooding across Europe in 2021 killed 242 people, with an economic impact in Germany alone of €30 billion. Forest fires across the EU from 2000-2017 caused average economic losses of €3 billion per year. The recent volcanic eruption on La Palma (Spain) is causing catastrophic disruption.

In order to respond most effectively to such crises, the best possible information needs to be available rapidly to decision-makers and those coordinating response efforts on the ground. Space already plays an important role providing spatial information from Earth Observation satellites. It also enables communication in areas where ground-based infrastructure is absent or damaged by a crisis. However, the value of information is limited in terms of quality of spatial resolution, timeliness and quality of communication (e.g., bandwidth and security).

### What we need to do

The available capabilities need to be enhanced and utilised in an integrated way through the development of a **European crisis information management system**, building on space assets as a central element.

Self-learning AI solutions should be maximised to exploit the full potential of available data, combining space- and ground-based services and integrating feedback from users directly responding to crises.

New developments in satellite constellations and secure satellite communications will further enhance response significantly. The combination of both space and non-space smart, interconnected ecosystems - using disruptive quantum technologies in communications and in Earth Observation - will reliably and rapidly generate new and relevant information. The proposed crisis information management system will also be an important customer of the Secure Connectivity Initiative of the European Commission.

## Accelerator 2: Space for a Green Future

**Space for a Green Future** will use advanced space data, science & technology for sustainable life on Earth, and support society and decision-makers to reach carbon neutrality by 2050.

### Urgent problem we need to solve

The IPCC's recent 6<sup>th</sup> report is a 'red alert'. The recent extreme weather events of 2021 underline the fact we are in the last hour to act if not beyond. There is a political drive to become CO<sub>2</sub> neutral by 2050 and establish a circular economy without using the finite resources of planet Earth.

Space-based Earth Observation underpins the IPCC report, and many "Space Solutions" combining Earth Observation, Telecommunications and Navigation capabilities already support decarbonisation. But **Space has untapped potential to do much more**, helping achieve a precise understanding of the Earth through modelling, allowing predictive forecasts, and supporting policy formulation, implementation, monitoring and evaluation. Space can also offer sustainable commercial solutions for a Green Economy.

### What we need to do

We must exploit this exceptional wealth of data more effectively to monitor, understand, model, predict and act. We should combine Earth Observation with in-situ and social data in a Digital Twin of the Earth, allowing for a much better **understanding** of our planet and enabling **what-if analyses**. Through the development of **Green Information Factories**, the **Accelerator** will enable the creation of products and technologies to support all sectors of the Green economy, while also stimulating and accelerating the growth of a competitive European Downstream and Upstream Industry. We should prepare novel connectivity infrastructures and services to further support decarbonisation and

the green economy and prepare for next generation Earth Observation missions using quantum technologies enhancing our ability to monitor climate change with unprecedented precision.

### Accelerator 3: Protection of Space Assets

**Protection of Space Assets** will ensure resilient availability and functioning of space infrastructure on which Europe's economy and society relies for day-to-day life.

#### Urgent problem we need to solve

Some 36,000 objects larger than a tennis ball – and many more smaller ones – orbit Earth, posing a constant threat to active space objects. Space weather events, a natural phenomenon caused by the Sun, harm not only space assets, but also sensitive, critical ground infrastructure. **Together, these events risk causing significant economic damage.** As mega constellations are deployed and dependence on space based critical infrastructure increases further (e.g., autonomous driving, power grid control and mobile broadband), our vulnerability to these threats will only grow. It is paramount that Europe ensures that these assets, the data they transfer and process, and the services they deliver, remain resilient and protected against disruption and interference.

#### What we need to do

**Autonomous European systems** – independent of US data sources, and allowing the detection, identification and prevention of hazards – are needed to tackle the problems of Space Debris and Space Weather. Improved accuracy in debris tracking will reduce numbers of false collision alerts and, as a direct consequence, reduce considerably ongoing satellite operating costs and extend mission lifetimes. This accelerator will secure ESA assets in space and the European technological and commercial leadership and autonomy in safely accessing and using space. It will also strengthen Europe's position in regulatory discussions and will grow European industrial champions in the commercial market in observation, forecasting, debris removal and in-orbit servicing.

## Structural Benefits from the Three Accelerators

#### European leadership

**Accelerators** in these areas will sustain European leadership in Earth Observation and space-based Green Transition solutions for society and business. It will also help establish Europe as a global leader in humanitarian action and support European autonomy in energy and water supply. This will strengthen the strategic independence of Europe's digital ICT infrastructure both in space and on Earth and support the European industrial space supply chain.

The high technical innovation needed to develop space hazard management systems will place Europe in a leading role to determine future global regulatory frameworks, lead development of the in-orbit servicing market, and reinforce economic value through protecting critical assets

#### Joint architecture and cooperative approach

ESA is already a leader across a broad range of space technology and applications and in developing next generation architectures. It has a strong track record of collaboration with space and non-space industry, analysing and answering to user needs, and building partnerships. But a new architecture – the **Accelerators** – will add value to ESA's established role and its activities and programmes, and develop new partnerships, with a broad range of public and private actors and funding models, capable **together** of addressing outstandingly complex global challenges.

Effective global engagement at policy level will be supported by excellent technical leadership and **strong user engagement**.

## Benefits to society

Improved climate information and analysis will underpin better informed political choices. It will improve monitoring of the effect of climate policies, allow better and faster actions, in anticipation of and during future crises. It will foster the development of space-enabled solutions in support of the future Green Economy. This will reduce loss of life and cost to society and economy, support the timely intervention of civil protection services and reduce the impacts of humanitarian crisis globally. Europe's economy will be strengthened significantly and be more globally competitive. The security of critical data infrastructure will be improved and crucial resources in space and on Earth protected.

## 5 BEYOND THE THREE ACCELERATORS: FURTHER MAXIMISING THE POTENTIAL OF SPACE

Beyond immediate societal urgency, Europe must also further foster scientific excellence, innovation, inspiration, competitiveness, sovereignty and leadership alongside the spirit of the proposed **Accelerators**.

