

FUTURE OF SPACE EXPLORATION

STRATEGIC SCENARIOS FOR
EUROPEAN SPACE
EXPLORATION 2040-2060



Prepared for:



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INTRODUCTION

THE POINT OF DEPARTURE

The space exploration sector finds itself in winds of change! New geopolitical power shifts, macroeconomic uncertainty, technological advancements, and demographic changes are fundamentally altering the way space exploration is perceived, embedded, and developed, as well as the part that space exploration, and space at large, play in our daily lives.

Hence, strategic anticipation has probably never been more important and cannot be limited to the known operational context in the near term. To chart a viable course forward and evolve, there is a need for clarity about how forces of change and critical strategic uncertainties reshape the space (exploration) sector. Doing so, requires a detailed understanding of what the future might hold. From a long-term strategic vantage point, this is best done by considering a range of plausible strategic scenarios.

Against this backdrop, The European Space Policy Institute (ESPI), in collaboration with the Copenhagen Institute for Future Studies, initiated this scenario planning project tuned in on the Future of Space Exploration 2040-2060. This foresight journey sets out to develop explorative scenarios that help uncover new insights and blind spots with longer-term implications for the European space sector. The overarching goal is to elevate conventional thinking and strengthen the basis for the longer-term strategic decision making of European space exploration.

This report serves to introduce you to thinking about possible futures and provides a backdrop for contextualising European space exploration between 2040 and 2060, building upon the ESPI 2040 Policy Vision for Europe in Space. In other words, we will catapult ourselves into 2040 as the start of our journey and explore different potential directions the world and the space sector might develop towards 2060.

The first section outlines the scenario planning process and the methodology behind it. The following section delves into a range of categories and their future issues, each with their own unique considerations. When combined, these considerations can serve to be powerful catalysts for discussing critical uncertainties and creating plausible scenarios for the future of European space exploration.

We can't predict – but we can anticipate and prepare! For the space sector, many factors come together in complex ways creating surprising futures in a non-linear world, potentially leaving the sector at a turning point!

TIME IN PERSPECTIVE

There are nearly four decades between 2023 and 2060. This can seem like a very long time, or a very short time, depending on your perspective. A lot can happen in 37 years. There were only five years more between Charles Lindbergh crossing the Atlantic Ocean non-stop in his Spirit of St. Louis and Neil Armstrong taking his small step on the Moon.

37 years ago, it was 1986, the year the Soviet Union launched the Mir space station, the space shuttle Challenger exploded, and the Chernobyl reactor had its accident – all of which seems like ancient history today. Halley's comet came to visit and won't come our way again until 2061.

Towards 2060, we will likely see massive geopolitical upheavals, astonishing advances in artificial intelligence, robotics, and virtual and augmented reality technologies, recurring climate disasters, sweeping social changes, the world population passing 10 billion, and hopefully, a complete transition to a sustainable economy. By then, very few people who have witnessed the Apollo 11 Moon landing will be alive.

When planning for 2060, we should not do so based on what the world looks like today, but rather what it will look like then.

EUROPE TOWARDS 2060

The world, and hence Europe, will facing a range of challenges and shifts in the coming decades. We are in the middle of a geopolitical power shift from the West to the East, with Africa caught in the middle, and tensions growing between USA and China. Europe is facing declining populations, eroding political unity, immigration pressure from the south, and the prospect of persistently slow economic growth over the coming decades.

Furthermore, the effects of climate change are beginning to be felt and will undoubtedly only grow worse towards 2060, even with strong climate policies and advances in climate technology. Simultaneously, digital advancements will impact and alter the everyday lives of the European citizen in terms of convenience and seamless solutions. Technology will be the backbone of all industries.

It is against this backdrop that the future of space exploration will unfold. European space exploration may suffer from a lack of funding and strategic direction in comparison to other space powers, but with the right choices, European space exploration could be a lever for growing the European economy and unity, creating a strong foundation for Europe towards the second half of this century and beyond.

POINT OF DEPARTURE: 2040

Space exploration has the potential to transform and ripple throughout almost every facet of European society. From the products we consume, and how we make them, to creating a common identity and fostering political cohesion in an increasingly uncertain world. (The following section and our point of departure in 2040 is based on a triangulation of perspectives, please see our research approach, p. 63).

In 2040 we find ourselves in an age of technological phenomena, a multi-polar world order and a new frontier in space with the Artemis program in full swing and its Lunar Gateway established, the newly built Chinese lunar base, and several other global players (e.g., India) further increasing its influence on the space exploration environment. All this while private companies from around the globe are providing technologies necessary for space exploration and setting sights on new frontiers, enriched knowledge, and revenue opportunities.

The human population has crossed the 9 billion mark, and Europe is facing an aging and declining population, compounding the need for political cohesion and stability.

As technologies from space programme continue trickling down and become reappropriated into other industries such as agriculture, pharmaceuticals, mining, defence, insurance, among others, the public knowledge around space has increased. This interacts dynamically (in favour) with the political will within Europe.

From the nascent attempts of the 2020's and early 30's, Europe has cultivated private partnerships for space technology solutions as ESA and its member states took on a bold ambition and played a crucial role in coordinating public and private efforts in European exploration.

However, major societal, economic, and geo-political changes are still leading to disruptions and volatility in political priorities, international collaboration, and cross-border coalitions.

All this leads us to the question: What's next?

CIFS' SCENARIO PLANNING METHODOLOGY

The future is inherently unpredictable, and many factors may come together in complex ways to create surprising futures in a non-linear world. There are no definitive answers about what the future will hold, and this is exactly why we turn to future scenarios for better longer-term anticipation and exploration.

With scenario planning we are trying to learn about the present through the lens of the future, in contrast to per default trying to understand the future from the perspective of the present. It is a structured approach that allows organisations and sectors to consider alternative future outcomes representing novel perspectives and contexts. It is a process that involves both thorough analysis and storytelling to craft convincing and engaging images of the future that 'provoke' decision-makers to think differently about the future and to inspire action. This can help organisations and sectors widen their strategic perspective and devise strategies that are more resilient across different futures.

Scenario planning adopts an 'outside-in' approach, focusing on potential changes in an organisation's or a sector's external environment – including outcomes 'beyond the numbers' that might otherwise be overlooked. This, in turn, influences the relational (transactional) environment and consequently strategic decisions. The process is both explorative and deductive: it aims to derive images of plausible and consistent futures through close examination of driving forces, key strategic issues, and critical uncertainties.

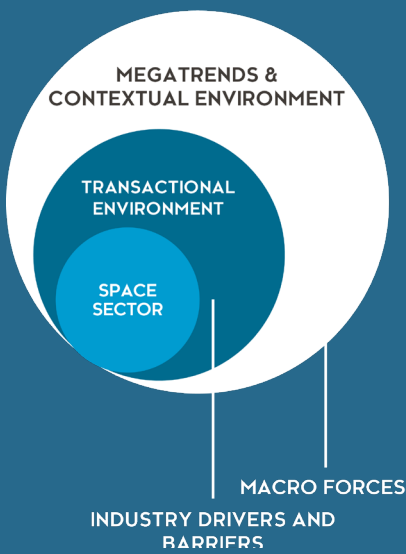
CIFS' approach to scenario planning is anchored in co-creation and broad participation and follows a structured, multi-step process. This specific foresight journey unfolded over three distinct project phases, including two co-creational workshops, directly engaging 32 individuals from various functions, departments, and locations within the space sector. The participant-group was put together to include people who are in a position to contribute with valuable insights and perspectives, while also bringing diverse perspectives to the table, which is key to generating quality strategic foresight/scenario planning outcomes.

The steps in the process are outlined in more detail below:

Visualisation of the scenario planning process

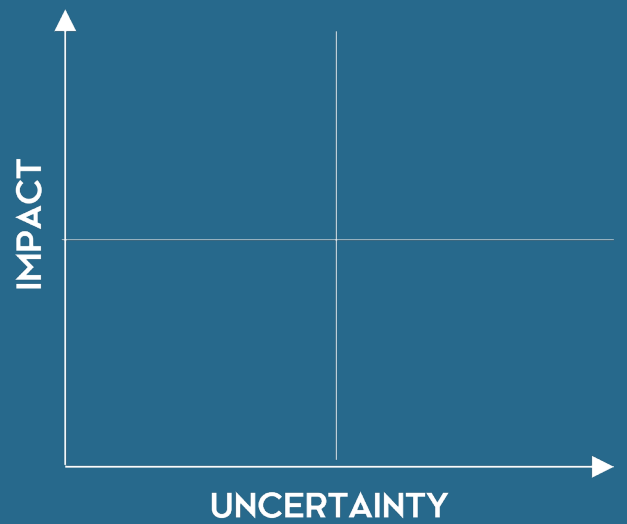
PHASE 1

Explore



PHASE 2

Understand



PHASE 3

Build

Indicator (common themes)	Scenario A	Scenario B	Scenario C	Scenario D
Zeltgeist – Values & attitudes				
Economy & global issues				
People, everyday life & society				
Sustainability, climate and regenerative aspects				
Tech and digitisation				
Funding and priorities				
Talent pool				
Cost of acces to space				
Space behaviour and relationship to space				
Regulatory environment				
Spill-over effects				
Europe compared to other space powers				
Enabling technologies				

PHASE 1

Exploring societal current and future issues

This initial phase is designed to gather intelligence about what drives change in the future in a sound and comprehensive manner. When trying to understand what drives change, it is important to look beyond the immediate vicinity of the European space sector, as many of the factors that will shape the longer term will emerge from outside the sector's current operational and geographical environment.

The contextual environment, which covers factors at the macro level, is where you find megatrends and related developments. These are developments that the European space sector has little or no influence over, related to e.g. demographic developments, technological transformations, societal shifts, economic conditions, political tides, etc.

Ultimately, this analysing phase provides a solid compilation of relevant future issues related to the external environment of the European space sector. A future issue of relevance describes an issue that encapsulate interactions, frictions, and sometimes paradoxes between related underlying driving forces, and where future developments are murky or unclear, yet where the potential developments carry relevance for the future of space exploration broadly and for the European space sector more specifically.

It is a fundamental premise that change never happens in isolation, and the forces that shape the future are all interconnected and interdependent. Hence, this approach facilitates a more nuanced understanding of change than merely scanning for industry related trends.

Future issues are identified based on dedicated research (scanning), a preliminary analysis of driving forces external to the European space sector, and a series of expert interviews. Additionally, the issues are cross-checked with industry reports for explanatory power - i.e. does the issues cover current industry trends (see overview of approach in appendix).

Purpose of this phase

To identify key future issues related to the external environment of the European space sector.

Key activities in this phase

Research and analysis of trends and driving forces

Exploratory expert interviews (with internal and external experts)

Synthesising a future brief as a compilation of future issues

Tools and frameworks used

'Futures Storm' (internal multidisciplinary CIFS workshop)

External environment scanning

Expert interviews (semi-structured)

Driving forces analysis

Purpose of this phase

To understand impact and uncertainty surrounding future issues and identify strategically important critical uncertainties as the outset for scenario building

Key activities in this phase

Co-creation workshop with focus on impact and uncertainty

Qualification of critical uncertainties

Defining axes of uncertainty as the outset for scenario building

Tools and frameworks used

Impact/uncertainty assessment (workshop activity)

Critical uncertainties prioritisation (workshop activity)

PHASE 2

Understanding Critical Uncertainties

A fundamental premise in strategic foresight and scenario planning is to acknowledge uncertainty. Being able to identify the key external uncertainties and tensions that matter the most for the future outlook of an organization or sector is paramount.

