NATIONAL 2023-2027 ACTION PLAN

LUXEMBOURG SPACE AGENCY

Guiding Principle:

Sustainability

INTRODUCTION

Luxembourg's commitment to develop a space sector dates from the 1980s with the formation of Société Européenne des Satellites (SES). The policy objective was clear at the time, and remains so today: to make spacetech one of the pillars of the Luxembourg economy. Since 2016, the space ecosystem has recorded significant development. Nowadays the Grand Duchy of Luxembourg is home to more than 70 space-related public and private enterprises, together employing over 1400 people. Moreover, the space sector has discovered a new sense of dynamism in recent years. Developments in technology, miniaturisation and lower launch prices are among the factors which ultimately have facilitated and driven new business initiatives in this field. This development in turn brings new challenges deriving from the increased use of Earth orbits, where new risks of congestion arise.
Those latest developments, plus a meeting of the ESA Council at Ministerial Level, have led to a renewal of Luxembourg's strategy and its ambitions to develop the civil space sector, backed by a commensurate financial package.

70+ space-related public and private enterprises

1400 employee

01

Successes and impacts of the previous action plan

1.1 Key results from the previous period (2020-2022)

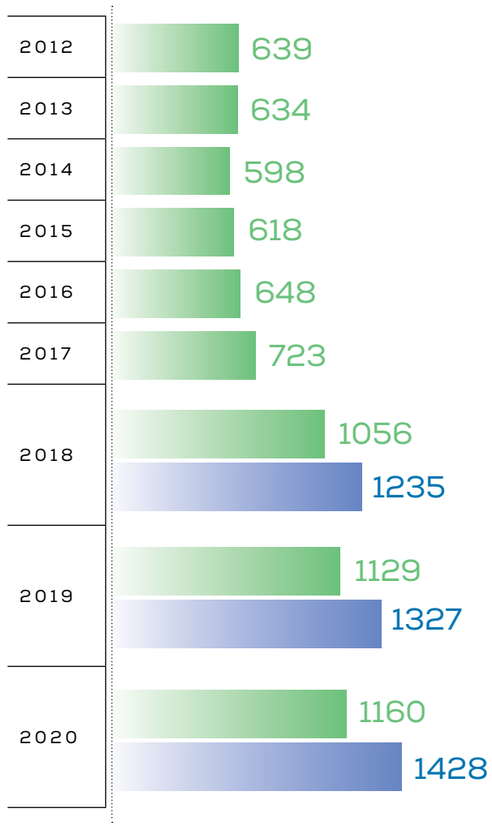
Since 2020 the sector has continued to record significant growth, with 19 start-ups or new establishments.
The trend in the number of businesses since 2012 shows growth by a factor greater than 4 over a 10-year period:

NUMBER OF BUSINESSES IN THE SPACE FIELD IN LUXEMBOURG SINCE 2012

2012	16
2013	18
2014	18
2015	19
2016	22
2017	30
2018	32
2019	39
2020	48
2021	58
2022	67

In terms of new jobs, the statistics highlight a near-doubling in employee numbers within these businesses. Add to this the number of space-related jobs in public research bodies, and the employees exceed 1400 in number.

EMPLOYEES WORKING IN THE SPACE SECTOR SINCE 2012



Estimates indicate a slight increase in value added by the businesses most recently established in Luxembourg, despite the pandemic – a very encouraging sign of their development. However, this trend excludes SES, whose business has been affected by a downturn in the market for satellite TV broadcasting. Figures are in € million.

› ESA

Luxembourg's businesses and public research institutions have been successful in winning a share in the ESA programmes, with an industrial return coefficient slightly less than or equal to one. This coefficient is one of the main indicators used by the ESA to determine whether Member States are receiving a fair share in the Agency's programmes in return for their financial contributions. This is a reflection of the targeting of Luxembourg's investments on activities carried out in Luxembourg.

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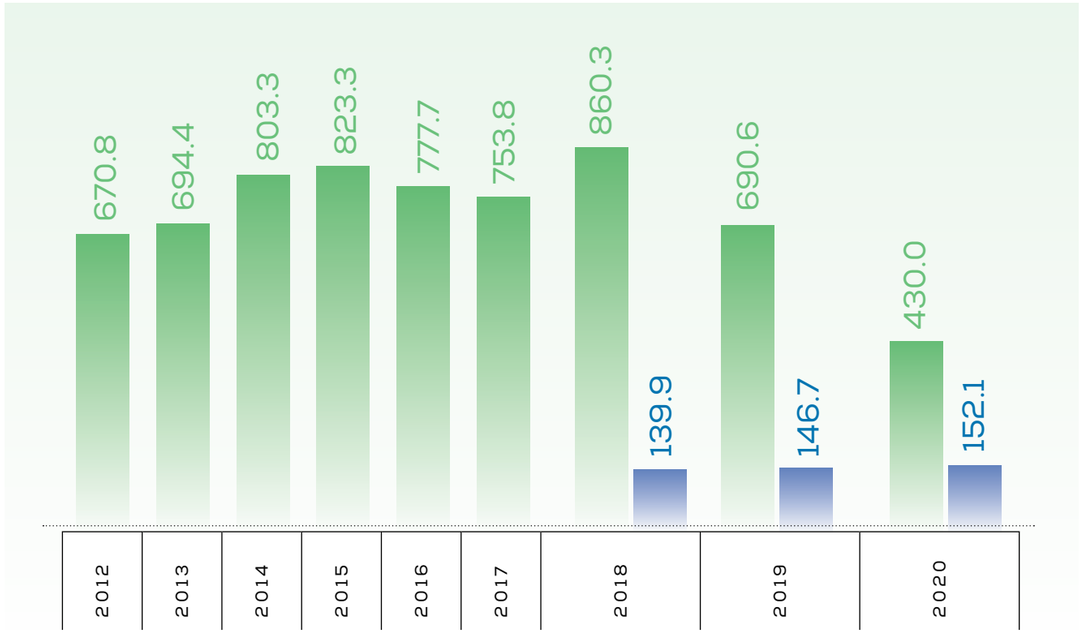
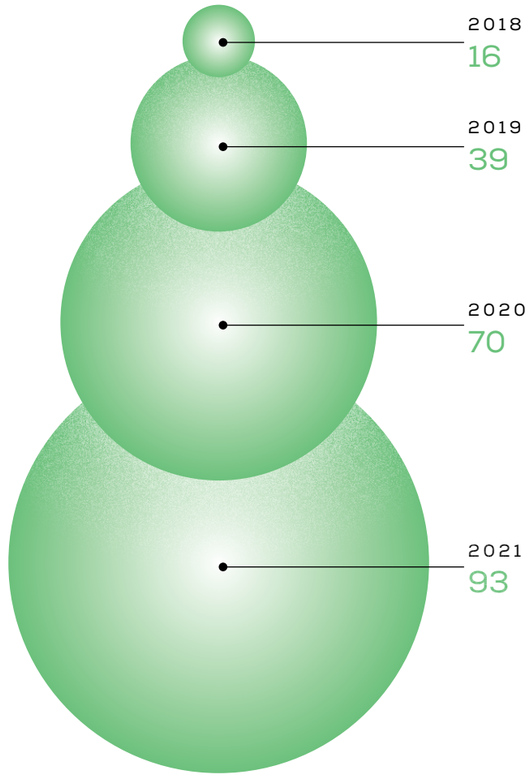


› LuxIMPULSE

In addition to the optional ESA programmes, Luxembourg has an agreement with the ESA to implement a national programme called LuxIMPULSE. Its purpose is the development of technologies, products and services by Luxembourg businesses with a view to market launch.
As the sector has expanded in size, LuxIMPULSE has seen significant growth in its activities.