The High-Level Advisory Group therefore believes **ambitious initiatives and concepts should be pursued as key priorities**, as they yield breakthrough developments in science & technology, ensuring European leadership in the coming decades.

### Prospects of an icy moon sample return mission

Icy moons of the giant planets in the outer Solar System potentially harbour life. They are a prospective destination for future space missions and have been identified as one of the core themes of the new strategic plan “Voyage 2050” of the ESA Science Programme.

Features of an icy moon sample return mission build upon ESA’s expertise in exploration of the Solar System and can exploit existing capabilities and synergies with ongoing programmes (e.g. Mars sample return mission).

The High-Level Advisory Group **advises the ESA Director General to consider preparatory steps towards a sample return mission from icy moons of giant planets**, given the broad benefits brought by such a mission:

- **Outstanding scientific return:** A mission composed of sending a probe to the icy moons and returning a cryogenic sample back to Earth would have an unprecedented scientific objective, which could provide crucial evidence and insights into fundamental questions of humankind.
- **Breakthrough technology development:** Cryogenic sample return from the outer Solar System entails cutting-edge technologies, e.g. in-orbit autonomous fuelling, advanced transportation and docking, taking advantage of development of quantum sensors developed for Earth Observation, and cryogenic sample extraction and storage.
- **Profound source of Inspiration:** Having foundation in an inspiring destination and a goal neither attempted nor accomplished by anyone else, an icy moon sample return mission could greatly reinforce European leadership in space science and attract new generations of talented Europeans to the STEM sector.

### Europe’s Human space transportation capability

Human space transportation is an essential sovereign capability among all the major space powers except in Europe. European space actors, and in particular ESA, have long contributed to different collaborative frameworks in human space transportation, providing key elements and modules of human-rated crew vehicles. Despite developed expertise, Europe has not identified autonomous human space transportation as a priority objective.

The High-Level Advisory Group **advises the ESA Director General to further investigate the technical, political, programmatic and economic relevance of developing a Europe-made human-rated space transportation solutions**. These analyses should be developed in light of recent developments observed on the global scene:

- Indicating that human transportation will become a permanent activity;
- Suggesting that a destination towards cislunar space is likely to shape the next decades in space exploration;
- Offering, through space tourism, new and uncharted commercial perspectives, as a first step of the expansion of the space economy;
- Demonstrating that the development of such systems is increasingly affordable, based on the recent experience in the United States.

Additionally, such capacity would provide Europe with outstanding opportunities to play the role it deserves in future international endeavours related to space exploration, in a highly visible and rewarding manner.

In line with the Accelerator concept, the development of human rated capacity should be considered through innovative procurement models seeking higher technical and financial involvement of private actors and industry.

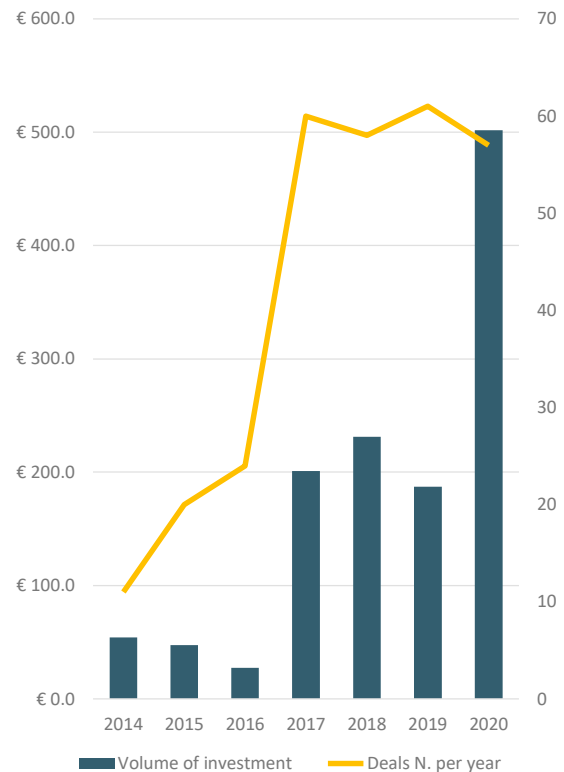
## 6 TRANSFORMATIONAL AGENDA

### Favouring Commercialisation

The success of existing innovative NewSpace initiatives in Europe demonstrates the opportunity to further develop the European commercial space sector and attain global leadership. The global space economy represents today more than 300 B€ per year and could double within a decade. This commercial “explosion” touches on all sectors of space, from launchers to applications, from exploration to LEO economy.

Thus, the High-Level Advisory Group **advises the ESA Director General to further enable and facilitate the emergence of a European NewSpace** by acting on three main factors:

- **Talent** = invest in brains and in human capital, encourage cross-discipline innovations, invest in disruptive or game-changing technologies while accepting the related risks / failures; develop a European-wide Phi-Lab network; protect its inventions through patents and identify technology transfer opportunities;
- **Capital** = beyond seed funding and series A, facilitate access to scale-up funding for newcomer entities and start-ups; partner with entities such as the European Investment Fund or with (European) VC funds and advising capital markets related bodies, building on its recognised technical and engineering competences and providing advisory services to its financial partners, as well as cooperating with the EC on its Cassini initiative. Among the start-ups incubated in ESA BICs, those with a commercial potential should be supported to be integrated in supply chains;
- **Speed** = Institutional processes (contractual, industrial policy) should allow enhanced access to ESA contracts to newcomers and small entities and provide regular IOD/IOV opportunities. This requires transformation and change in the culture of risk-avoidance, and an adapted role (e.g. by procuring services, specifying user needs, but not how they should be implemented, or by adopting new contractual tools such as agreements with a gateway approach).



*Growing investment in space start-ups in Europe, Source: ESPI*

### Fostering Human Capital & STEM

Furthering the impact of space systems and programmes for the benefit of our societies requires a suitable and aptly-trained and educated workforce. Today, Europe is confronted with three main challenges, which lead to an emerging “race for talent”:

- **Increasing the interest of European students in STEM** subjects to avoid the risk of brain drain,
- **The Future of Work:** The need to enable the uptake of new competences, including the digital skills, preparing the human capital that European space will need in the future,
- **A retirement wave** in the European space sector that will increase competition to find the right talents.