In this phase we work directly with the participant group in a workshop aiming to assess and prioritize strategic impact and uncertainty inherent to the identified future issues. In its essence, the aim is to identify strategically important critical uncertainties – high impact and with uncertain outcomes. Critical uncertainties are characterised by their unpredictability and the lack of consensus or clarity about their future direction or outcomes. This makes them the foundation for shaping alternative futures and allows them to influence the success or failure of strategic decisions and plans.

Critical uncertainties are also the outset for the scenario building. After the workshop, the CIFS project team consolidated and analysed the workshop outcome to arrive at two broad ‘axes of uncertainty’ (scenario axes) that give us a scenario matrix with four structurally different scenario spaces. Each axis is balanced with two ‘extreme’ but plausible set of outcomes describing alternative directionalities in which future development might ‘play out’ (i.e. polarities). This was an iterative process internally in the CIFS project team and was ultimately signed off by the ESPI project team.

PHASE 3

Building Future Scenarios

In the scenario building phase, we co-create different scenarios that carry strategic decision-making relevance for the European space exploration sector. The scenarios are framed around the most impactful strategic uncertainties and take the form of narratives outlining contextual developments, unique features, and different outcomes for societies, the space sector, and individuals alike.

We again work directly with the participant group in a co-creational workshop setting to leverage the collective intelligence to create rich, coherent, and engaging images of the future with strategic relevance. We focus on immersing into the scenarios to identify and understand the spectrum of challenges, opportunities, and strategic implications within and across all four scenarios in relation to eight parameters of change specific to the space exploration sector.

Prior to the workshop, CIFS drafted 'contextual scenario outlines' for each scenario as an outset to further explore specific aspects in each of the scenarios. To support the consistency across scenarios, we make use of a 'scenario grid' that covers a range of elements or dimensions that should be considered across all scenarios. After the workshop, the CIFS project team consolidated and qualified the scenario dynamics and crafted the final narratives to arrive at four plausible, consistent, engaging, and structurally different scenarios.

Each scenario outlines a series of future developments and outcomes that the European space exploration sector needs to strategically consider across different levels of the field. The scenarios can be used in different strategic settings to drive futures-oriented discussions, and, depending on the context, unveil a broader spectrum of strategic implications.

Purpose of this phase

Co-create future scenarios that carry strategic relevance for the European space exploration sector

Key activities in this phase

Workshop with focus on co-creating scenarios

Qualification of scenario dynamics and finalisation of scenario narratives

Tools and frameworks used

Scenario matrix (2x2)

Scenario grid

Co-creational scenario building (workshop activity)

“

The future is not mere space.

This is where I part company with a whole variety of science fiction, the imperialistic kind, as seen in all the space wars and star wars novels and films, and **the whole new branch of sci-fi that reduces the future to high-tech.**

In such fiction, space and future are synonymous; they are a place we are going to get to, invade, colonise, exploit, and suburbanise. ”

SPECULATIVE FICTION AUTHOR

URSULA K. LE GUIN
(1929-2018)

OVERVIEW OF ISSUES

The following section outlines 18 future issues across six principal categories that relate to the external environment of the European space exploration sector. A future issue is broader in scope and encapsulates interactions, frictions and sometimes paradoxes between related underlying driving forces. As well as where future developments are ambiguous or unclear, yet the potential developments carry relevance for the future of European space exploration broadly.

Each issue is accompanied with some highlighted drivers, enablers, and barriers. These perspectives serve as ‘food for thought’ but do not necessarily cover all relevant future aspects in relation to an issue.

POLITICS

ECONOMICS

SOCIAL

TECHNOLOGY

ENVIRONMENT

LEGAL



CATEGORY

POLITICS

TRENDS

EUROPEAN COHESION AND STABILITY

PUBLIC AND GOVERNMENT SUPPORT

MULTIPOLARITY AND INTERNATIONAL RELATIONS

BASELINE TOWARDS 2040

“

During the next two decades [...] no single state is likely to be positioned to dominate across all regions or domains, opening the door for a broader range of actors to advance their interests. These power dynamics are likely to produce a more volatile and confrontational geopolitical environment, reshape multilateralism, and widen the gap between transnational challenges and cooperative arrangements to address them.”

Global Trends 2040, p.90, 92.

By 2040, the world population has grown beyond 9 billion. Human development has taken strides since 2023 despite slower economic growth and rising national debt. A more complex and fragmented trading environment, a shift in trade, and new employment disruptions have shaped conditions within and between states. Asian economies continue to show strong growth, albeit slower than in the previous decades. Large platform corporations have driven continued trade globalisation and try to exert influence in political and social arenas. No single state is positioned to dominate across all regions or domains, and a broader range of actors compete to shape the international system and achieve narrower goals. There are accelerating shifts in military power, demographics, economic growth, environmental conditions, and technology, as well as hardening divisions over governance models. Rival powers jockey to shape global norms, rules, and institutions, while regional powers and nonstate actors exert more influence. These highly varied interactions produce a more conflict-prone and volatile geopolitical environment, undermine global multilateralism, and broaden the mismatch between transnational challenges and institutional arrangements to tackle them.

FUTURE SPACE EXPLORATION ISSUES TO CONSIDER

“

An ongoing race for geopolitical influence and future economic gain is unfolding at an unseen pace and further accelerating. Heightened tensions around the world underscore the fact that Europe's security and prosperity increasingly rely on our ability to access and act in space. ”

Revolution Space, p. 9.



European Cohesion and Stability

Europe consists of 44 sovereign nations, 27 of which currently are part of the European Union (EU). Even within the EU, there are tensions between East and West, North and South. Division in Europe can hurt European space programmes, but on the other hand, could a reinforced European space program help improve unity?

Drivers, enablers, and barriers

- Common space projects with a long-term vision can aid cohesion.
 - Nationalist populism can be a barrier.
 - The Russia/Ukraine war has stressed the need for European unity.
 - Bureaucracy can be a barrier for development.
-



Public and Government Support

European space programs rely on support from both governments and populations. In a time when Europe is facing many challenges, space programmes may be seen as 'nice to have rather than 'need to have, which may make it difficult to get more than minimal funding. What can be done to strengthen public support?

Drivers, enablers, and barriers

- An ambitious "Apollo Project" could ignite public interest and support – but not if seen as a frivolous political project with few benefits for the public.
 - Media relations and coverage in general could be improved.
 - A 'space ambassador' close to decision-makers would be helpful.
-

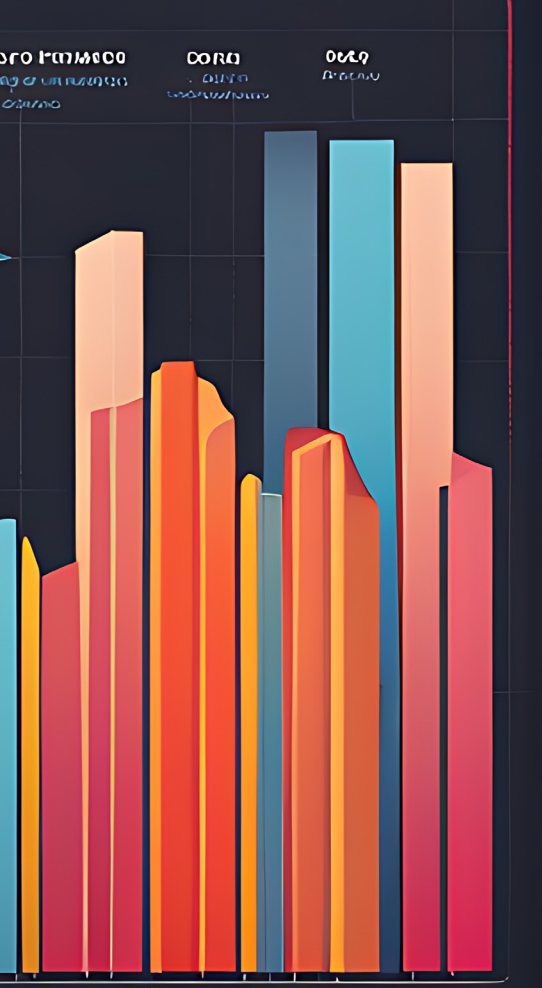
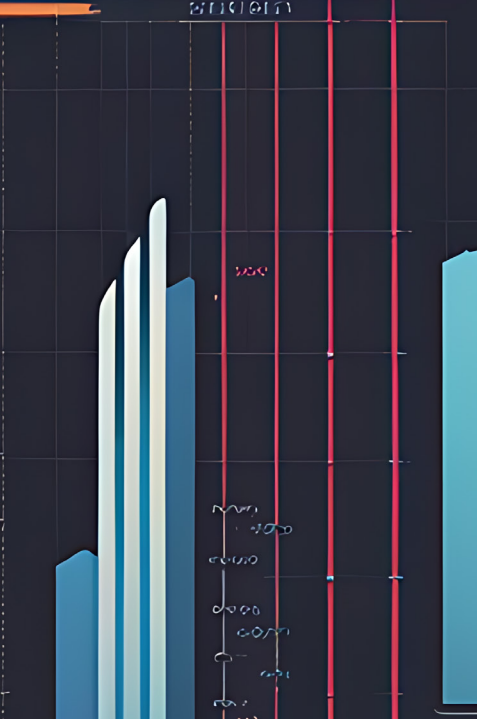
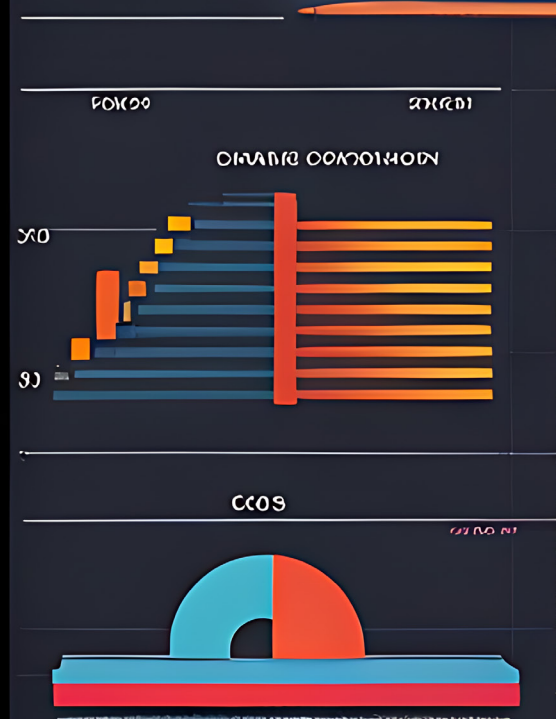
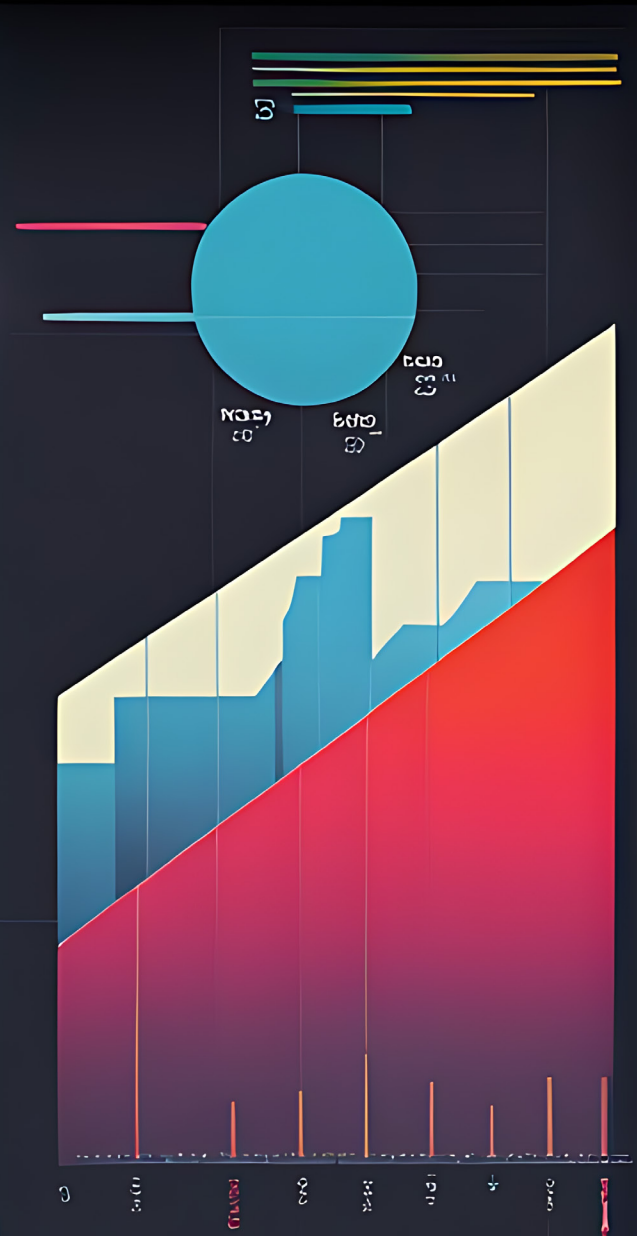
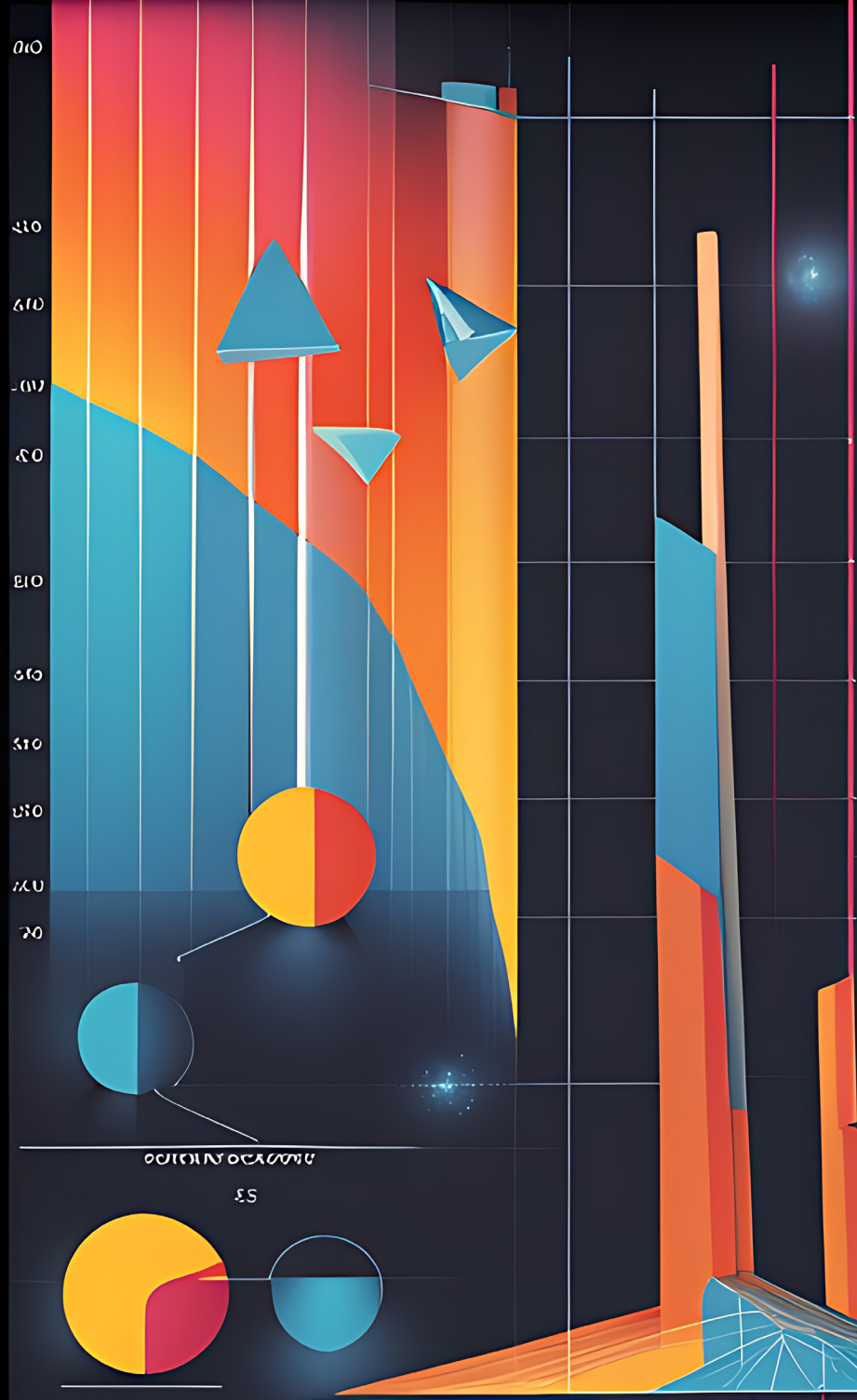