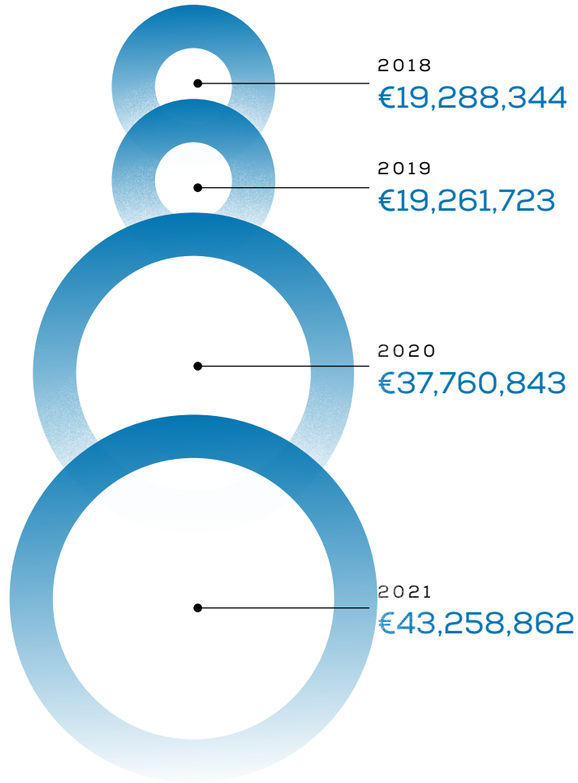
NOMBRE DE PROJECT CUMULÉS

Cumulative number of project supported within the frame of the LuxIMPULSE national programme



MONTANT ANNUELS

Evolution of the Luximpulse Budget since 2018



1.2 Commercial successes

Spire Global, Inc.

(NYSE: SPIR) is one of the world's leading suppliers of space data, analysis and services. The company offers access to unique data sets and information with added value, so that organisations can make their decisions with complete confidence. Spire uses one of the largest constellations of multi-purpose satellites in the world to obtain these unique data, which it then enriches for industries in the maritime, aerospace and meteorological fields. With Luxembourg's support, Spire has been able to develop new services in these three fields.
Since opening its European headquarters in Luxembourg in 2018, Spire has grown exponentially, both in the Grand Duchy and on a global scale.
Note that Spire has received an investment from the Luxembourg Future Fund and has been listed on the New York Stock Exchange since August 2021.

Bradford Space

Bradford Space has operated in Luxembourg since 2016, where it now has around ten employees. Bradford Space recently signed an MoU with a commercial client with a view to supplying up to 42 units of its Comet water-based propulsion system for a constellation of microsatellites. Six Comet 1000 systems have already been delivered; 15 are still in production; an additional 21 are planned. Furthermore, an order has been received for eight thrusters from the top-of-range system (Comet 8000), four of which have now been delivered. An R&D contract awarded in the context of LuxIMPULSE has made it possible to develop the Comet technology and bring it to maturity. While work is still ongoing to produce the technology at scale, a major success and unprecedented return on investment have already been recorded.

Maana Electric SA

Maana Electric SA was founded in 2018 after submitting a successful competitive bid to the SpaceResources.lu initiative. The company has a staff of 50 and now specialises in In-Situ Resource Utilisation (ISRU) technologies. In particular, Maana is developing TerraBox and LunaBox, appliances designed to produce solar panels from local resources, such as sand on Earth and regolith on the Moon. The LuxIMPULSE programme enabled Maana to get its flagship TerraBox product ready for market in 2023. The company has attracted global interest for its sustainable production of solar panels. As a result, it has signed five commercial agreements for future TerraBox installations. The know-how gained in developing TerraBox and the sales revenue earned from this product will act as a springboard for the development of LunaBox. Maana can now be considered a world expert in ISRU and is successfully positioned at the leading edge of this innovative field. With LuxIMPULSE's support, the company has been able to bring its flagship product to maturity and attract its first private investments. Others are sure to follow in the near future.

LuxSpace

LuxSpace, an OHB Systems Group subsidiary, established in Luxembourg since 2004, develops complete microsatellite systems. It currently employs about 50 people. With the backing of the ESA programmes, it has been able to develop the necessary technology to supply a modular platform capable of serving different types of application. This summer, LuxSpace won its first commercial client. In competition with two other suppliers, the LuxSpace solution was finally selected. This is a satellite which will have 15 experiments on board, in fields ranging from communication to navigation, Earth observation and materials science. This first contract will pave the way to other commercial opportunities in a market enjoying strong growth.

GRADEL

In 2018 GRADEL made the decision to diversify and to adapt its corporate strategy to market trends in the spacetech sector. Gradel has identified ultralight structures, fabricated using innovative technology, for in-house development as a business opportunity. This new sector relies on digital process technology known as “xFK in 3D,” which makes it possible to wind a bundle of fibres to form complex 3D structures without resorting to the use of industrial robots. Due to a LuxIMPULSE R&D contract in 2020, Gradel has qualified this new process for space applications under ESA supervision with three partners: Airbus Defence and Space, OHB Systems and Thales Alenia Space. This project was completed in close cooperation with the Luxembourg Institute of Science and Technology (LIST), in a laboratory shared with the Institute. Gradel’s patented process achieves weight savings of up to 71%. The outcome of three years of focused development is a system produced and marketed under the GRAM brand, which stands for Gradel Robotic Additive Manufacturing. The system can impregnate and wind complex but durable ultralight 3D structures. Deployment of the process on this scale is a world first. This new technology is aligned with the Green Deal targets, because it facilitates sustainability in the aerospace industry, reducing its consumption of material and energy resources. The plan is that the first components manufactured by Gradel will be used on board satellites by the end of 2023. Gradel currently employs 65 people. Spacetech accounts for around 45% of the company’s turnover. At present 13 Gradel employees are working on GRAM. Gradel has launched a €7 million investment programme (2022-2025) to expand this new business sector in house. Market opportunities exist in similar number on the terrestrial side, in the automotive, aerospace and architectural fields.

Redwire Space Europe

Established in Luxembourg since 2018, Redwire Space Europe currently employs 24 people. The company’s core business in Luxembourg is the development of an affordable, highly modular robotic arm called STAARK. The first customer for the robotised arm was found when the product was still under development. This was an American company, Momentus. Momentus has commissioned Redwire to explore the possibilities of using STAARK on their satellite for a future space transport mission. After this study, the robotic arm will go on its first flight on the Momentus satellite at the end of 2023. Redwire has also received a procurement order for a terrestrial version of the robotised arm from the SnT interdisciplinary centre in Luxembourg. The company Thales Alenia Space UK has commissioned a utilisation study, now at an advanced stage, from Redwire with a view to developing a lunar version of the arm for an ESA mission. Redwire has discussions ongoing with over 30 international partners for other STAARK sales contracts.