To prepare for these challenges, the High-Level Advisory Group **advises the ESA Director General to explore ways in assuring ESA's leadership in attracting the best and brightest talents:**

- attracting more European students in STEM subjects, e.g. through leveraging the unique inspirational and innovational content of space programmes;
- supporting a more systematic exchange between the space sector and start-ups, in order to increase the exposure of young people to innovative endeavors and ensure knowledge exchanges;
- offering middle, high school and university students opportunities for more exposure to space activities, better access to test facilities and providing more hands-on training;
- pursuing greater exchange between educational institutions and engagement with academia and beyond to reinforce the hard and soft skills that will be in increasingly higher demand;
- investment in HR policy, preparing the leadership needed in managing and implementing future space programmes and making ESA an attractive employer with modernised procedures and the ability to provide attractive career growth beyond single projects.

## European Space Cooperation for a stronger Europe

Throughout the past decades, European space cooperation among ESA Member States and with European institutions (ESA, the European Union, EUMETSAT, etc.) has resulted in a number of success stories, in achieving ambitions in all domains of space activities, proving that space is a domain where European cooperation delivers concrete results and thus creating a stronger Europe.

Copernicus and GALILEO are outstanding examples where the EU and ESA have worked together to develop the world leading space infrastructure and services, creating value for the European economy and tangible benefits for European citizens.

The **Accelerators** provide a unique opportunity to put this reinforced cooperation into action by combining their respective strengths and resources to respond to the most urgent societal challenges for Europe. **Accelerator 1** (Rapid and Resilient Crisis Response) and the European Commission's Secure Connectivity initiative depend on each other in order to succeed in delivering the full benefits. Likewise, **Accelerators 2-3** can only be implemented by bringing together the policy and user competence of the European Union with ESA's technical expertise.

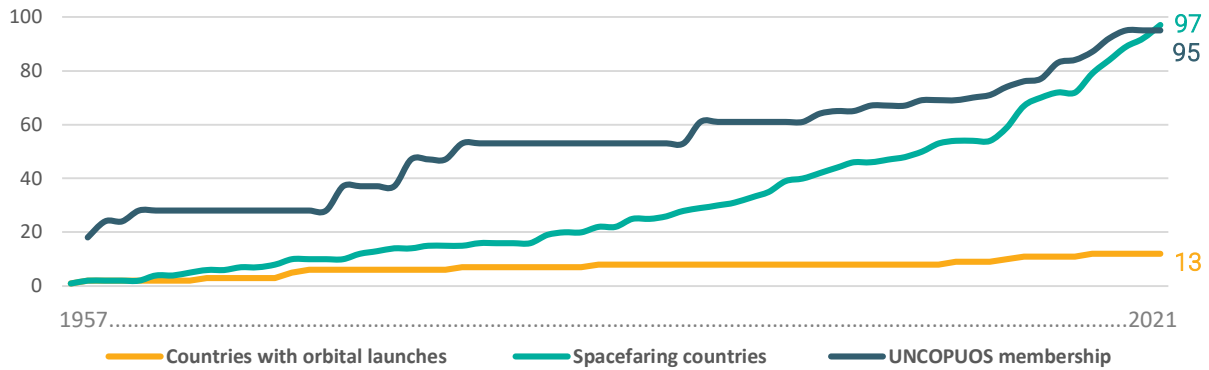
Therefore, the ESA Director General is advised **to further work with ESA Member States, the EU and its institutions and other public and private partners**, to build up the **Accelerators**.

## Global Cooperation for a Better World

Europe has a strong heritage in international cooperation and is a highly regarded and trusted partner. By construction, international cooperation is deeply entrenched in ESA's governing mechanisms that make it an effective instrument to promote European leadership internationally and contribute to diplomatic stability.

It is important to consider major trends at play in the space sector and in the global political environment at large. The rise of commercial actors, the emergence of new spacefaring nations and rising geopolitical tensions, create new challenges and opportunities for future international cooperation in space.

The new Financial Framework Partnership Agreement (FFPA), signed in June 2021 between the European Commission, ESA and EUSPA, provides the basis for a reinforced relationship for the next seven years. It is a major milestone in line with the first objective of the ESA Agenda 2025, to provide positive impulse to ESA-EU cooperation.



*Increasing number of countries engaged in space (1957-2021), Source: ESPI*

Ensuring a level-playing field among international partners, including unrestricted access to the state-of-the-art technologies, and identifying clear objectives to be achieved through international cooperation are important prerequisites in shaping Europe’s international cooperation strategy.

Europe needs to strike an informed balance between possible cooperation (e.g. space science, climate change monitoring and mitigation, exploration) and competition (space data economy, critical space infrastructure deployment, national security space activities, space commercialisation).

Some of the foundational principles of ESA’s international engagement, such as leading by example and being a trusted and reliable partner remain as valid as ever also in the evolving global landscape. Acknowledging that the Agency serves as Europe’s gateway to the world, the High-Level Advisory Group **recommends the ESA Director General to assess opportunities for more partnerships where Europe is in a leadership position.**

## Ensuring Resilience and Embracing Security

The space environment is increasingly congested and contested, owed to the proliferation of space actors, the increasing utilisation of the orbital environment and the critical reliance on space-based services and infrastructure. These developments result in the emergence of new security challenges. As the **Accelerators** address vital needs to provide resilience for Europe and beyond, **ESA should embrace that security plays a pivotal role in the future of space activities**, starting with ensuring the resilience and protection of its own assets and promoting responsible behaviour in space.

At the same time, space has a potential to make the difference with security on the ground, with space-based services becoming ever more essential in the wider security context. The **Accelerators** can unlock this potential to both deepen and broaden the ability of space to help users respond to security challenges.