Multipolarity and International Relations

The world is moving from a Western hegemony to a multipolar world, with the Chinese and Indian economies growing to challenge the EU, the United States, and Western-led international policies. This extends to space, with Chinese and Indian space programmes making impressive progress. Moreover, Japan, South Korea, and the Gulf States are also all increasing their ambitions. What will the role of European space programmes in a multipolar world with possibly strained international relations look like?

Drivers, enablers, and barriers

- Geopolitics and a possible shift in power from West to East.
 - Can the coexistence of commercial, scientific, and political objectives rise above international strife?
 - International tension can impact space cooperation, as seen with Russia's behaviour around the ISS.
 - Tensions between East and West could ignite a new space race, meaning more funding for space exploration and space infrastructure.
 - Europe could benefit from new and reinforced collaborations, such as space alliances with India or Africa.
-



CATEGORY

ECONOMICS

TRENDS

INVESTMENTS & YIELDS

DIRECTION & GOALS

COMPETITION & ADVANTAGE

BASELINE TOWARDS 2040

“

We will continue to see the shift in global economic power away from established advanced economies, especially those in Europe, towards emerging economies in Asia and elsewhere [...] Meanwhile, the EU27 share of world GDP could be down to less than 10% by 2050, smaller than India. ”

The Long View: How will the global economic order change by 2050?, p. 5,6, 2017.

Many governments find they have reduced flexibility as they navigate greater debt burdens, diverse trading rules, and a broader array of powerful state and corporate actors exerting influence. Productivity growth remains weak. This challenges governments seeking to provide the education and infrastructure needed to improve the productivity of their growing urban middle classes and sees increased privatisation of welfare and infrastructural tasks. Shifting global demographic trends have aggravated disparities in economic opportunity within and between countries and created more pressure for and disputes over migration. Governments are coming under greater pressure from new challenges and more limited resources. Shifting social norms are expanding the notion for what is considered valuable, what constitutes wealth, and what signals prosperity and social status. The recognition of non-material aspects of wealth and value, such as well-being, health, time wealth, social capital, or contributing to environmental causes heavily influence how we perceive, accumulate, and exchange resources – as individuals and as communities.

FUTURE SPACE EXPLORATION ISSUES TO CONSIDER

“

Space has a broad economic impact on \$80T global economy in '25-40 (7x sector size), and it enables solutions key to safeguard Europe's future, managing existential risks including water scarcity, climate/energy crisis and security. ”

Beyond Earth: The value of space exploration to empower the future of humankind, p. 14

€ Investments and Yields

When it comes to funding space exploration, it isn't just a question of how much, but also who and why: With both old and new players entering space, new incentives, expectations, and demands for funding arise. European space programmes might not depend entirely on public funding. New frameworks for splitting the associated investment risks and benefits between public and private actors will need to materialise. Furthermore, space exploration technologies could cross-fertilise into various industries, thereby providing significant ROI.

Drivers, enablers, and barriers

- Rise of private space companies providing cheaper solutions for space exploration.
- Space tourism?
- Gold rush in space?
- International tensions could further increase military funding.
- Co-funding by powerful digital conglomerates.
- Private/commercial investments in space innovation could impact new future directions in space exploration

🧭 Direction and Goals

European space programmes could aim to achieve various objectives, including advancing knowledge, expanding human presence in space, exploiting space resources, creating practical space infrastructure, and safeguarding Earth and low Earth orbit from space-based threats. Furthermore, they might reflect notions of longer-term sustainability as opposed to shorter term growth.

Drivers, enablers, and barriers

- The choice and weight of goals will be impacted by overall changes in economic focus by European governments, such as a shift from short-term economic growth to long-term sustainability, adoption of a laissez-faire attitude to exploiting space resources, or worries about loss of European sovereignty.
- Long-term slow growth of the European economy could restrict the opportunity space for European space agencies.
- Any long-term goals set by space agencies could be overthrown by political shifts. Foresight could be employed to anticipate such shifts.

🏆 Competition and Advantage

Europe has always lagged behind its big cousin USA when it comes to space. Now, Europe also risks falling behind developing economies like China and India – when it comes to exploring space. This could seriously impact European technological competitiveness, and Europe could miss out on enormous future economic opportunities in space.

Drivers, enablers, and barriers

- The promise of valuable resources on the Moon and on other celestial bodies.
- New forms of PPP's enable private entities to engage in space exploration.
- Mature phases of lunar activities engage extensive logistics chains on Earth.
- Falling behind in the new space race doesn't just mean missing out on being part of scientific projects; in the long term, there could be a major economic impact.
- Growth of critical space infrastructure outside European control can severely impact European economic sovereignty.
- Commercial interest and competition in space exploration could provide both advantages and disadvantages.



CATEGORY

SOCIAL

TRENDS

SOCIAL CHANGE

SKILLS & COMPETENCIES

SPACE EXPLORATION NARRATIVE

BASELINE TOWARDS 2040

“

The most certain trends during the next 20 years will be major demographic shifts as global population growth slows and the world rapidly ages. Some developed and emerging economies, including in Europe and East Asia, will grow older faster and face contracting populations, weighing on economic growth. In contrast, some developing countries in Latin America, South Asia, and the Middle East and North Africa benefit from larger working-age populations, offering opportunities for a demographic dividend if coupled with improvements in infrastructure and skills. ”

Global Trends 2040, p.6.

Societies see increasing fragmentation over economic, cultural, and political issues. This, combined with rapid social and technological changes, has made large segments of the global population wary of institutions and governments that they see as unwilling or unable to address their needs. People are gravitating to familiar and like-minded groups for community and security, including ethnic, religious, nationalist and cultural identities as well as groupings around causes, such as environmentalism and gender politics. The combination of diverse and fluid identity markers and allegiances is exposing and aggravating fault lines within states, increasing volatility.

Populations in every region are increasingly equipped with the tools, capacity, and incentives to agitate for their preferred social and political goals and to place more demands on their governments. Populations are increasingly empowered and demanding more, while governments are coming under greater pressure from new challenges and more limited resources.

This widening gap has led to more political volatility, erosion of democracy, and expanding roles for alternative providers of governance.

FUTURE SPACE EXPLORATION ISSUES TO CONSIDER

“

Space exploration has proven it can play a role as a binding agent for societal cohesion, by enabling collective experiences, common memories, and shared narratives – key ingredients to reinvigorate the development of European identity, inspire the next generation, daring them to dream of visionary futures and seize unexplored opportunities.