SES

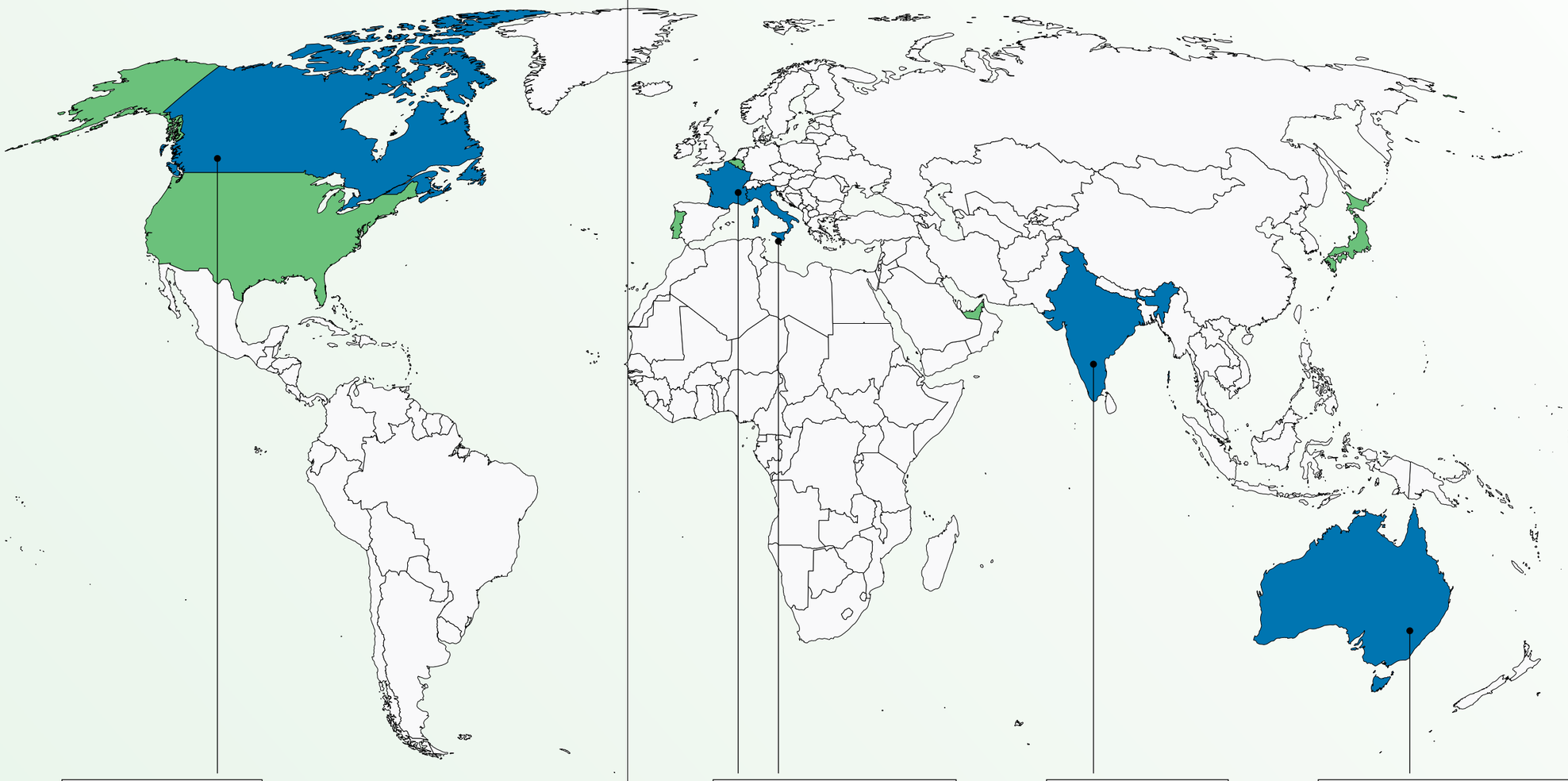
At the International Astronautical Congress in Paris, SES announced that it had signed a contract with the ESA for the design, development and deployment of a satellite-based quantum key distribution system. Named EAGLE-1, this mission serves the primary objective of demonstrating and validating cyber security services in orbit, based on quantum technology. This demonstration will open the way to new applications and the commercial prospects look promising.

1.3 International cooperation

Cooperation began with the Australian State of New South Wales in January 2020, with the Italian and French space agencies in October 2021 at the International Astronautical Congress in Dubai, with the Indian space agency in February 2022 and with the Canadian Space Agency in June 2022. This followed on from existing projects in cooperation with Belgium, Portugal, the United Arab Emirates, Japan, China and the USA.

In October 2020, Luxembourg also signed the Artemis Accords with the USA. Artemis is the US exploration programme which envisages sending the first woman and the next man to the Moon's surface by 2024. The stated objective of the Artemis Accords, set up by NASA, is to guide future cooperation activities carried out through bilateral agreements. The international cooperation under the auspices of Artemis seeks not only to support space exploration, but also to strengthen peaceful relations between nations. The Accords are a very good fit with the efforts made by Luxembourg at both national and international levels in support of peaceful exploration and the sustainable use of space and its resources for the benefit of humanity.

MAIN INTERNATIONAL COLLABORATIONS



1.4 National regulation

At regulatory level, it is worth noting that two new laws entered into force in Luxembourg on 1 January 2021:

1) the law of 15 December 2020 approving the Convention on Registration of Objects Launched into Outer Space, adopted by the General Assembly of the United Nations in New York on 12 November 1974;

2) the law of 15 December 2020 on space activities amending:
- > the law amended on 9 July 1937 on insurance tax known as the "Versicherungssteuergesetz;"
- > the law amended on 4 December 1967 on income tax. The second law concerns a system of authorisation and supervision of space activities carried out from Luxembourg. The first authorisations were issued in late 2022.

NATIONAL REGULATORY FRAMEWORK

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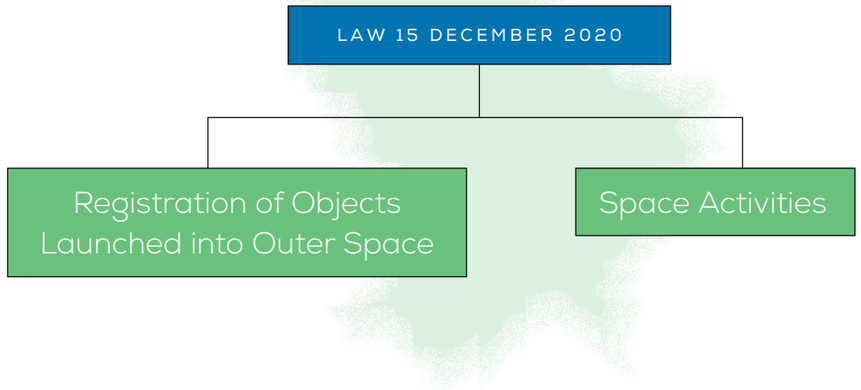


1.5 Talent development

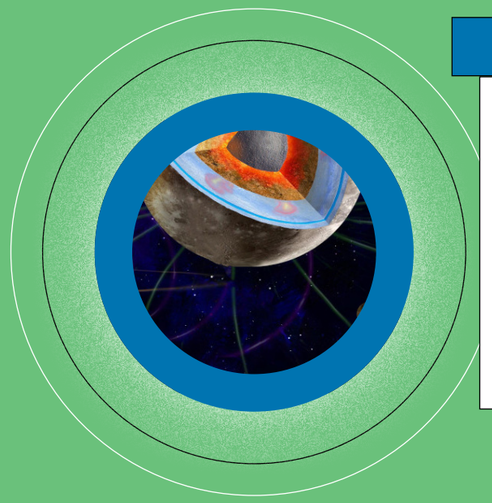
› ISM

As regards talent development, past initiatives have continued successfully despite the difficulties caused by the Covid-19 pandemic. The Interdisciplinary Space Master (ISM), a master's degree in space science, has continued to attract international students from Europe and elsewhere.

Seven students finished their course and graduated in December 2022. Three of them found employment in Luxembourg, while one other is continuing an academic career by studying for a doctorate at the University of Luxembourg, in cooperation with NASA's Ames Research Center.

LuxYGT programme

Young recent graduates have joined the LuxYGT programme which seeks to offer initial working experience within the ESA. Two candidates were admitted in 2020 while, in 2021, four applicants were able to join the ESA. The selection process for 2022 is still in progress, with a shortlist of six candidates.



Alpbach Summer School

As an ESA Member State, Luxembourg is eligible to send students to the Alpbach Summer School, organised by the Austrian space agency in cooperation with the ESA. N.B: the Luxembourg aerospace grouping GLAE and the national research fund FNR contribute financially to the selected students' costs. In 2020 the school was cancelled because of the pandemic. In 2021 three Luxembourg students participated remotely. In 2022, the school was back in Alpbach, where two students from Luxembourg attended.