Acknowledging the central importance of security in space, and of space for security on Earth, the High-Level Advisory Group advises the ESA Director General **to further affirm ESA’s role in the area of security, in line with ESA’s mandate and the strategic orientations of its Member States.**

## 7 RECOMMENDATIONS

The High-Level Advisory Group recommends to the ESA Director General to **immediately take action and formulate proposals to initiate the Accelerators and implement a Transformational Agenda**, with ESA Member States and other partners, on these recommendations:

### 1. Increasing the societal & economic impact of space, prioritising user-driven solutions and leveraging commercialisation

The major societal challenges induced by climate change and its knock-on effects require immediate action. While space has the potential to enable effective and resilient solutions, **it remains underutilised**. The ESA Director General should investigate options for increasing the societal and economic impact of space, **prioritising user-driven solutions** and leveraging commercialisation.

### 2. Creating new tools to aggregate resources for concrete solutions to societal challenges

**Accelerators** should innovate and implement space-enabled solutions to wider societal aspirations and challenges by **uniting various actors**, including public and private, under a shared umbrella and blending cash, in-kind contributions and other public policy measures.

### 3. Initiating three Accelerators for immediate action

From a set of proposals put forward by the ESA Director General, three priority streams replying to urgent societal challenges have been identified for immediate action through **Accelerators**:

- **ACCELERATOR 1 – RAPID AND RESILIENT CRISIS RESPONSE**, for enabling security stakeholders to ensure rapid provision of information, hence allowing quick response to climate-induced and other crises facing Europe;
- **ACCELERATOR 2 - SPACE FOR A GREEN FUTURE**, using advanced space data, science & technology for sustainable life on Earth, including the development of digital twins of our planet to support society and decision makers to reach carbon neutrality by 2050;
- **ACCELERATOR 3 - PROTECTION OF SPACE ASSETS**, to ensure resilient availability and functioning of space infrastructure on which Europe's economy and society relies for day-to-day life.

### 4. Defining a stepwise approach for implementation of the Accelerators

**Accelerators** require a stepwise approach in order to build-up consensus with the ESA Member States and potential partners to define common objectives and aggregate resources.

### 5. Preparing for future ambitions and destinations

Considering the potential breakthrough scientific results, and the diverse set of technologies required in the next decade (advanced Transportation, Autonomous Rendezvous & Docking, Quantum Sensors, Telecommunications, Cryogenic Sample Extraction and Storage, Precision landing and ascent on remote solar objects), the High-Level Advisory Group recommends the ESA Director General to initiate preparatory steps towards a **sample return mission from icy moons of giant planets**.

The High-Level Advisory Group further recommends to investigate the technical, political, programmatic and economic relevance of developing **Europe-made human space transportation** solutions.

## 6. Implementing a transformational agenda

Adapting ESA to better fit the future requires transformation:

- **Commercialisation:** The success of commercial initiatives in Europe demonstrates the opportunity to further develop and take advantage of the European commercial space sector to foster global leadership. Further steps should be taken to stimulate the European space economy, as well as through novel procurement practices (e.g. service-oriented procurement), fully leveraging the innovation excellence of industry.
- **User-driven approach:** Putting users at the core is a key condition for success to properly define the services to be delivered as well as the supporting operations. User representatives should be formally involved in the design stage.
- **Human Capital & STEM:** Catalysing interest in STEM subjects amongst younger generations, by leveraging the unique inspirational capacity of space is a priority. Continued investment in Human Resource and educational strategies is recognised as crucial in developing the necessary skillset to equip Europe for future leadership in science & technology. ESA shall invest to prepare the workforce needed for managing and implementing future space programmes and make ESA an attractive employer with modernised procedures.

## 7. Cooperating for a stronger Europe and a better world

**European cooperation** in space has a proven track record in driving technological leadership for the benefit of European industry and its citizens. **Accelerators** provide an opportunity to combine the respective strengths and resources of various actors (including policymakers, parliamentarians, citizens and the private sector) to respond to the most urgent societal challenges for Europe.

Europe is recognised as a trusted and reliable partner in **international space cooperation**, with ESA serving as Europe's gateway to the world. Assessing opportunities for further partnerships to tackle global challenges will position Europe in a leadership role.

## 8 HIGH-LEVEL ADVISORY GROUP ON ACCELERATING THE USE OF SPACE IN EUROPE

As communicated to the ESA Council in June 2021, the High-Level Advisory Group comprised 9 members, nominated in their personal capacity as recognised, independent experts in space policy matters.

The recommendations of the Group represent a key milestone within a wider process of defining ESA's future ambitions, kickstarted by the release of ESA Agenda 2025 in April 2021.

The mandate of the Group was to advise the Director General on ambitions for ESA's way forward, considering the evolving global context and emerging challenges, contributing to European policies and to the future of Europe at large.

As per the Terms of Reference, the High-Level Advisory Group focused on:

- **The urgency to act:** assessing the economic, societal and political role space for Europe, in light of developments in other space powers and the fast-developing commercial sector;
- **Identifying a suitable approach:** identifying technology, scientific, exploration and application domains in which Europe must invest to attain its goals, thereby delineating the objectives to be set for future European space ambitions;
- **Realising the ambition:** proposing appropriate approaches, instrumental to achieving this ambition;

The Group has met in person on three occasions:

- First Meeting 19 – 21 July 2021, ESRIN, Frascati, Italy
- Second Meeting, 30 August – 1 September 2021, ESTEC, Noordwijk, The Netherlands
- Final Meeting, 27 – 28 September 2021, ESA Headquarters, Paris, France

The report is a product of intensive deliberations, which were supported with presentations by external experts and senior ESA Staff (See Section 8; Acknowledgment).

### Members of the High-Level Advisory Group on Accelerating the Use of Space in Europe

**Roberto Battiston** (former President of the Italian Space Agency)

**Mauro Dell'Ambrogio** (former Secretary of State for Science, Switzerland)

**Jean Jacques Dordain** (former Director General of ESA)

**Cristina Garmendia** (former Minister for Science and Innovation, Spain)

**Maria van der Hoeven** (former Minister of Economy, The Netherlands)

**Rafal Modrzewski** (CEO and co-founder of ICEYE)

**Matthias Ruete** (former Director General at the European Commission)

**Anne Sulling** (former Minister of Foreign Trade and Entrepreneurship, Estonia)

**David Willetts** (former Minister of State for Universities and Science, United Kingdom)

## 9 ACKNOWLEDGMENT

Elaborations and discussions of the High-Level Advisory Group on Accelerating the Use of Space in Europe were supported by a set of guiding presentations provided by a leading external experts and ESA Staff, addressing pertinent issues, providing expert opinions and actionable proposals and commentary on contemporary developments.