(Executive Overview Perspectives on European Space Exploration, p. 1)

”

Social Change

Moving towards 2060, the people of Europe will not remain the same as they are today. Some social changes, such as demographics, are easy to forecast, while others are less easy, since they depend on socio-economic, socio-cultural, or global events, innovations and movements that shape the zeitgeist and value mindset. Nevertheless, the mental and physical makeup of the European population will strongly affect opinions of European space programmes, and what their goals should be.

Drivers, enablers, and barriers

- By 2060, very few people alive will remember the first moon landing. The common goal for the global space identity will be shaped by other events and defining moments.
- Higher life expectancy and lower birth rates.
- Globalisation of media, greater mobility of populations.
- Increasing automation of job tasks.
- People born in this century will have grown up with the climate crisis.

Skills and Competencies

Scientific excellence and industrial competitiveness are still some of the few realms where Europe is part of the lead. No space programmes can exist without talented people to run and develop them - but there is no guarantee that there are enough talented people with the right educations, or that people with the right talents will be attracted to the space sector instead of other sectors that may offer higher pay or other benefits. What can be done to ensure that the space sector will get the talented people they need?

Drivers, enablers, and barriers

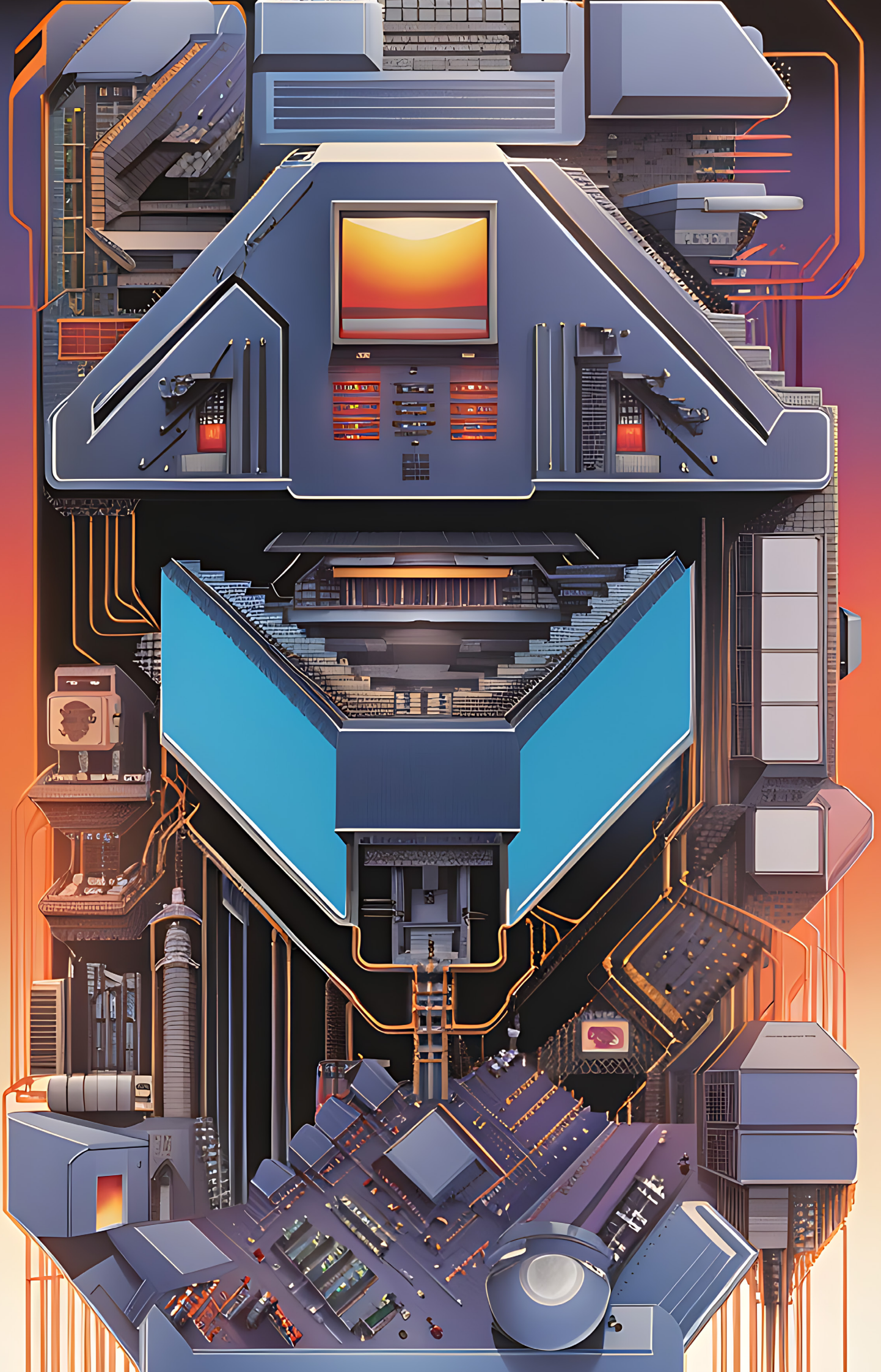
- Declining labour force.
- Growth economies may attract talent.
- Lack of space education and awareness of space.
- Lack of connection between space and inspirational discourses within younger generations.

Space Exploration Narrative

The significance of narrative is paramount in today's and tomorrow's societies. The narratives about space exploration in the broader public are shaped by an interconnected web of actors - the space agencies, politicians, entertainment, and social media, etc. What sorts of narratives would European space agencies like to be spread? What can they do to make it happen?

Drivers, enablers, and barriers

- No clear visions in the public mind of tomorrow's space age.
- Other narratives, such as greening the world, seem more urgent and speak more to younger generations.
- The European space sector might need to formulate a common narrative for space exploration, focusing on the (long-term) meaning of the projects rather than just the achievements themselves – and share it widely.
- Lack of comprehensive media coverage whereby better collaboration with news and entertainment media may be needed.



CATEGORY

TECHNOLOGY

TRENDS

AUTOMATION AND ROBOTICS

SPACE INFRASTRUCTURE

BIOLOGY IN SPACE

BASELINE TOWARDS 2040

“

During the next two decades, the pace and impact of technological developments are likely to increase, transforming and improving human experiences and capabilities and offering the potential to tackle challenges such as aging, climate change, and low productivity growth, while creating new tensions and disruptions within and between societies, industries, and states [...] The next decades will see increasing global competition for the core elements of technology supremacy, such as talent, knowledge, and markets, potentially resulting in new technological leaders or hegemonies in the 2030s. ”

Global Trends 2040, p.54, 64.

Since 2023, the pace and reach of technological developments have increased ever faster, transforming a range of human experiences and capabilities while also creating new tensions and disruptions within and between societies, industries, and states. State and nonstate rivals vie for leadership and dominance in science and technology with potentially cascading risks and implications for economic, military, and societal security. The main areas of technological progress have been artificial intelligence (AI), robotics, virtual reality, battery technology, connectivity, and biotechnology. The world has seen major advances in green energy, with the promise of practical fusion power coming closer but still a decade or two away. Automation has liberated workers from routine toil, but it has also increased economic inequality within societies and potentially throwing many unskilled labourers into long-term unemployment. Autonomous vehicles have become more common on roads and streets, mainly long-haul trucks and city cabs. Virtual reality and the metaverse offer new ways of experiencing places that are far away or only exist as digital fantasies. Advances in biotechnology have been thrown at the challenges of climate change and feeding a growing world population, with some promising results.

FUTURE SPACE EXPLORATION ISSUES TO CONSIDER

“

Space exploration is a driver for innovation. It has contributed advancements in technologies touching every aspect of everyday life, from health and medicine, public safety, consumer goods, to energy and the environment, industrial productivity and transportation. ”

The Global Exploration Roadmap, p. 4



Automation and Robotics

We can expect great advances in AI, robotics, and automation in general towards 2060. This is certain to change how we do space projects, both on and off Earth.

The question will be how robots and humans will best complement each other, and how the evolution of robots will impact human presence in outer space.

Drivers, enablers, and barriers

- Advances in artificial intelligence and robotics.
- Vulnerability of human beings.
- Cost considerations.
- Robots and other machines, like 3D printers, will undoubtedly supplement in tasks of construction and maintenance.



Space Infrastructure

An expanded presence in space, whether people or robots, requires expansion of space infrastructure to make it easier and less costly to send people and cargo into space and keep people there for lengthy periods of time.

This includes better launch and landing abilities, better in-space infrastructure and bases that are liveable for people or human proxies in the shape of robots. However, in a space race to “get there first”, focusing on long-term infrastructure can slow things down in the short term.

Drivers, enablers, and barriers

- Technological advances such as cost of access to space, reliability, and resilience.
- Economies of scale.
- Space debris and space weather events.
- Technology developed for travel and living in space could also find practical uses on Earth.
- Market-creating effects through infrastructure.



Biology in Space

Open space and other bodies in our solar system are hostile for human living, lacking breathable atmospheres and readily available food and water. Extended exposure to microgravity has turned out to be harmful to human bodies in many ways. Research in space-related biology could facilitate off-Earth farming and better living for people there, while simultaneously reducing reliance on provisions from Earth. Gene therapy could also prove useful in making humans more suitable for life in space.

Drivers, enablers, and barriers

- Advances in medicine and genetic technology.
- Advances in biomedicine could cross-fertilise in other areas.
- Farming developed for establishing long-term settlements in space could also find practical uses on Earth.



CATEGORY

ENVIRONMENT

TRENDS

CLIMATE

RESOURCES & ENERGY

EXISTENTIAL RISKS

BASELINE TOWARDS 2040

“
During the next 20 years, the physical effects from climate change of higher temperatures, sea level rise, and extreme weather events will impact every country. The costs and challenges will disproportionately fall on the developing world, intersecting with environmental degradation to intensify risks to food, water, health, and energy security.”

Global Trends 2040, p. 30.

The physical effects of climate change have intensified since 2023, with the impact falling disproportionately on the developing world and poorer regions, which in combination with environmental degradation creates new vulnerabilities and exacerbate existing risks to economic prosperity, food, water, health, and energy security, leading to mass migration from the worst affected areas. Governments, societies, and the private sector are expanding adaptation and resilience measures to manage existing threats, but these measures are unevenly distributed, leaving some populations behind. There is debate about how to reach net zero greenhouse gas emissions. Many are concerned that climate efforts are too little, too late, while others caution that too severe measures will impact economic growth, making it more difficult to handle climate-related disasters. The transition to sustainable energy is well underway but far from finished. Global CO₂ levels are higher than ever despite emissions reductions, and it is expected that it will still be at least two more decades before this trend turns.

FUTURE SPACE EXPLORATION ISSUES TO CONSIDER

“

Space exploration should be aligned with Europe’s efforts in tackling Earth’s grand challenges. Future activities beyond Earth can serve as practical demonstrators of how we can have a lower impact on our environment. ”

Revolution Space, p.19

Climate

Today, climate change is a high priority for European space, which uses satellites to monitor and quantify climate-change indicators. Climate change will likely be no less important towards 2060 - and if global warming can’t be prevented, it can perhaps be counteracted from space. A concern, however, is the climate impact of rocket launches. Simultaneously, space exploration technologies might increasingly serve purposes on Earth, thus leading to better climate adaption.

Drivers, enablers, and barriers

- Technologies such as fleet management systems, developed for space exploration, can improve efficiency on Earth, thereby alleviating climate footprint.
- Transition to a zero-emission economy. With growing space industry, the climate footprint of rocket launches becomes a factor in global warming.
- Looking for less damaging alternatives could become a priority.
- Space projects to monitor and diminish the effects of global warming could find easier funding.