ESERO Luxembourg

In June 2018, Luxembourg inaugurated ESERO Luxembourg, a resource office within the Luxembourg Science Center. This educational programme, launched by the ESA and rolled out nationwide by the LSA, seeks to raise young people's awareness of opportunities in the field of space and motivate them to go into the technical and scientific sectors. It also offers tools for teachers of STEM subjects to use space as a powerful source of inspiration. Despite Covid-19, teacher training courses and activities in schools have continued to develop. The course catalogue now comprises nine modules for primary school teachers and six for secondary teachers. It is worth noting that a further two modules have been developed for student teachers at Uni.lu. In the period 2020-2022, an average of 120 courses per year were delivered for primary and secondary school teachers.

Frontier Development Lab.

Since 2017, Luxembourg has also participated in the Frontier Development Lab. (FDL), organised by the SETI Institute with major involvement by NASA. In 2020 and 2021, the FDL programme had to adapt to the pandemic and took place remotely. In 2020 we had one participant and two mentors from Luxembourg, while in 2021 one participant and three mentors from Luxembourg took part in the programme. In 2022 the FDL returned to normal, with two participants and three mentors from Luxembourg.

Luxembourg Tech School

The LSA has maintained its support for the Luxembourg Tech School in its development of extra-curricular activities on the utilisation of space resources. Specific modules have been developed to teach the basics to secondary school students. These students have also taken part in the ESA challenges and educational initiatives such as CanSat and Astro Pi.

1.6 Communication

› TV programmes

With regard to communication, efforts since 2020 have focused on consolidating the positioning of Luxembourg and its space ecosystem at international level.
The communication activities at all levels have been many and varied. The question of space resources, for which Luxembourg now has an international reputation, continues to interest and galvanise the international press. LSA representatives have taken part in many documentaries and radio and TV programmes on the subject (Arte, Bloomberg and ZDF, to name but a few).

2021

1000 participants

NEW SPACE EUROPE

› Events

The events organised by the LSA (Space Resources Week and NewSpace Europe) have resumed since the pandemic and grown in scale and public profile. The 2021 editions attracted more than 1000 and 800 participants respectively. Parallel to this, the LSA and the Luxembourg ecosystem have become more closely involved in international spacetech events (Le Bourget, the International Astronautical Congress and Space Tech Expo Europe in Bremen). National players have been able to hold presentations in the pavilions provided, enhancing Luxembourg's general profile.

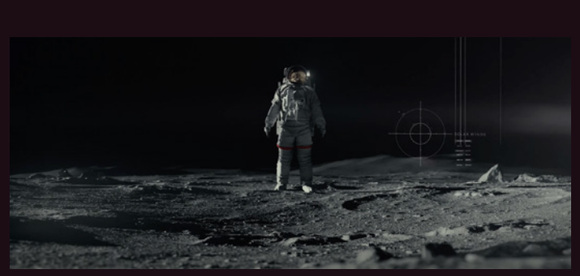
LUXEMBOURG SPACE RESOURCES

2021

800 participants

Communication via social media, especially LinkedIn, has taken off in a big way and is structured to ensure consistent messages. It relies especially on video productions which highlight the Luxembourg ecosystem's priority themes and competences. One example is the video "Space Resources, Driving the Future of Space Exploration," which has won several prizes and is an excellent illustration of Luxembourg's vision for space resources.

Multiple initiatives have also been launched to continue the work of raising public awareness of the space sector. This is done via the programmes of the LSA partners and LSA itself, and is always a success.



Space Resources, Driving the Future of Space Exploration

1.7

Focus on SpaceResources.lu (including ESRIC)

In 2016, the SpaceResources.lu initiative was launched with the aim of promoting peaceful exploration and the sustainable use of space resources. It seeks to establish a coherent ecosystem for the development of private-sector economic activities in the field of space resource utilisation.

Thus many policymaking, legal and regulatory initiatives have been undertaken. There has been public research and work has been done in schools, in higher education and in the economic and financial fields. In the space of a few years, Luxembourg has won international acclaim for its ambitions surrounding the use of space resources. SpaceResources.lu has also contributed to the sector's development and to the Luxembourg ecosystem more generally.

In recent years, the international scene has changed dramatically. Many public and private entities are now interested in using space resources, and the field continues to make rapid progress.

In November 2016, the Council of Government of Luxembourg decided to create an Advisory Board on Space Resources, tasked primarily with advising the government on space resource utilisation. The Advisory Board consists of international experts, especially the former ESA director general, Jean-Jacques Dordain, and the ex-director of NASA's Ames Research Center, Dr Simon Peter Worden.

Meeting most recently in May 2022, this Advisory Board drew some highly positive conclusions about the results achieved since the launch of SpaceResources.lu. In particular, it noted the business growth of the 10 Luxembourg enterprises in this field, which thus heighten the economic impact of the space sector.

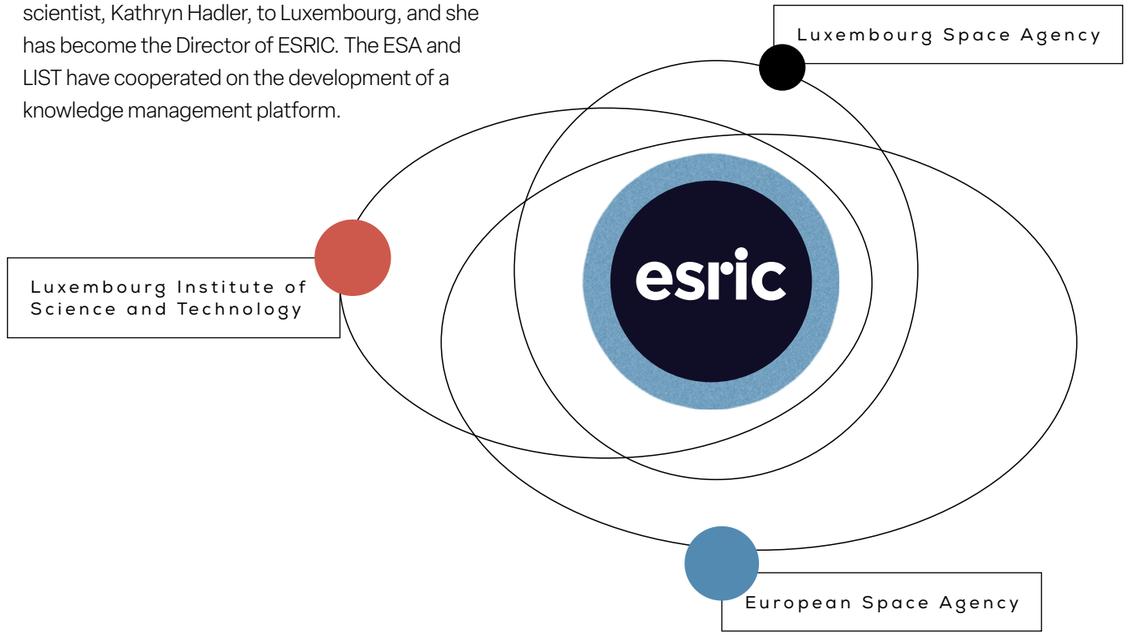
Other positive developments in the recent past, despite the global pandemic, have been the formation of a Committee on the Peaceful Uses of Outer Space at the UN (COPUOS), the different editions of Space Resources Week held in 2021 and 2022, each time bringing together over 1000 participants, the projects implemented under LuxIMPULSE auspices and the progress made towards a potential contribution to NASA's Artemis programme.

To strengthen the positioning of Europe and Luxembourg in the space resources field, the LSA decided to cooperate with the ESA to create a European Space Resources Innovation Centre (ESRIC) in Luxembourg. ESRIC is home both to the research activities planned in the context of the national initiative SpaceResources.lu and those of the ESA.