### First Meeting 19 – 21 July 2021, ESRIN, Frascati, Italy

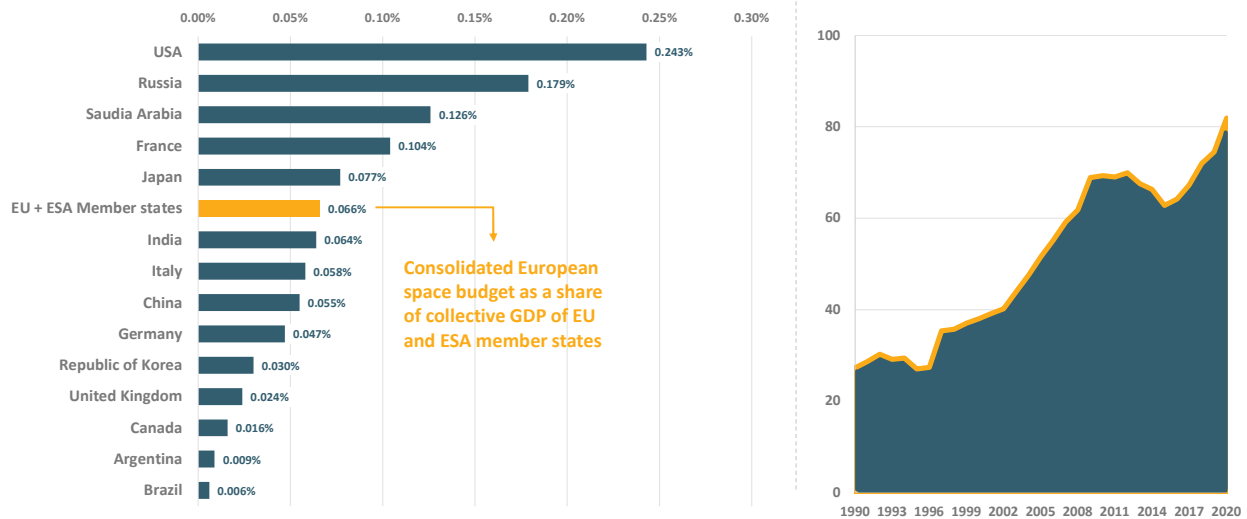
| Speaker (in order of appearance) | Position  |
|----------------------------------|---|
| Frederic Nordlund                | Head, European and External Relations Department, ESA                                 |
| Jean-Jacques Tortora             | Director, European Space Policy Institute   |
| Christopher Rapley CBE           | Professor, Climate Science, University College London                                 |
| Frank de Winne                   | Head, LEO Exploration Group, ESA  |
| Daniel Neuenschwander            | Director, Space Transportation, ESA   |
| Linda Tacconi                    | Senior scientist, Max Planck Institute for Extraterrestrial Physics                   |
| Hosuk Lee-Makiyama               | Director, European Centre for International Political Economy                         |
| Daniel Voelsen                   | Head, Global Issues Division, German Institute for International and Security Affairs |
| Davide Petrillo                  | Executive Director, Space Generation Advisory Council                                 |
| Xavier Pasco                     | Director, Fondation pour la recherche stratégique                                     |
| Eric Morel de Westgaver          | Director, European, Legal and International Matters, ESA                              |

### Second Meeting, 30 August – 1 September 2021, ESTEC, Noordwijk, The Netherlands

| Speaker (in order of appearance) | Position   |
|----------------------------------|--|
| Mariana Mazzucato                | Professor, Economics of Innovation and Public Value, University College London |
| Andreas Schleicher               | Director, Directorate of Education and Skills, OECD                            |
| Ersilia Vaudo Scarpetta          | Chief Diversity Officer, ESA   |
| Guenther Hasinger                | Director, Science, ESA   |
| Toni Tolker-Nielsen              | Director (acting), Earth Observation, ESA                                      |
| Elodie Viau                      | Director, Telecommunications and Integrated Applications, ESA                  |
| Pascal Legai                     | Senior Advisor to the Director General, ESA                                    |
| David Parker                     | Director, Human and Robotic Exploration, ESA                                   |
| Géraldine Naja                   | Director (acting), Commercialisation, Industry and Procurement, ESA            |

## ANNEX A - SETTING THE SCENE

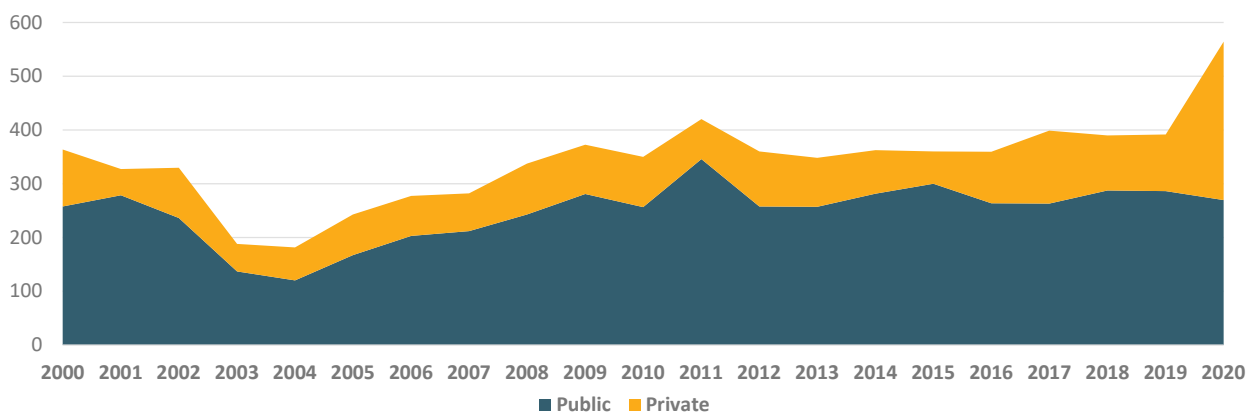
Globally, the space sector is experiencing major growth, both at institutional and commercial level. Major space powers, in particular the United States and China, are committing significant and increasing resources to their space capabilities, whilst a variety of new spacefaring nations are also emerging, bringing along high ambitions and new cooperation opportunities.