Resources and Energy

An important part of the green transition is a shift from fossil fuels to zero-emission power sources. The European space sector can play an important part here. While its feasibility remains to be thoroughly proven, space-based solar energy looks to be economically feasible, and once fusion power has been tamed, the Moon is a promising source for Helium-3. Energy is also required to power off-Earth vehicles and infrastructure.

Drivers, enablers, and barriers

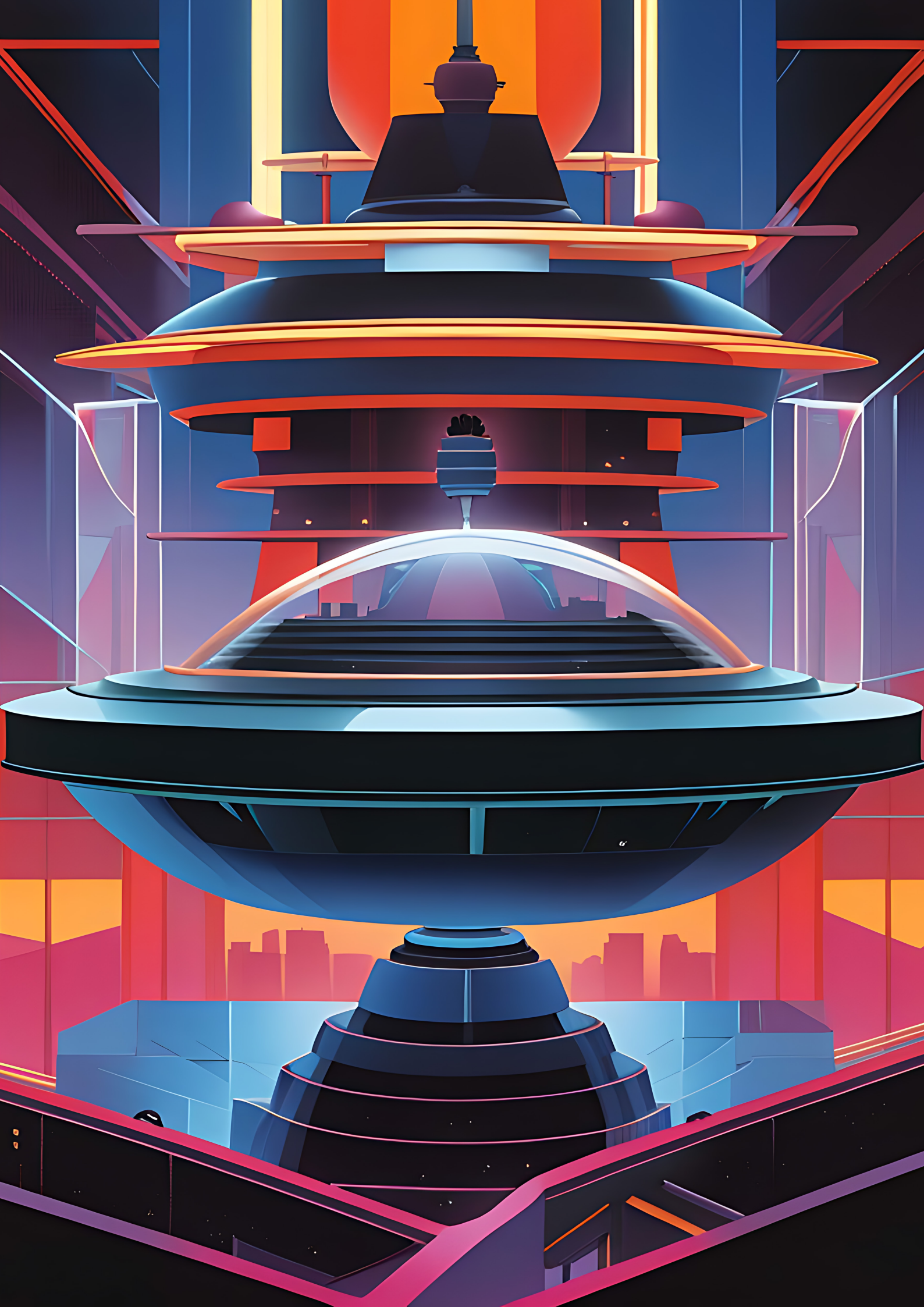
- Transition to green energy.
- Development of fusion energy.
- The energy sector could become an important investor for the space sector.
- Providing solutions for sustainable energy could improve the space sector’s image.
- Spinoff technologies from SRU will likely enable greater resource utilisation and efficiency on Earth.
- The degree of sustainability in space resources extraction depends on the nature of future law and interpretations thereof.

Existential Risks

Asteroids or comets, solar flares, and more: We are constantly at threat from space. Space infrastructure is even more vulnerable, with solar storms and space debris threatening satellites and space stations. Moreover, intentional anthropogenic threats could further deteriorate the environment.

Drivers, enablers, and barriers

- The cost of devastating disasters, which could be mitigated by early warning and/or planetary defence systems.
- The more LEO becomes populated with infrastructure, the more vulnerable it becomes.
- Increasing dependence on infrastructure in space such as edge-computing might create unforeseen vulnerabilities.



CATEGORY

LEGAL

TRENDS

RIGHTS, OBLIGATIONS, AND DISPUTES

PROPERTY AND TERRITORY

JURISDICTION AND ENFORCEMENT

BASELINE TOWARDS 2040

“

The rivalry between the United States and China is likely to set the broad parameters for the geopolitical environment during the coming decades, forcing starker choices on other actors. States will leverage these diverse sources of power to jockey over global norms, rules, and institutions, with regional powers and nonstate actors exerting more influence within individual regions and leading on issues left unattended by the major powers. The increased competition over international rules and norms, together with untested technological military advancements, is likely to undermine global multilateralism, broaden the mismatch between transnational challenges and institutional arrangements to tackle them, and increase the risk of conflict. ”

Global Trends 2040, p. 67

Towards 2040, international law has seen a shift away from Western traditions, with many UN treaties becoming increasingly benign. Consequently, some of the new economic superpowers now seek to create a new world order under their leadership. National and regional governments are attempting to reign in the power of major platform-economy firms, with only moderate success. The largest multinational corporations have in effect become lawmakers in themselves, being able to find jurisdictions that give them what they want in terms of environmental regulations, labour rights, data ethics, and tax advantages. Cybercrime has become a major issue, and we are seeing the dawn of a new 'digital cold war' where global powers – corporate as well as national – harass each other with cyberattacks and disinformation disguised as news or citizens' social commentary. Even in many advanced Western nations, democracy, national courts, and the freedom of press are coming under attack from corrupt populist governments seeking to retain their power.

FUTURE SPACE EXPLORATION ISSUES TO CONSIDER

“

In the coming years, many nations will continue developing domestic policy, regulatory and legal frameworks to most effectively implement sustainable human space exploration “

The Global Exploration Roadmap, p. 32



Rights, Obligations and Disputes

All existing space treaties are under the auspices of the United Nations, which will face reshaped balances in a multipolar world.

Without strong treaties or agreements, we are bound to see further disputes about different interpretations of space law.

Drivers, enablers, and barriers

- Greater international cooperation, e.g., through a stronger UN, could pave the way for stronger space treaties.
 - Increased likelihood of disputes due to increased activities and new state and private actors.
 - A multipolar world, where new superpowers don't respect old treaties, could make it difficult to form new agreements.
 - Future legal frameworks in space are created within the confines of Earth – old patterns of division could re-emerge.
-

Property and Territory

By the Outer Space Treaty, outer space, including the Moon and other celestial bodies, is not subject to national appropriation. However, we already see nations interpreting treaties in different ways. In recent years various discussions and opposing views have emerged on the question of ownership and commercialisation of space resources.

Drivers, enablers, and barriers

- Unbounded extractive capitalism.
 - NASA estimates that the value of asteroids that could be exploited for resources is in the neighbourhood of USD 700 quintillion.
 - About 10% of Near-Earth Asteroids are energetically more accessible than the Moon.
 - Geopolitical conditions might hinder the creation and alteration of common international regulatory frameworks regarding space.
-



Jurisdiction and Enforcement

Some international agreements may apply to activities in outer space, but there remain shortfalls that make laws hard to apply – and there is no clear precedent enforcing law in outer space.

Drivers, enablers, and barriers

- Expansion of human presence in space.
 - Lack of enforcement mechanisms.
 - Due to the nature of public-private partnerships in future space exploration, we might see the role of private entities integrate more tightly with institutional roles.
-

**WHAT IF
WE TRIED
TO
SHOOT
FOR THE
STARS...?**

FUTURE SCENARIOS

The following section outlines four future scenarios for the future of European space exploration between 2040-2060. The scenarios are framed around the most impactful strategic uncertainties and take the form of narratives outlining contextual developments, unique features, and different outcomes for societies and the space sector.

The characteristics of the scenarios are developed at the intersection of two broad critical uncertainties – the scenario axes – around the Social Makeup and Narrative of Europe and the Societal Power Structures and Agenda for Space. Each scenario axis has its own clearly defined extreme polarities that pull in opposing directions. How these two axes intersect – the scenario matrix – provides the backdrop on which four explorative, structurally different, and engaging scenarios unfold.

It is important to see these scenarios not as a prediction of the future but rather a tool for effective thinking. **They are not meant to be ‘right’ or ‘wrong’, ‘good’ or ‘bad’. Rather, their function is to challenge assumptions and explore alternative ways that the future may develop. And even though we have collaboratively built four scenarios, no one scenario will prevail.** The future of European space exploration will per definition be a unique configuration of interlaced scenarios.

The scenarios are accompanied by a series of sector specific parameters that explore their impact in the different scenarios.

HORIZONTAL AXIS

Social Makeup and Narrative of Europe

Critical uncertainty:

In a global society in flux, what will characterise the European imagined community and its social narrative?

Potential directions/trajectories:

Will Europe be able to develop a “grand”, strong narrative for itself towards 2060? or will Europe be more socially fragmented and less united around a common story? consequently, how will this narrative, or lack thereof, impact European (perceived) coherence and unity?

Socially Cohesive Europe

European citizens have a global outlook, viewing themselves as European citizens.

A shared common discourse for Europe guides European citizens (including outside the EU). There exists a unifying vision for what citizens want the continent to look like.

Collective narratives and identity markers across Europe.

Global dynamics cement the European identity. European countries are aware that they can't stand alone against their global counterparts.



Socially Fragmented Europe

European citizens have a national outlook, viewing themselves as citizens of their country of origin.

Different and often conflicting discourses across Europe. Strong national visions outshine a European narrative, with citizens buying into national goals above European goals.

Individual identity markers are very local/nationally located.

Regional clusters have formed in Europe, driven by regional proximity or agreement on key issues such as climate, defense etc.

VERTICAL AXIS

Societal Power Structures and Agenda for Space

Critical uncertainty:

In an evolving societal landscape and shifting power dynamics, which actors will shape the agenda for space?

Potential directions/trajectories:

In the interplay of societal, political, and commercial powers; will the agenda primarily be driven by governmental bodies, or will there be a decisive shift towards more commercial players?

Governmental bodies

Governmental bodies heavily influence the agenda.

Larger and more public entities involved in discussions related to space exploration.

(Inter)governmental institutions are setting the agenda in terms of space infrastructure that drive the demand for various suppliers.

R&D and innovation is primarily being driven forward by governments.

Governmental bodies such as NASA / ESA are the source for funding, where commercial providers still primarily rely on public funding.



Commercial players

Commercial players heavily influence the agenda.

Corporations are increasingly enablers of space exploration. Development is commercially driven.

Public-private partnerships are still largely a part of space exploration; however, the agenda is set by the private company driving the partnership.

R&D and innovation is primarily being driven forward by companies.