This cooperation between Luxembourg and the ESA was formally recorded in the Memorandum of Cooperation in the Field of Space Resources, signed in the margin of the last meeting of the ESA Council at Ministerial Level (Space19+) in November 2019 in Seville, ESRIC was set up within LIST in August 2020 and announced at a launch event in November 2020.

ESRIC continued its development in 2021 and 2022 in close cooperation with its three strategic partners. A first team of around 12 researchers was recruited and R&D and innovation work began in the core sections of ESRIC. Notably, ESRIC has installed laboratories on the LIST campus at Belvaux. The first ESA demonstrator has arrived (oxygen extraction by hydrogen reduction from lunar regolith) and R&D activities have begun on space resource processing. ESRIC has secured an FNR PEARL project on the sustainable use of space resources. This has attracted a high-level scientist, Kathryn Hadler, to Luxembourg, and she has become the Director of ESRIC. The ESA and LIST have cooperated on the development of a knowledge management platform.

To boost cooperation with the private sector, ESRIC has entered into partnerships with companies such as Air Liquide, Maana Electric and Airbus Defence and Space. In this way, these companies will contribute to ESRIC's research and development work. Furthermore, ESRIC has launched a programme of support to start-ups in the field of space resources, in cooperation with Technoport and the ESA. This is the world's first incubation programme dedicated to space resources. A first call for projects identified about 20 teams, five of which were admitted to the programme's first stage. A "challenge" on prospecting for space resources was launched with the ESA. The first round, in which 13 teams competed, took place in the Netherlands and the final, with five teams, was held in September 2022 at the Rockhal venue in Belval, Luxembourg.



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Sustainability at the heart of space strategy

The aim of the strategy and the action plan deriving from it is to continue the effort being made to develop Luxembourg's space sector. They are not only a way of diversifying Luxembourg's economy and assuring its long-term future, but also major contributors to the sustainability of activities on Earth, while promoting a responsible approach to activities in space.

Luxembourg's space strategy 2023–2027 centres on sustainability.

Something which was already present in the background to the strategy so far pursued, mainly with regard to the long-term future of economic activities, now becomes the leitmotif of the strategy.

The 2023-2027 strategy is compatible with the adoption by Luxembourg and the international community of the 17 Sustainable Development Goals and the National Plan "Luxembourg 2030" for sustainable development.

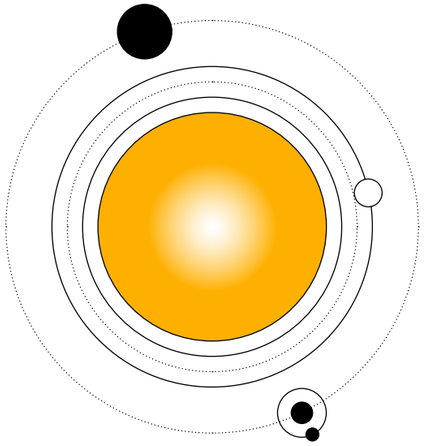
Its purpose is not only to consolidate the existing competences but also to develop new ones, in order to seize new opportunities presented by major trends in the sector. These are relevant to Luxembourg both in terms of economic prospects and compatibility with its ecosystem.

The international community recognises space as one of the essential drivers of sustainable development.

The United Nations General Assembly, at its 76th session, adopted resolution 76/3 on 25 October 2021 on "the Space 2030 Agenda: space as a driver of sustainable development." Essentially this resolution seeks to reaffirm and strengthen the contribution of space activities to the 2030 Agenda for Sustainable Development, the Sendai Framework for Disaster Risk Reduction (2015-2030) and the Paris Agreement.

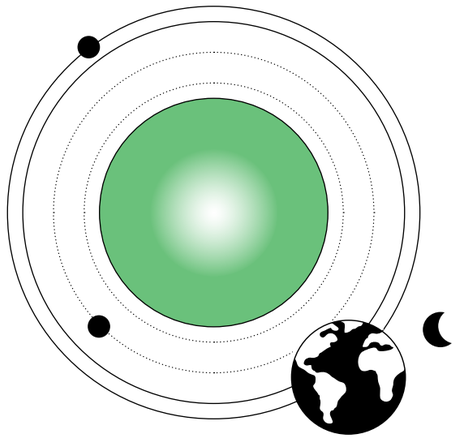
THE FOUR LINES OF APPROACH TO SUSTAINABILITY:

1 Economic sustainability



The sustainability of space-related economic activities is directly linked to the primary objective of the development of the commercial space sector in Luxembourg, economic diversification, and seeks to maintain the skills developed to date for the long term.
The aim will therefore be to consolidate Luxembourg's positioning on its preferred market segments, but also to position the country on new segments offering attractive commercial prospects.

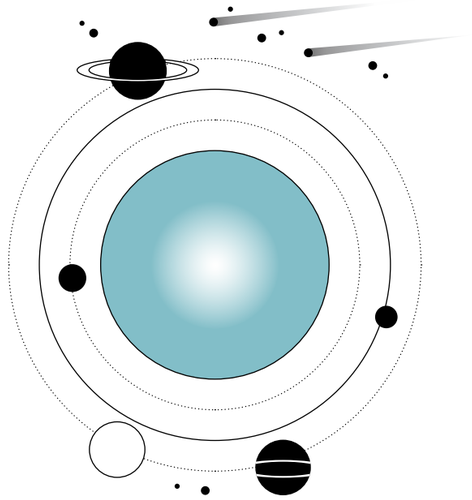
2 Sustainability of activities on Earth



Spacetech today makes it possible to offer answers, or serious contributions, to societal and environmental issues.
To help make activities on Earth sustainable entails building bridges between the space sector and the terrestrial sector, and strengthening national competences in the segments likely to be useful to other economic sectors. There will be a more specific focus on sectors of interest to Luxembourg, to prompt a multiplier effect and simultaneously contribute to the economic sustainability of Luxembourg's space sector.
The development of expertise will also concentrate on the segments likely to contribute to some of the sustainable development goals, with a special focus on the segments of relevance to development cooperation and Luxembourg's humanitarian action.

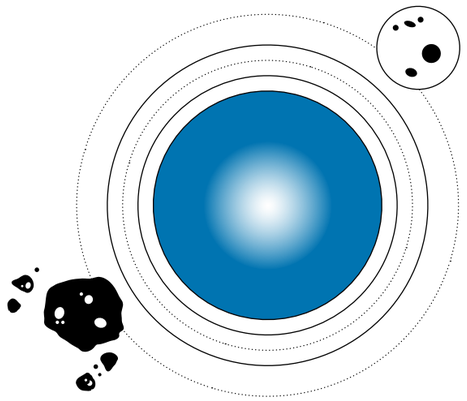
3 Sustainability of activities in space

The new dynamism noticed in the space sector in recent years, and the intensive use of Earth orbits in the near future, are generating greater operational risks in orbit and more debris in space. Nevertheless, nowadays space is part of our everyday lives. Furthermore, space infrastructure also has commercial, security, environmental and societal implications. It is therefore urgent and vital to promote responsible long-term use of space. Luxembourg's commitment will take effect at both national and international levels, and through the development of national competences in space traffic management and services in orbit.



4 Sustainable and responsible use of space resources

The SpaceResources.lu initiative aims to promote peaceful exploration and a sustainable development approach to the use of space resources.
The R&D projects of businesses and public research centres in this field, especially ESRIC, will have to tackle the issues of sustainability, circularity and resource management, while ensuring the economic viability of the activities being developed.
Luxembourg will continue its international engagement, especially at the UN, in order to create a respectful international framework and develop these new space activities for the benefit of humankind as a whole. Technological developments in space may also make certain activities on Earth more sustainable, especially in the mining industry.