Government space budgets (as a share of GDP, 2019) and worldwide government space expenditures (1990 – 2020, in \$ billion); Source: OECD, Euroconsult & ESPI

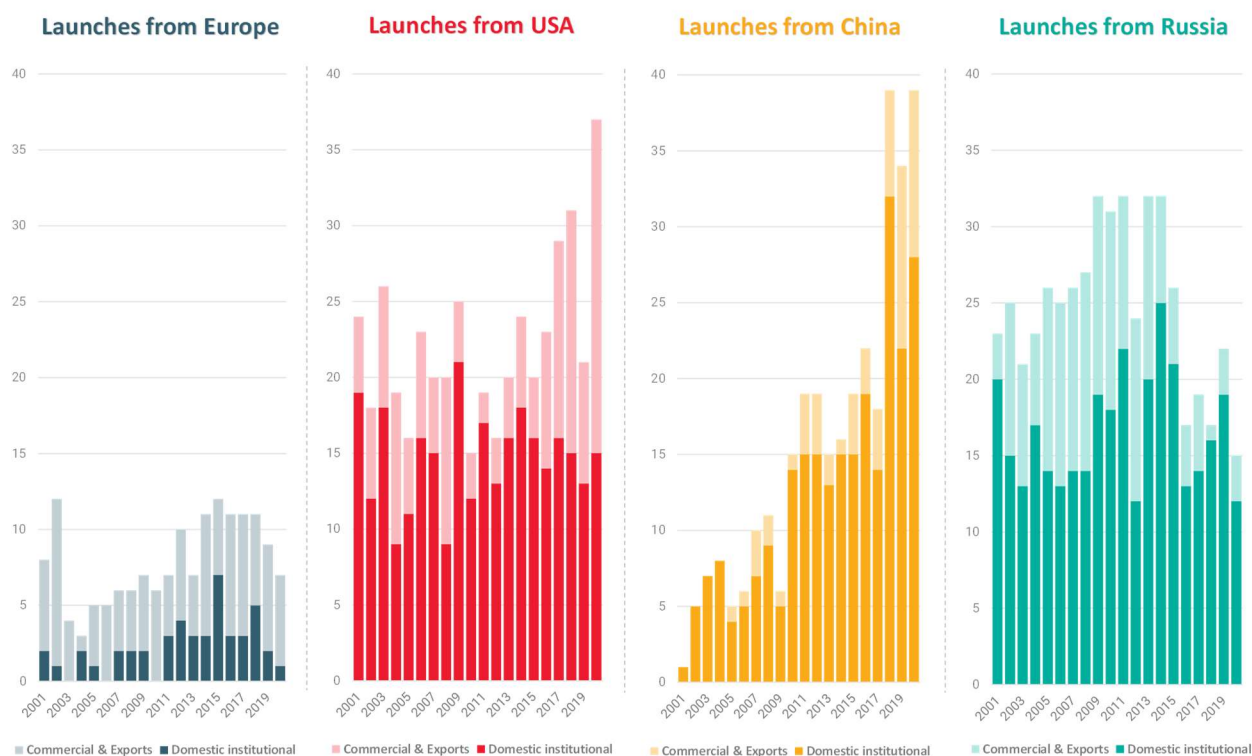
Commercialisation has been one of the most important trends in recent years – dramatically taking off in the United States roughly a decade ago – and is now profoundly influencing the entire space sector. Since the inception of the space era, Europe has proven to be a pioneer in constructing commercial models and fostering the industrial competitiveness, to the extent that the European approach to space puts emphasis on industry’s capacity to capture significant shares of the accessible international markets.

Undoubtedly, space is resurfacing as an increasingly relevant topic among the general public, and various stakeholders around the world – public and private – are entering the sector. This is reflected in political and financial support directed to critical space-based infrastructure as well as towards inspiring, at times prestige-driven, science and exploration missions. This trend fuels the overall rapid growth in the number of actors conducting space activities, which not only includes new companies but also new countries that are embarking on their own pioneering journeys, rapidly expanding their footprint in space, inspiring new communities and raising the enthusiasm amongst younger generations.



Global Space Activity since 2000 by customer type (in tons launched); Source: ESPI

Despite Europe's space investment being fairly constant over the past decade, the previously attained European leadership on multiple space sector domains is increasingly challenged, lacking a sizable, predictable and stable institutional demand, most often the driving force for creating and scaling up new markets in other global space powers.