Most space missions and projects are predominantly privately funded projects, with support provided by governmental bodies such as NASA / ESA.

GOVERNMENTAL BODIES

*Societal Power Structures
and Agenda for Space*

Scenario A

**UNITED
ORBITS**

Scenario B

**COMPETITIVE
COSMOS**

**SOCIALLY
COHESIVE EUROPE**

Social Makeup and Narrative of Europe

**SOCIALLY
FRAGMENTED EUROPE**

Social Makeup and Narrative of Europe

Scenario D

**CORPORATE
GALAXY**

Scenario C

**SOVEREIGN
SPACEWAYS**

COMMERCIAL PLAYERS

*Societal Power Structures and
Agenda for Space*

UNITED ORBITS

An intergovernmental focus drives forward initiatives and long-term strategies.

SCENARIO VANTAGE POINTS

Zeitgeist – Values & attitudes

Stronger faith in (inter)governmental institutions, held together by public support and a belief that the public sector provides the backbone of what constitutes modern Europe.

Global aspects & Economy

The hyper-globalized world proved robust, thereby paving the way for more integrated power dynamics cementing fewer but stronger power centres.

People & society

Even though they are considered expensive, Europeans take pride in their sweeping welfare programmes, securing a high level of social mobility and social security.

Purpose of space exploration

Space is considered a public good for all European citizens, much like the infrastructure of roads and utilities is today. Therefore deciding on space matters is a public concern, and a great deal of effort is placed on not mismanaging space efforts.



The world around us

2040 was a turning point in the European common narrative. Until then Europe had been quite fragmented due to more populist nationalist governments. However, in the wake of their failure to tackle global issues, a need blossomed for stronger intergovernmental institutions, held together by public support and a belief that the public sector provides the backbone of what constitutes modern Europe. The EU is strengthened and collaborates with non-member states to support the European agenda for climate, social issues, global politics, and technological development.

European governments have thus chosen a path away from the growing economic, political, and social polarisation that characterised the first four decades of the 21st century. Technological advances and the resulting economic growth should benefit Europe as a whole, not just a small global elite. Grand European narratives revolve around sustainability, democracy, welfare, and justice.

Short-term thinking by governments and corporations alike have failed to address major 21st century issues like climate change, tech-driven inequality, social unrest, and mass immigration. The focus has thus shifted to more long-term visions with clearer common goals, rather than negative narratives that erode social cohesion. Stronger cross-national legislation and interventions are in focus to promote these long-term goals, with an attempt to discourage lobbying and jockeying-for-power by individual nations and corporations. Measures are put in place seeking to limit welfare migration to and within Europe and strengthen worker rights to prevent importing cheap labour from outside Europe.

As a result, the European public sector has grown in impact towards 2060, and the former trend of privatisation has been supplemented with more government-defined public transport, health services, banking, and energy infrastructure, as well as strengthened public education and research, with local and national projects aligned with and supported by a cross-European agenda. This development proves challenging at times with rising budgets where civil society is forced to carry some of the responsibility in welfare related issues.

While the European share of the global market has shrunk, governing European bodies still play an important role in global agendas by virtue of Europe being a large unified market. A key focus area for Europe is to reduce the reliance on other superpowers as well as the increasingly powerful multinational corporations. An important part of this is to further improve European-based global alternatives to GPS, LEO Broadband Connectivity (e.g. Starlink), and privately-owned space infra-structure, including launch facilities, and focus on space exploration (LEO space stations, lunar bases, etc.).

Europe seeking to reduce its reliance on other superpowers and on multinational corporations does not mean that the region is closing in on itself. Rather, the idea is that collaborations with other powers – governmental or private – should be undertaken as equal partnerships with shared control. This is reflected in major collaborations to develop fusion power and sustainable energy as well as various space projects, always with an eye to the long-term goals set by European governments and shared by their populations.

The EU, backed by other national European governments, is lobbying for strong global regulations to ensure that benefits from technology and innovation will provide value to the region and ensure European relevance in international relations.

Future of European space exploration – implications

FUNDING AND PRIORITIES

Europe's approach to space exploration prioritises its regional concerns, with a dedication to diplomatic solutions and a commitment to multilateral projects based on the recognition of other more powerful global nations setting the agenda. Government driven public-private partnerships flourish where space exploration is perceived as a panacea to all earthly challenges. Collaboration with international governments, including emerging space nations, have been central to maintaining peaceful cooperation in space. This allows Europe to exert influence by contributing expertise, technology, and resources to large-scale global space endeavours and deep-space missions.

REGULATORY ENVIRONMENT

The entry of the Global South into the space race means that regulations are (still) increasingly a matter of geopolitical power. Navigating regulations in the realm of space exploration remains a complex challenge in 2060. Bodies such as the EU and COPUOS have made efforts to establish norms and guidelines for space activities; however, the acceptance of these norms depend significantly on the support they get from influential geopolitical powers.

COST OF ACCESS TO SPACE

Europe's cost of access to space is closely tied to the global developments beyond its borders. However, there is a strong unified government driven commitment to cost reduction through the support to develop cutting-edge technologies, which has significantly reduced the cost of reaching space. The general climate change discourse that informs most policies on Earth, also impacts space costs where i.e., the cost of debris is included in the total cost of access.

SPACE BEHAVIOUR AND RELATIONSHIP TO SPACE

Space exploration is tied to European pride and social cohesion, with a focus on practical benefits for all, including international stability. A long-term promise for sustainable space activity seeks to strike a balance between resource exploitation and sustainability in space. European governments have played a pivotal role in integrating space exploration into the European identity. The people of Europe actively follow space activities and feel a close connection to the astronauts representing their nations in space.

TALENT POOL

Europe's space efforts have adopted a holistic, multi-disciplinary focus, which in addition to engineering and physics includes biology, psychology, and human sciences. To counter brain drain, Europe has proactively sought to attract talent from around the world, and this approach has made Europe's talent pool increasingly international and diverse. However, Europe is still not on top of the list for the young generations in terms of prestige among global space powers. Advanced automation and AI-driven systems have become integral to space missions, reducing reliance on human resources.

SPILL-OVER EFFECTS

European governments incentivise stakeholders such as start-ups, universities, and established commercial players to dedicate resources to expanding the spillover benefits of space-related innovations. This focus reinforces the social narrative. Spillovers include AI, nuclear propulsion, energy, life sciences and communication. Medical and agri-tech developments not only address the unique challenges of human health and food production in space, but also find applications on Earth.

EUROPE COMPARED TO OTHER SPACE POWERS

Europe as a whole remains closely aligned with the US but increasingly recognises the importance to build bridges with countries such as India and China. Europe's role as a powerful ally in the realm of space exploration is underscored by its unified vision. This unity enhances Europe's capacity to contribute to global space initiatives.

ENABLING TECHNOLOGIES

Europe has significantly invested in technologies such as AI, nuclear propulsion, energy, quantum technologies, and life sciences to support and bolster space exploration efforts, in turn securing Europe's leadership in these technologies. Europe's focus on innovative energy solutions (nuclear energy, space-based solar power) and advancements in areas like quantum technologies, unhindered by military commitments, are vital and maintain their geopolitical power globally.

COMPETITIVE COSMOS

Strong national identities provide the backbone for visions and missions.

SCENARIO VANTAGE POINTS

Zeitgeist – Values & attitudes

Weaker faith in intergovernmental institutions, which is mostly held together by economic necessity, however the national governments are highly acknowledged for how they take care of their citizens.

Global aspects & Economy

The global economy has undergone a profound shift from decades of developments and tensions. However, national governmental bodies still have an impact on political economic decisions.

People & society

There is an appetite for decentralised models and applications that promote self-sovereignty. Key societal institutions have managed to maintain legitimacy and trust through increased transparency and innovative policy making.

Purpose of space exploration

European citizens have different sentiments as to why we are in space. However, most agree that our presence does more good than harm. People are generally engaged in how space affects their own national identity and narrative, otherwise they are not interested.



The world around us

The European Union entered the 2040s weakened and did not manage to create a strong narrative or a long-term vision to unify its populations. The EU has since become a body that only handles easily agreeable, short-term practical issues. In return, national governments have been strengthened, using their greater freedom to pursue national goals and projects aligned with their own diverse values, often in collaboration with relevant global powers. The populations generally support their government in their inward focused agenda, echoing feelings reminiscent of the 2010s in the UK and US, however now more favourable towards the value of cultural diversity and fragmentation.

The European Union has lost a lot of the power it once had, even though it expanded to include more countries during the 2030s. The diversity of values and ideas of democracy among member states stalled action on important issues, as one or two countries could block decisions or ask for favourable terms in exchange for their support – which in turn reduced the willingness of other member states to provide economic and political support to the Union. By 2060, several nations have left the Union in favour of going their own way or collaborating on a case-by case basis with global private or state powers. For this reasons, the most important agendas and decisions are left in the hands of individual governments or tightly knit regions within Europe such as the Nordic and the Baltic Regions.

Reflecting their greater national pride, the individual countries and smaller regions undertake various prestige projects in green energy, transport infrastructure, and space exploration, often looking to international tech companies to provide the necessary technology. There is little collaboration with other European actors pursuing similar projects. The idea is that competition strengthens the project rather than diminishing it, and there is a lot of ‘bootstrapping’ where nations look to the successes of their competitors. Individual governments actively support, initiate or fund new (short-term) goals. The philosophy is that if nations each choose their own paths, some of them are bound to find paths that prove better than others, and their successes can then be emulated by everyone. This friendly rivalry has improved relations within Europe more than a divided Union ever did.

In general, European citizens are satisfied and are willing to give up some material wealth in return for greater national sovereignty. After all, in this age of virtual reality, AI and robots, digital entertainment, services, and mass consumer products are very inexpensive. Aware of the dangers, most governments strictly regulate digital service providers in terms of ethics and economy, which in turn has been a clear barrier for commercial players to advance.

With many strong European and global players pursuing their own agendas in space and elsewhere, the need for international regulation has proven great. Ad hoc multilateral agreements have been agreed on by old and new superpowers, especially with a goal to restrain the short-term profit excesses of private corporations. Such treaties govern access to orbits, the Moon and Mars, as well as the exploitation of space resources. These treaties are practical rather than ethical or visionary; focusing on letting things move smoothly for everyone without unfortunate incidents.

Unsurprisingly, the strongest national economies effectively set the main agendas, trying to outdo their rivals to show superiority. The smaller economies can’t hope for much more than riding along on locomotives provided by the major actors – which still provides room for unique, specialised projects that can satisfy national pride.

Future of European space exploration – implications

FUNDING AND PRIORITIES

Europe's continuing internal fragmentation has meant that each nation state's government favours their own defence budget. Space is a part of that game in terms of funding and priorities. There are only a few European economies that possess the resilience to remain a part of the agenda. Each country focuses on finding their own niche, and innovation and priorities are a patchwork rather than commonly aligned and strategically planned. Pan-European collaboration is limited to a few key areas like secure communication.

REGULATORY ENVIRONMENT

The emerging Global South sparks a new intergovernmental powerplay involving China, India, and the United States. These major spacefaring nations vie for influence in shaping the evolving space regulatory landscape, but ideological differences and interests make regulatory agreements difficult. In these dynamics, space diplomacy takes centre stage. European nations have low regulatory influence due to the lack of a shared stance towards regulation but seek to promote collaborative space endeavours moving in between changing regulative customs and norms.

SPILL-OVER EFFECTS

The noticeable spillover effects are limited in European space exploration simply because they are hardly recognised by the European populations. One contributing factor to a more positive driver is found in the superpowers' innovative technological achievements, which act as an encouraging lever for European governments once they see the accomplished benefits.