Finally, the development of space activities cannot fail to consider ethical aspects and the impact of human actions on nature, in space and on our society at large. This will be done by promoting the positive change brought about by the space sector at various levels, in consultation with experts in applied ethics and implementing various initiatives in partnership (events about ethical concepts, one-year research posts on astroethics, for example).

Sustainability of activities on Earth

DEVELOPMENTS 2023-2027

Space in support of sustainable activities on Earth

› Contribution to sustainable development goals

The vast majority of space applications are usable to support most, if not all, of the goals of sustainable development. For a number of years now, Luxembourg has supported development in the satellite telecommunications sector and the downstream sector of applications using data of space origin via the LSA Data Center (access to Earth observation data originating from space) and the funding of R&D work.

Pursuing this strategy we shall:

→ evaluate Luxembourg's positioning on resolution 76/3, "the Space 2030 Agenda: space as a driver of sustainable development;"

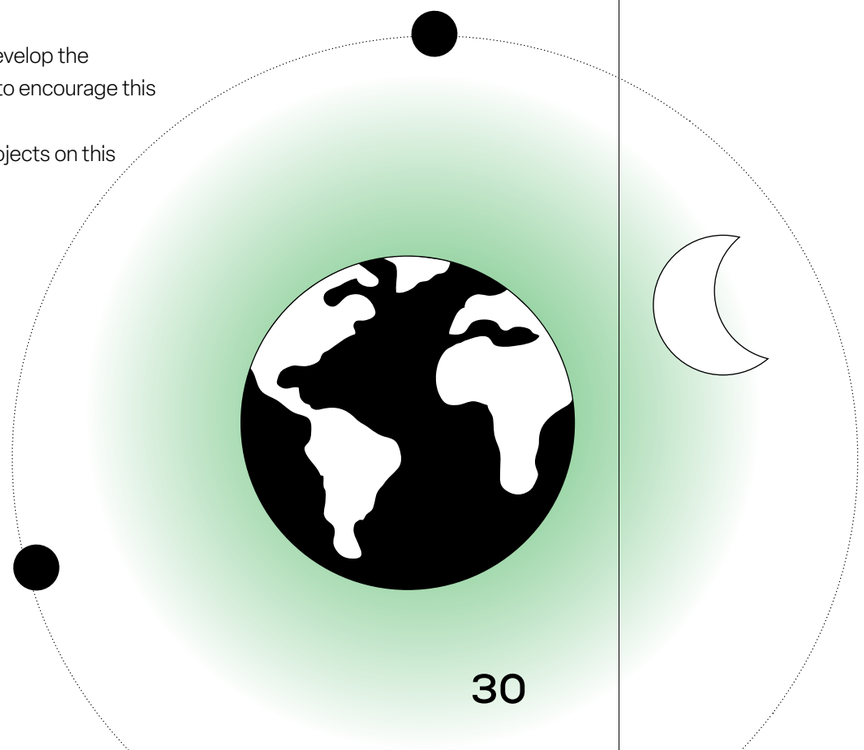
→ continue the LSA Data Center's operations with closer attention to using it to promote sustainable development;

→ evaluate our potential to contribute to the sustainable development goals, especially those linked to our expertise:

→ to consolidate and develop the necessary expertise to encourage this contribution;

→ to launch a call for projects on this subject.

The renewed strategy will focus on developing industrial know-how in disciplines which will make a partial contribution to the sustainable development goals, support Luxembourg's development cooperation and humanitarian action or even contribute to the development of other economic sectors of interest to Luxembourg.



› Space at the service of development cooperation and humanitarian action

Development cooperation and humanitarian action occupy an important place in the policy of the Luxembourg Government.

Space technologies have the potential to lend direct and powerful support to the implementation of development cooperation projects.

Examples are: by facilitating access to space for developing countries and increasing the necessary capacity for this purpose (including training and technical assistance), or even providing secure satellite telecommunications equipment.

The 2023-2027 strategy therefore seeks to identify the types of problem faced by the countries with which Luxembourg is engaged in development cooperation, ascertain which skills available in Luxembourg might contribute towards innovative solutions, and issue an appeal for projects, the ultimate purpose of which will be to deploy and demonstrate these solutions in the selected countries.

The chosen topics might include the provision of secure connectivity services, management of freshwater resources, flood control, reclaiming land for farming, prevention of desertification or surveillance of access corridors for humanitarian aid.

The LuxIMPULSE national programme will be one of the potential frameworks of support for the selected projects.

› Space at the service of other sectors

There are many examples of space infrastructure or data used in other economic sectors such as transport, energy, agriculture, finance or the environment. This potential is still far from fully tapped.

Space may also contribute to other aspects of national policy, such as digitalisation, sustainable development, energy, research or even defence.

Continuous assessment will be set up to identify economic sectors with strong potential to benefit from services based on space infrastructure or data, monitor trends in these sectors, and suggest new lines of development. Besides, this approach will enable new opportunities to be seized in the corresponding markets.

For this purpose, it will be necessary to forge and develop links with other economic sectors and raise their awareness of the value added by the space sector. In this spirit, the Newspace Europe conference was devised. This initiative will also involve participation at events in these different sectors, contracts with professional organisations and possibly the arrangement of invitations for cross-sector ideas.

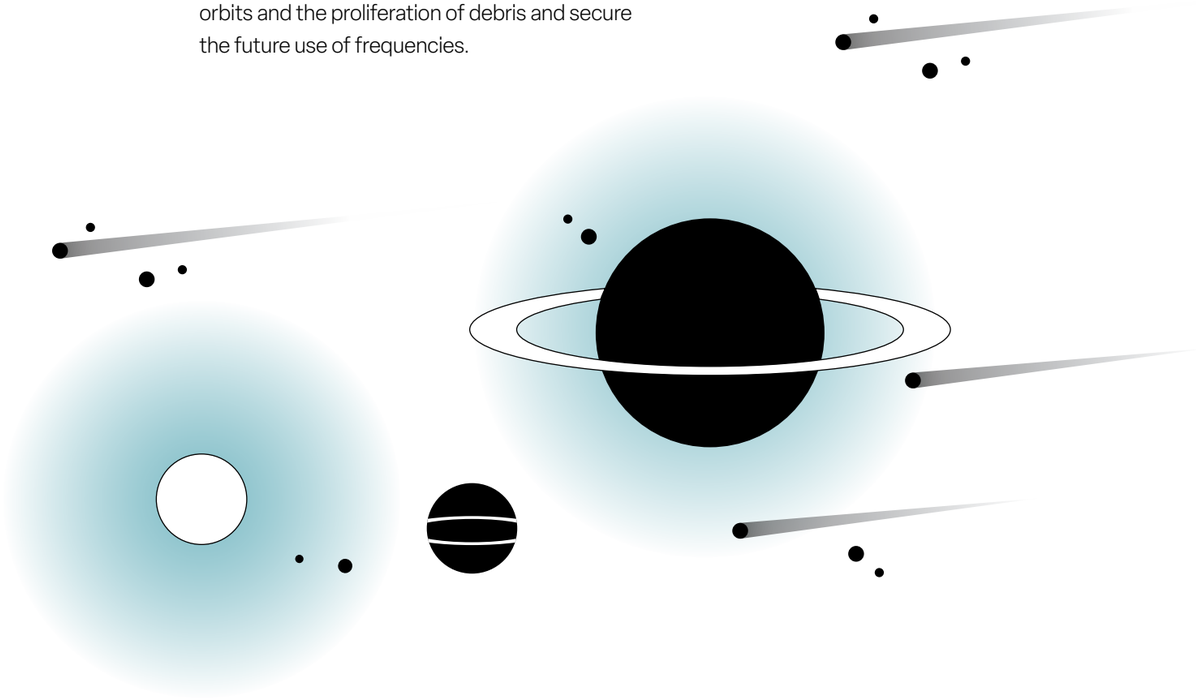
Sustainability of activities in space

DEVELOPMENTS 2023-2027

Long-term activities in space

Space technologies have impinged on our daily lives for so many years that it would be neither conceivable nor reasonable to put the clock back. Who in today's world can imagine doing without satellite navigation or telecommunications? On the other hand, there are major security and economic interests associated with the exploitation of space infrastructure and it is in no way acceptable that these should be threatened. In the present day, the advent of mega-constellations heralds the intensive use of Earth orbits, especially low orbits which may disrupt or even imperil the operation of existing systems. In addition, there is the threat of irresponsible practices leading to the proliferation of debris, increasing the danger to institutional and commercial space infrastructure.
It is therefore imperative to promote responsible long-term use of spaceto avoid the congestion of orbits and the proliferation of debris and secure the future use of frequencies.