Evolution of space launch activity (2001-2020); Source: ESPI

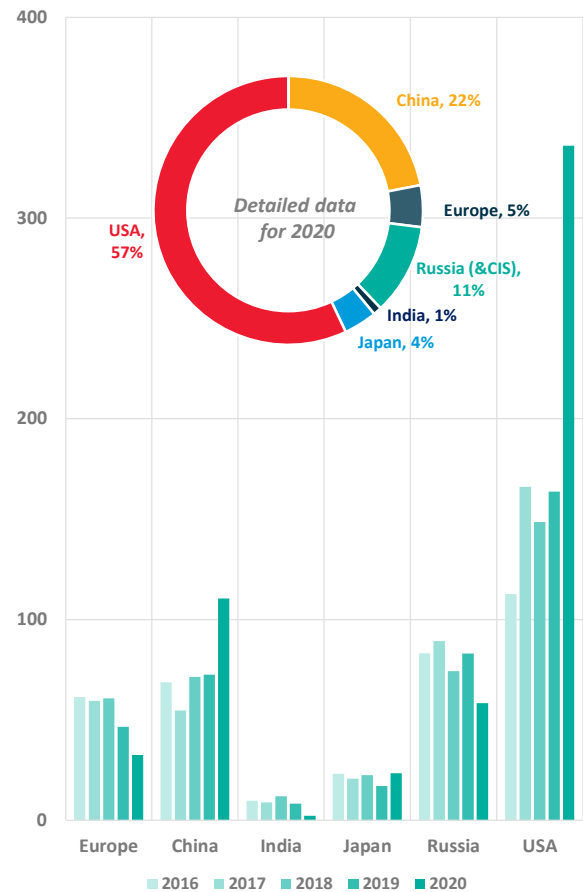
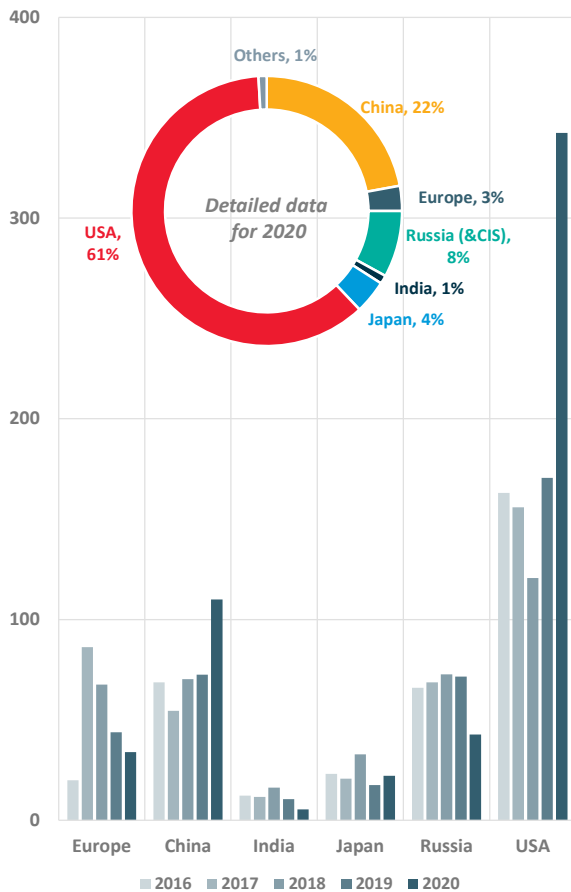
Global space launch activity indicators give significant insights into the position of Europe on the global space map.

- U.S. developments in recent years show steady institutional efforts complemented by a steep increase in commercial launches, related in particular to the advent of mega-constellations.
- China has notably increased its launch activity over the past two decades and while most of the demand comes from institutional customers, the rate of non-institutional launches has notably increased in the last years.
- Russia has struggled recently to keep pace on the commercial markets, but the number of institutional space missions remain almost on par with the U.S.
- Europe experiences a downturn over the last few years with strikingly lower numbers compared to other three.

The global spacescape and consequently the position of the European space industry on international markets are profoundly affected by a fiercer competition brought along by new aggressive providers, as well as by the shift of some markets, e.g. the decline in manufacturing and launch of big GEO Satellites, in which European industry successfully managed to establish a strong historical leadership.

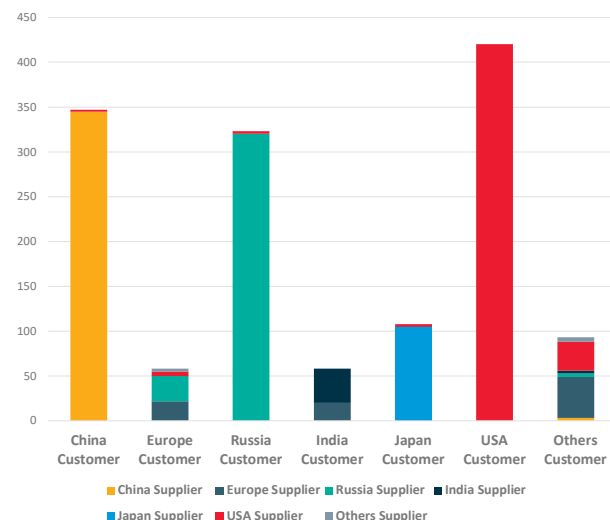
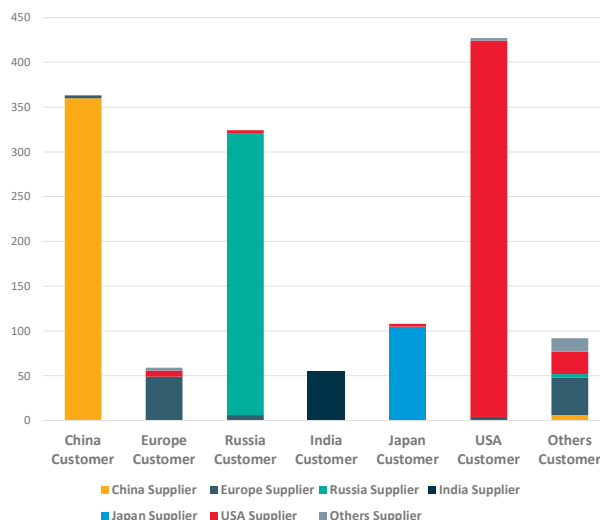
Moreover, there is a clear move towards increasingly protective public policies, perhaps best marked by a view shared by one of U.S. president Biden's main economic advisors, Brian Deese, stating that "*strategic public investment to shelter and grow champion industries is a reality of the 21st-century economy. We cannot ignore or wish this away.*" during a speech in June 2021.