ENABLING TECHNOLOGIES

Europe continues to maintain its leadership in certain cutting-edge space technologies like satellite technology, propulsion systems, and deep-space communication systems; however, the region still faces challenges when it comes to space launch capabilities.

TALENT POOL

Increasing brain drain is now a challenge for most European nations. The generations beginning their careers and work lives do not embody a shared space narrative. They have been raised with climate change as informing the primary zeitgeist and are thus attracted by green-technology sectors. As a result, the space sector is facing challenges in relation to attracting talent. This issue is exacerbated because most European countries restrict immigration, making it difficult to attract foreign talent.

SPACE BEHAVIOUR AND RELATIONSHIP TO SPACE

While Europe has made significant contributions to space science, space is not present in the minds of citizens. Most European nations seek to build their own national brand story, and space is primarily perceived as a science sphere and not relevant for people's everyday lives. The absence of a cohesive political and cultural identity across the continent poses a significant challenge to forging common space values and norms. Within the fragmented European landscape, a sense of powerlessness emerges as a common characteristic.

COST OF ACCESS TO SPACE

Different European governments find themselves always dependent on other countries and superpowers, as cohesive European budget efforts and strategies around space exploration keep being a challenge. Due to orbital congestion in space, superpowers restrict access to space except for critical missions. Deep space exploration remains very expensive and is just for a few players, though nuclear propulsion make interplanetary travel faster and less expensive. CubeSats and LEO missions are cheaper but not agenda setting.

EUROPE COMPARED TO OTHER SPACE POWERS

Some European countries remain closely aligned with the US, but others increasingly build bridges with countries such as India and China and shift to collaborate mainly with these space nations, while navigating the dynamics of intergovernmental tensions between the superpowers as well as the fragmentation of European nations.

SOVEREIGN SPACEWAYS

Strong commercial and entrepreneurial civil communities take on the responsibility of innovation, for profit and for the world.

SCENARIO VANTAGE POINTS

Zeitgeist – Values & attitudes

Tighter-knit civil communities clustered around commercial maintainers of public infrastructure are recognised for their value to society overall.

Global aspects & Economy

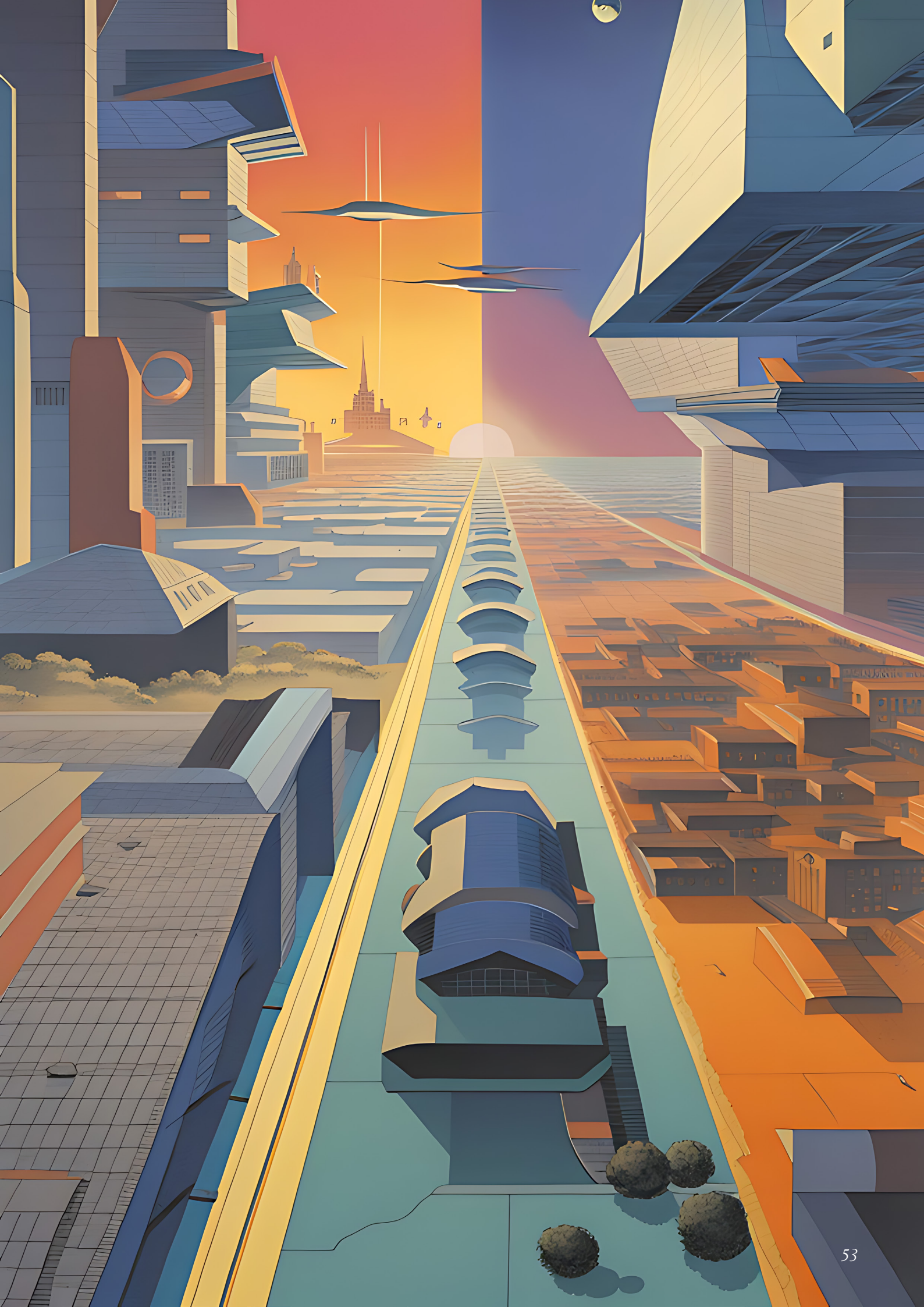
The trust in globalization is gone – and regional power centres have emerged, where and strong national commercial and local entrepreneurial communities flourish.

People & society

Often businesses and local bottom-up initiatives lead the way with innovative solutions and models for collaboration, outshining national politicians and global leaders.

Purpose of space exploration

Space is considered a resource for exploitation, much like oil and coal throughout the 20th century. Terrestrial disagreements accelerate space exploration, and space presence is considered a reflection of commercial success and capacity.



The world around us

The free market is a fact of life, and Europe has been divided since the early 2040s. Governments have given international corporations significant freedom with relaxed regulation to allow free trade and competition, hoping to stimulate economic growth and create much-needed jobs. Economic polarisation is on the rise, with automation replacing human labour. Certain segments of society are hard hit; however, AI has also meant great advancements in the everyday life of the ordinary citizen. The private sector is reaping the benefits of technological advances – which in turn has made it easy to find funding for endeavours that promise big profits, especially in the short term.

Between 2040 and 2060 there has been a formation of European regional clusters, shaped by cultural similarities, shared geo-political interests, and global dynamics. European countries form new and unexpected alliances, in some cases aligning with powerful nations to the West, East, or South. This is a result of conflicting national and regional interests dividing Europe, leading up to 2040, including disagreements on how climate and immigration issues should be handled and by whom. Geopolitical unrest and the inability to agree upon concrete actions led to a surge in national activism and entrepreneurship. While national governments often struggle to commit to and adhere to long-term promises, their legitimacy is gradually diminishing. Concurrently, the private sector is focusing on and pledging short-term economic growth. Citizens are turning towards the private sector to find clever solutions for wicked problems.

Regional clustering within Europe is reflected globally. The trust in ‘global solutions to problems’ is gone. Strong regional clusters are emerging based on similarity of ideologies. The old-world order is outdated, and new regional power centres have emerged with little interest in global unity. Climate change is handled by building local resilience rather than through international cooperation. National climate policy is a matter of national security. The local impact of extreme weather events forced nations and communities to respond at the local level to mitigate the impact, and commercial players have become the faces of sustainability efforts through altruism. A South-East Asian cluster led by India and China is gaining traction in solving problems and many European nations vie to form trade ties with them. Societal cohesion exists in regional or national pockets and is fostered through a resurgence of nationalism and pride. This is also driving innovative grassroots solutions.

A lack of regulation and plenty of available well-educated labour has made Europe an attractive place for global companies, and by 2060, the region has become a hotspot for technological innovation. Nations that have invested in their commercial opportunities through entrepreneurial civil communities or technological innovation spirit are better equipped for establishing international or regional partnerships with national economic gains. Products and services have become deeply polarised between those aimed at the middle-class majority, mainly smart solutions to everyday life, and the economic elite, who can afford extravagant luxuries, including space tourism – utilising space for private entertainment and leisure or for more efficient conduct of business. This has advanced practical space technology greatly, but exploration and science suffer. Space exploration thus focuses on trips to space, where e.g., robotic probes are mining near-Earth asteroids and the Moon for valuable minerals.

Space projects are more present in the public perception with private companies offering exploration opportunities at several pricing options but still only accessible for the various levels of the economic elite. There is growing activism and protest as many see this behaviour as escapism, given the number of unsolved problems on Earth. The other side of the argument posits that space exploration carries the secret of solving Earth’s problems.

Future of European space exploration – implications

FUNDING AND PRIORITIES

Both European and global commercial actors with their high level of ambition and achievements drive governments' aspirations for space. However, multinational corporations' investments in space technology and capability also challenge the need for major public space programmes. In a fragmented Europe where space activity is driven by commercial interests, the green priority serve as uniting factor in an otherwise polarised world. Climate change is a main political concern across Europe; commercial space actors thus find it strategically beneficial to build and herald green business models.

SPILL-OVER EFFECTS

Space innovations are the result of large companies, space- as well as non-space-focused, that invest and push innovations into different lines of business. The cross-fertilisation between sectors along with the low regulated space sector drive innovation into all sorts of fields, creating technological as well as commercial benefits for the people on Earth. The reaction to as well as the adaption of these new innovations into the everyday lives of European citizens vary greatly according to the diverging social space narratives, and also due to the fact that only a few commercial players own most IP rights and reap the benefits.

TALENT POOL

It is now common to see talent toggle between the space sector and related industries as more and more private corporations go across sectors and use horizontal integration. Europe seeks to protect its historically recognised scientific talent pool, but the initiatives are split into clusters between different European nations, and the global race for talent is highly competitive. This landscape provides an interesting playground for the younger generations, with arising expectations and demands.

ENABLING TECHNOLOGIES

Europe is an industrial technology base for larger space powers. Life sciences, AI and robotics, and the concentration of space companies in turn promote the continued development of these technologies and training of people in related fields, whereby Europe keeps cementing its position to the surrounding world.

SPACE BEHAVIOUR AND RELATIONSHIP TO SPACE

The public relationship to space is formed by a commercialised discourse as the main driver for the space sector. Although scientific discovery and new technological advancements through powerful commercial players are providing new leaps for mankind, another more polarised market of space tourism is flourishing for the rich, generating tensions in the public perception. Space exploration is not only present in popular culture as science fiction narratives but also in new formats as entertainment for the masses, adding to the general public's understanding of space exploration.

EUROPE COMPARED TO OTHER SPACE POWERS

Europe has no strong united space sector; instead, it has mostly foreign companies operating out of Europe, leveraging the well trained yet affordable workforce. Different European commercial actors are investing in international opportunities and collaborations, primarily on the provider side. However, some of the stronger nation clusters in Europe, vying for regional prestige, have strong, if narrowly focused, public-private space programmes with a very ambitious scientific focus on space exploration.