Three types of action will be carried out:
- ensure the sustainability of Luxembourg's activities in outer space;
- develop and strengthen industrial competences in space traffic management;
- develop industrial expertise in relation to services in orbit.



› Ensure the sustainability of Luxembourg's activities in outer space

The aim is to position Luxembourg in the responsible use of space and promote good practices within our space ecosystem, while maintaining the economic balance pending future regulations.
This will consist specifically of:
- monitoring and evaluating initiatives and work in this field to become a stakeholder when deemed appropriate;
- establishing the current positioning of the Luxembourg space sector in relation to the LTS Guidelines and identify avenues for potential progress;
- assessing the sustainability of activities extending into outer space by enterprises from the Luxembourg space ecosystem;
- issuing an open invitation for projects dealing with tools and products which promote the responsible use of space, which will allow the sector's economic progress to continue while taking firm action for the future.

› Develop and strengthen industrial competences in space traffic management

The unavoidable stage on the way to space traffic management is a detailed knowledge of active objects and debris of all sizes and their paths. So far this knowledge remains limited and relies essentially on surveillance and monitoring from Earth.
Regrettably, this limited knowledge leads to many alarms, mostly false. They are therefore either ignored, posing a proven potential hazard, or systematically responded to, resulting in sub-optimal operation which may lead to serious operating losses for commercial operators or a drastic reduction of mission time for institutional operators.

It is therefore necessary to improve the quality of these data, in terms both of numbers of objects and accuracy, as these are the data which will flow into the services which predict the conjunction of two objects, establish precise trajectories or plan avoidance manoeuvres.
In 2019 Luxembourg took its first step by signing an agreement with the company NorthStar for the development of commercial traffic management in space.
Our objective is to continue to support all R&D work of relevance to traffic management in space.

› Develop industrial expertise in relation to services in orbit

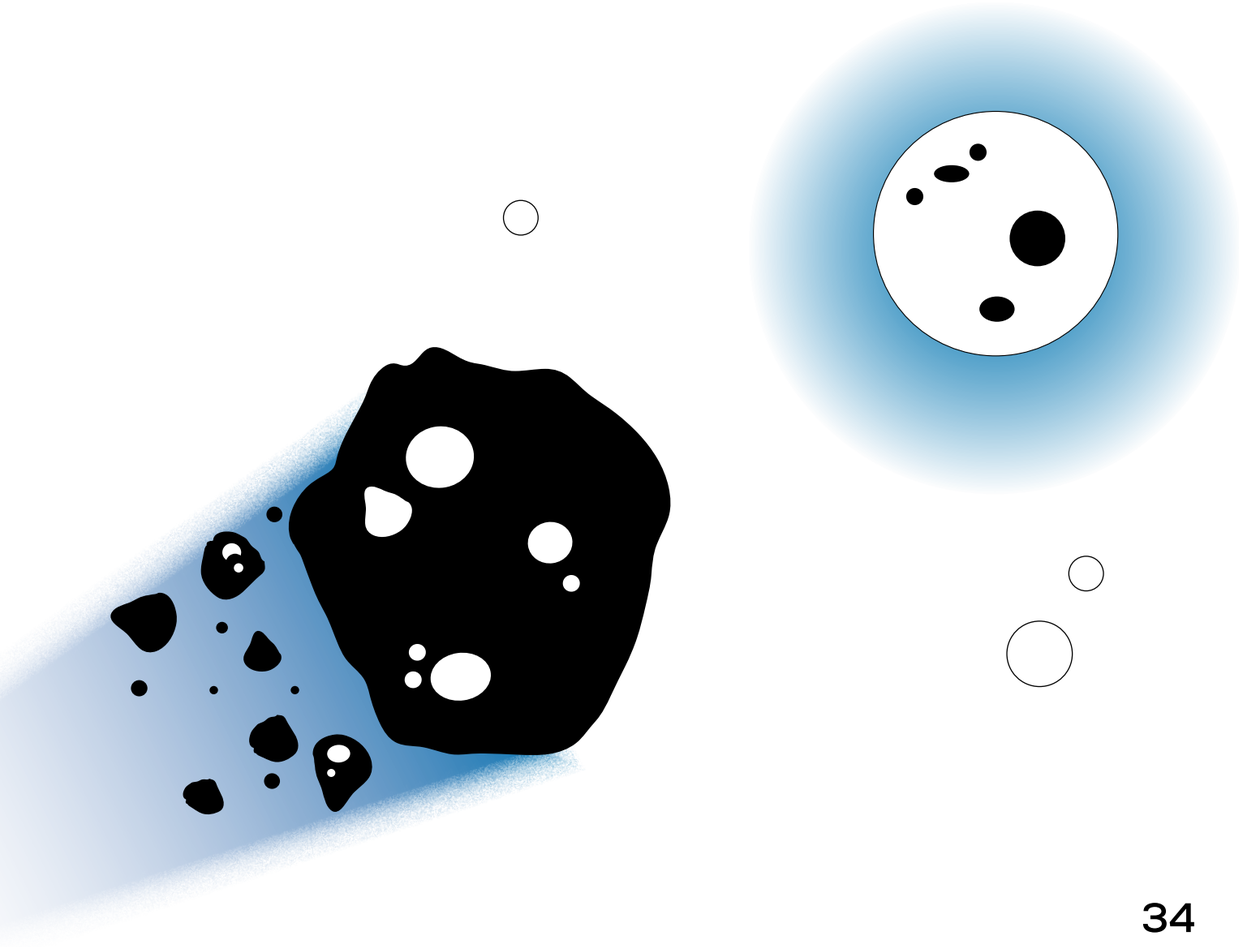
The sustainability of outer space activities will also entail the provision of services in orbit.
These services will encourage the development of a circular economy in space. They range from final release into orbit to manufacture and assembly in orbit, extension of mission duration and debris removal. Luxembourg already supports the development of rendezvous technologies and a robotic arm and will continue to support these activities and the development of additional technologies. Apart from technological developments, the 2023-2027 strategy envisages positioning in the supply of services which extend telecommunication missions in geostationary orbit.

DEVELOPMENTS 2023-2027

Sustainable use of space resources

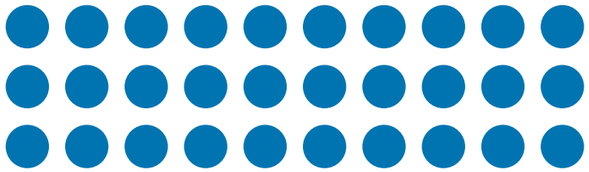
› SpaceResources.lu

The SpaceResources.lu initiative has the ambition of developing a long-term vision, which can only be done using sustained, long-term effort and resources. The initiative is especially well-suited to issues of sustainability, circularity and resource management.
Acting on the Advisory Board's recommendations, the effort will continue with an emphasis on enabling activities (international framework, international cooperation and contribution to government programmes), research, education and promotion, including the encouragement of innovation and private investment.