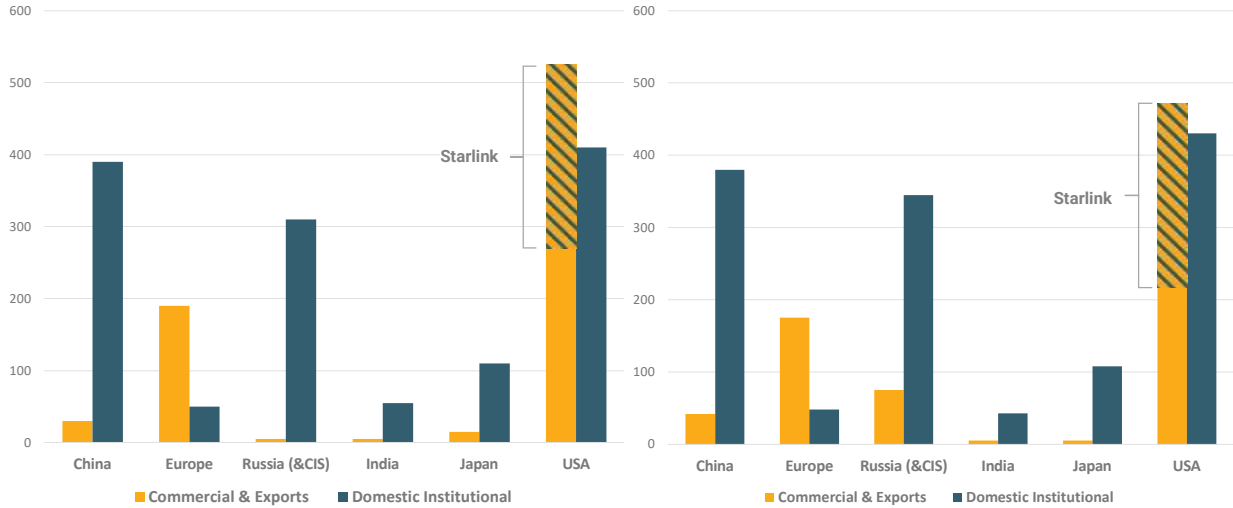
Spacecraft production (Left) and Launch activity (Right) in tons; Source: ASD-Eurospace & ESPI

As indicated, for decades, European industry has successfully relied on then leading commercial markets (GEO launches, satcoms) to make up for the gap in institutional demand compared to other global space powers showing the capability and the timing to competitively capture also non-European markets. This has been a distinctive feature of the European approach to space, but today this strategy is increasingly challenged, given the shrinking share of open and accessible markets and the fast increase of providers as we see in the chart below which clearly indicates that most institutional demand both for spacecraft manufacturing and launch is addressed by national providers.



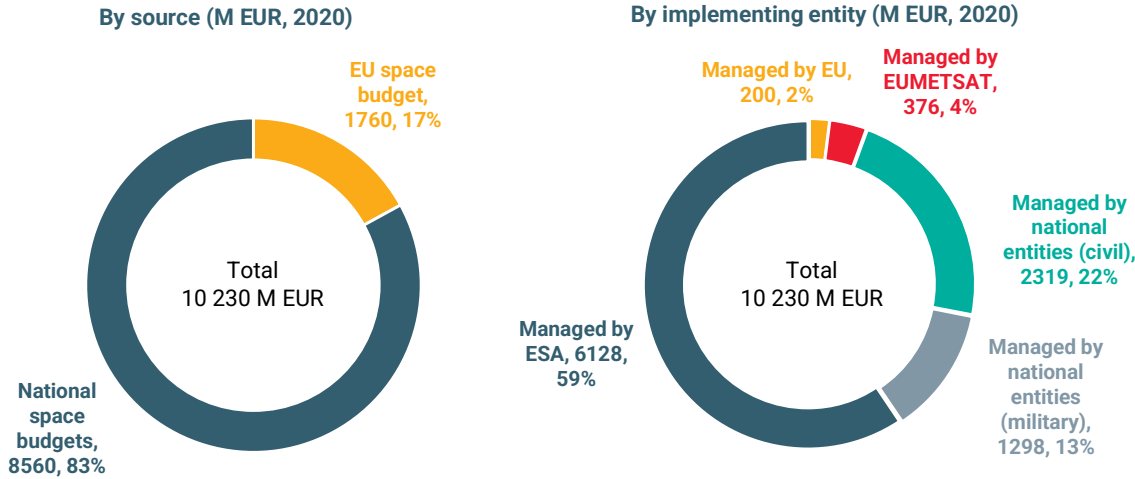
Institutional spacecraft (Left) and launch (Right) demand & supply (in tons); Source: ASD-Eurospace

Even in terms of pure commercial demand, the market is in some cases captive, as new commercial models, building on end-to-end vertical integration (e.g. Starlink) represent a substantial share of the global demand that might in turn supersede the European-led Geostationary business. Moreover, a potential wave of mergers & acquisitions might further intensify this trend.



Spacecraft production (Left) and Launch activity (Right) in tons (2016-2020); Source: ASD-Eurospace & ESPI

Today, ESA, mandated and enabled by its Member States, is by far Europe’s most important space actor, implementing almost 60% of the overall European budget devoted to space, and can therefore build on its recognised heritage to provide the needed new impetus and boost to the European space sector.



European consolidated (upstream) budget in 2020; Source: ASD-Eurospace,

Agenda 2025 contains five priorities for the Agency’s near-term future, to strengthen ESA–EU relations, boost green and digital commercialisation, develop space for safety and security, address critical programme challenges and complete the ESA transformation.

These priorities have been defined to put space-enabled technologies and services to work, at a speed matching the sense of urgency which characterise the societal challenges listed above, sustaining the excellence of the European space sector and reinforcing its position on the international stage. Implementing these priorities should also provide opportunities to further strengthen ESA-EU collaboration building upon the Financial Framework Partnership Agreement and complementing wider European space policy objectives.

For this, bold decisions need to be taken to fully take advantage of the role of space in a wider societal context encompassing multiple pressing needs on Earth. There is actually a need to design ambitious and future-defining initiatives that directly tackle various challenges faced by Europe and the world.

Furthermore, a can-do approach and the potential success of space in addressing timely and urgent societal needs has unique potential in driving a larger interest for STEM & other relevant subjects among the young European generations, fostering the necessary human capital for Europe's success in the decades to come.

*The viability of Europe's approach to space is strongly relying on industrial success on international markets and is marked by relatively low levels of institutional demand. Developments in the global space sector and the geopolitical context at large are putting the attained European leadership at risk. Europe should act decisively and timely to reaffirm its role in the international arena, reinforce its space capabilities, prepare to uptake the best and brightest talents of the next generation, and take advantage of the benefits of space for its countries and people.*