COST OF ACCESS TO SPACE

With a competitive, commercial space sector, the question of price is everything. On the one hand, great market-driven innovations have led to a significant cut in costs, on the other, the increase of commercial activities in space coupled with the poorly regulated space sector have led to more errors, mistakes, and even misadventures, i.e., climate change, space debris becoming a major problem, among others. These factors have made insurance premiums rise dramatically, increasing the overall cost despite expense cuts.

REGULATORY ENVIRONMENT

Commercial players are generally attracted to the superpowers advocating the fewest or most beneficial regulations, leading to a 'race to the bottom' regarding regulation. Competing nations and companies adopt policies of 'flag raising' to make claim on off-Earth resources, which serves as nation identity building for the diverse European populations. The countries with the strongest players have a heavy impact on the regulatory landscape. The only real regulation of space is driven largely by major space nations negotiating bilaterally.

CORPORATE GALAXY

Unified commercial European narratives stand on the shoulders of historic succeeding ambitions and developments.

SCENARIO VANTAGE POINTS

Zeitgeist – Values & attitudes

While commercial endeavours are celebrated, there is a societal emphasis on ensuring that benefits trickle across Europe for their populations, not only corporations.

Global aspects & Economy

Europe’s collaborative spirit and successful blend of public and private sectors still positions Europe as one of the frontrunners, enhancing Europe’s influence in global geopolitical matters.

People & society

While a unified European narrative exists, rapid technological and social change means that the European populace demands convenience and seamlessness from commercial entities.

Purpose of space exploration

Space presence serves as a measure of commercial success while space exploration provides the backdrop for commercial actors to showcase their role as a uniting social glue for Europe as a whole. In the end, it is the benefits for European society that matters.



The world around us

After four tumultuous decades, the need for European unity in a multipolar world has become clear to all. It is no longer possible to count on a single powerful ally, especially as power is shifting from nation states to international tech corporations. The focus is on providing all citizens with the best opportunities, and this is best achieved through competition between private providers of services under the auspices of European regulations, generally overseen by the European Union, which has a strong history of leashing tech giants. This proves to be a successful agenda and has strengthened the support for European unity.

Besides tax-paid welfare, Europe also has a thriving private sector ensuring broad coverage that competes on a seamless, transparent, and regulated market, ensuring the lowest cost for all. Corporate as well as labour taxes are low, but in return, minimum wages are high, labour rights strong, and steep climate taxes encourage innovation. Tax revenues remain sufficient to provide benefits for the vulnerable population. The European populace demands transparency and equity from both governments and commercial entities, occasionally resulting in political volatility. Digital platforms amplify specialised interest groups, from space enthusiasts to environmentalists, occasionally challenging the main European unity narrative.

European success in the past was shaped by the competition between nations. The same principle is now applied to European service providers, benefiting the success of industries, if not always individual companies. This requires a transparent market where it is easy for governments and citizens alike to gauge the efficiency and cost-effectiveness of different providers. The best are rewarded with public contracts and celebrated, and the rest must up their game if they want a cut of the pie.

The European space sector is largely left to commercial interests, whether national, European, or international. This has the benefit that when the EU, European nations, or European corporations have space projects they want undertaken, such as launching a satellite or performing zero-gravity experiments, they can shop around for the most efficient or least costly private providers. Though European space providers are favoured over others, Europe has a history of creating space technology that is cost-effective, and the private European space sector builds on these past successes.

This indirect subsidisation of the European space industry has helped European corporations remain competitive with their American and Asian counterparts. The focus on practical rather than prestige projects have been beneficial, and ‘frivolous’ uses of space, such as space tourism and mass-market entertainment, still provide new and useful knowledge.

Europe’s collaborative spirit and successful blend of public and private sectors has proved very successful, and between 2040 and 2060, Europe witnesses a significant economic upturn driven by tech-related industries, with spill-over effects across fields, sectors, and civil society. These wide ranging benefits have made the space economy one of the cornerstones of European economic growth.

By 2060, Europe is positioned as an economic and technological frontrunner, mainly through “soft power”, greatly enhancing Europe’s influence in global geopolitical matters.

Future of European space exploration – implications

TALENT POOL

The European narrative and employment policies play a crucial role in shaping the availability and development of a highly skilled workforce. High wages and strong labour rights make Europe very attractive to labour. AI and automation eliminates many routine tasks, driving the workforce towards more specialised roles, including in space exploration. A significant shift has seen people from social sciences playing a critical role in space programmes in defining policies, addressing competing interests, and ensuring ethical and equitable space exploration and utilisation.

REGULATORY ENVIRONMENT

The surge of commercial entities in space exploration amplifies pressure to deregulate, leading to challenges in law enforcement and accountability. The dynamic interplay between national laws and commercial interests raises questions about who enforces these laws, and how they adapt to rapid innovation. International bodies like COPUOS work to establish global standards and norms in space regulation, enforcing these rules on enterprises working in and out of Europe.

ENABLING TECHNOLOGIES

Europe's strengths in biotechnologies, space architecture, and alternative launch methods contribute to making outer space habitable and accessible. Europe's focus on innovative energy solutions and advancements in areas like quantum technologies are vital.

COST OF ACCESS TO SPACE

Commercial competition has lowered costs for certain missions, but deep space explorations remain premium. Europe's unity enhances collective funding capacity and strategic international collaborations, mitigating dependency on superpowers while engaging strategically with global powers, ensuring shared space access. The commercial drive amplifies Europe's role, balancing sovereignty with international collaboration, and focusing on both economic and societal benefits of space exploration.

FUNDING AND PRIORITIES

In a cohesive Europe, space exploration funding is bolstered by a robust commercial sector. Collaboration across countries maximises investments, fostering innovations and reducing reliance on public defence budgets and international superpowers. Europe's unity ensures that funding and the benefits of space exploration are not confined to wealthy nations. Commercial entities align investments with societal and environmental needs to a much greater extent because the synergies of visions and capabilities flow between European borders. The funding landscape is diversified, ensuring that space exploration not only advances technologically but also addresses pertinent issues like climate change and data security.

EUROPE COMPARED TO OTHER SPACE POWERS

Europe's strength lies in its collaborative nature, with a history of unified efforts in space and planetary sciences, setting it apart from countries with more individualised approaches. The openness of a unified Europe to foreign ownership in the space industry remains a pivotal factor. European space initiatives benefit from leveraging shared values and complementary capabilities, while navigating the dynamics of international commercial interests.

SPILL-OVER EFFECTS

Space exploration influences environmental and climate technologies on Earth, offering new insights and tools for resource management, while Earth's dwindling natural resources drive the need for space exploration and extraterrestrial resource utilisation. Innovations in AI, pharma, 3D printing, and energy efficiency improvements directly contribute to advancements in space technologies and vice-versa.

SPACE BEHAVIOUR AND RELATIONSHIP TO SPACE

Space exploration is framed by a techno-scientific narrative. This intertwines with an intensified focus on climate change, emphasising Earth's and space's interconnected futures. The private sector amplifies the view of space as a crucial resource, with the emergence of a lunar economy shifting psychological and economic perspectives, while global supply chains extend into space. A push for sustainable space colonisation emerges, aiming to balance exploitation and preservation.

NEXT STEPS

Massive changes are on the horizon that will force the space sector to think and act in different ways! This foresight journey has laid the foundation for approaching strategic preparation from novel angles, enhancing readiness for the future.

The four scenarios and the future issues outlined in this report are designed to provide strategic stimulus, be thought-provoking, inspiring, and even demanding. However, it's important to note that foresight outcomes are not strategies themselves. Instead, they serve as invaluable insights and input for more resilient decision making and strategic planning. But unless acted upon it nonetheless remains stimulus rather than strategic action. **For the space exploration sector at large, the decisions we make today are crucial in terms of the potential space futures we will be a part of in 2060.** To that end we invite you to actively engage more deeply with the foresight work to ignite strategic conversations and find ways to make it actionable.

The integration of foresight with strategy can appear daunting. The scenario approach leverages alternative futures as a resource for stimulating strategic thinking and idea generation. This gives a clearer view of e.g. what solutions alternative futures indicate, what different or altogether new strategies are needed, and how incumbents will act to survive, or thrive.

Foresight can take different forms and there are many pathways to its implementation. The onward strategic foresight journey starts here.

Enjoy the ride!

“
Imagination will
often carry us
to worlds that
never were.
But without it we
go nowhere. ”

ASTRONOMER & PLANETARY SCIENTIST
CARL SAGAN

APPENDIX

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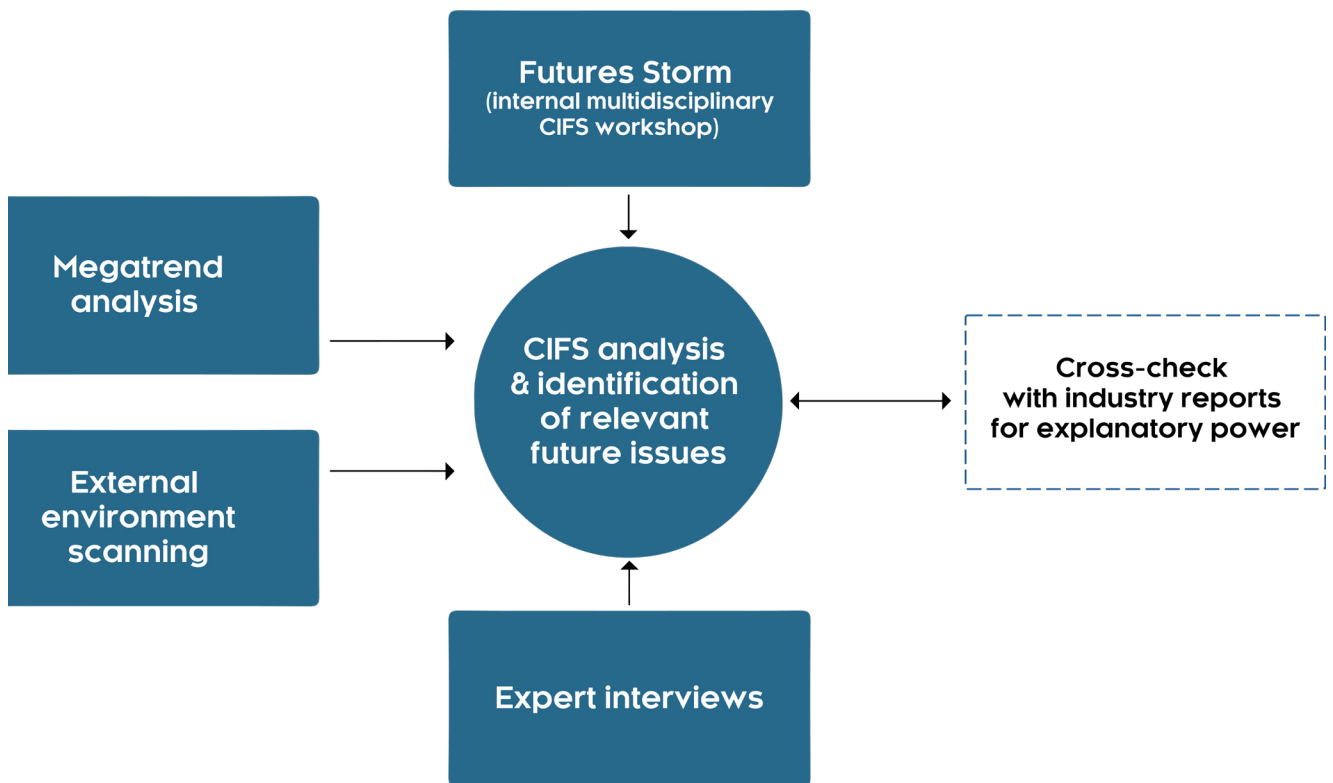
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APPENDIX

RESEARCH APPROACH



APPENDIX

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