› Role of ESRIC

ESRIC plays a key role in the achievement of the SpaceResource.lu objectives. ESRIC's development will continue in order to achieve the goals on which its partners have agreed. By 2024, ESRIC is going to number around 30 specialist researchers, especially in the context of the FNR PEARL programme, oriented towards sustainable utilisation of space resources.
Special emphasis will be laid on cooperation with private enterprises such as Air Liquide, Airbus and Maana Electric. The programme for start-ups will continue and possibly expand. A second edition of the ESA-ESRIC Space Resources Challenge will be held.
Luxembourg Space Resources Week is a conference to be held annually, since it has become an unmissable gathering point for the community. The knowledge management platform will continue to be improved in order to offer complete, easy access to knowledge in the field.
ESRIC's longer-term development will be clarified, in particular by updating the activities carried out in cooperation with the ESA. The first ESRIC building will be planned and constructed on the Space Campus in Belval. This will house the ESA's dusty vacuum thermal chamber (DTVC) and, in due course, a pilot line to test the extraction and processing of space resources. ESRIC will also handle building work using lunar regolith, e.g. for housing or infrastructure. In the longer term, flight opportunities will need to be identified to test these technologies in space.
As decided by the Government in 2020, it is planned to develop ESRIC into an independent European space research centre. This will enable closer integration of other European public and private partners in the development and management of the centre. Support for new enterprises in this sector will also be continued in order to develop and consolidate this new sector in Luxembourg.



30 specialist researchers

03

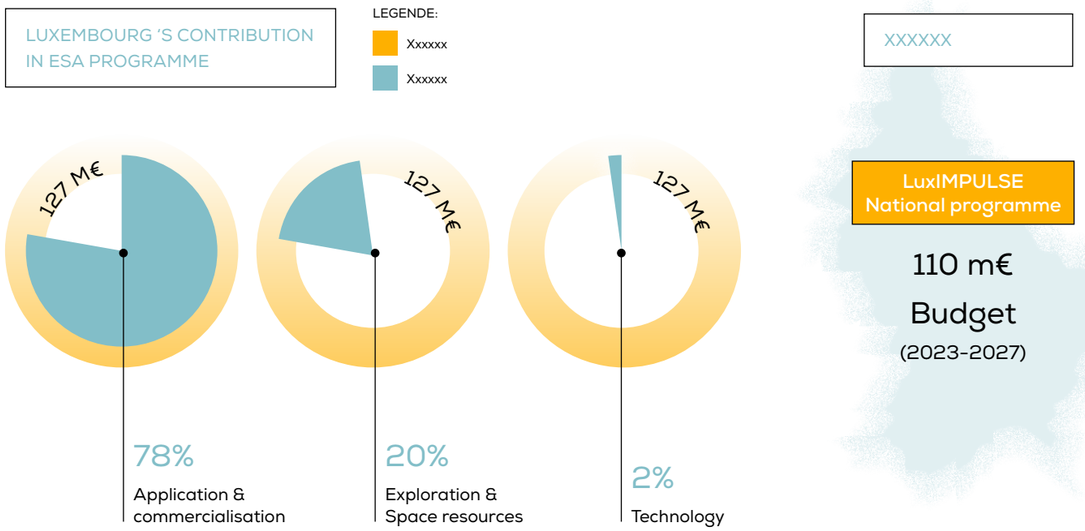
Implementation and strategic projects

3.1 Finance

› Financing RDI work

The ESA programmes are particularly interesting as means of support of the development of innovative space projects. The optional ESA programmes enable us to choose the topics of interest to Luxembourg and invest to meet the needs of development according to global market trends and prospects of commensurate economic returns. The topics identified as being of interest to Luxembourg are: satellite communications, especially recent developments in secure communication services and quantum communications, Earth observation, surveillance from space, space traffic management, exploration and, more generally, advanced technological developments. Supplementing these optional programmes, Luxembourg has entered into an agreement with the ESA to implement a national programme, LuxIMPULSE. This programme allows projects to go ahead outside the scope of the optional ESA programmes. This means quicker processes and enhanced protection of the intellectual property generated during the projects.

To fund RDI activities in the field of space, Luxembourg will therefore continue to contribute to the ESA and LuxIMPULSE programmes. The national financial contributions to the ESA programmes were announced at the ESA Council at Ministerial Level on 22-23 November 2022.

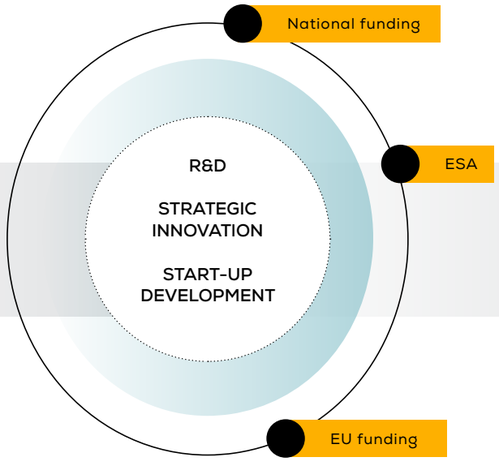


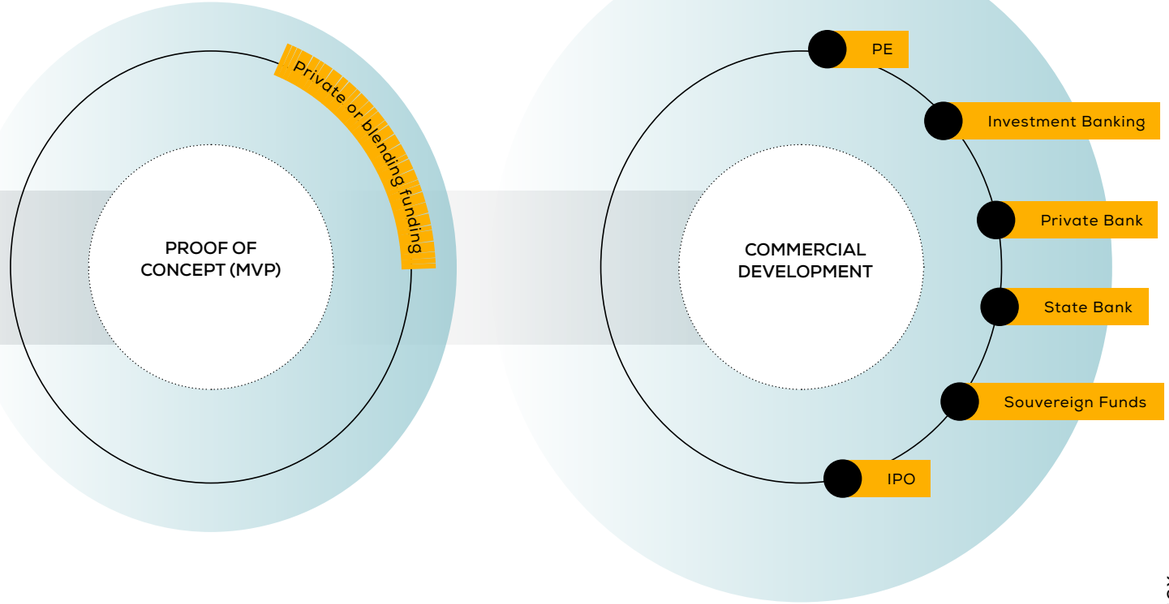
› Business finance

In addition to the necessary support for their technological developments, businesses require investment to develop their commercial activities. Helping businesses to locate private finance therefore remains an essential lever of the strategy, and depends especially on cooperation already commenced in the past with financial institutions such as the European Investment Bank or the European Investment Fund.
Another aim will be to attract and involve more private investors, by arranging seminars and conferences on the subject. These will seek to forge new contacts with funds or investors. The LSA will continue to extend its network of contacts with funds and private investors.
The LSA will encourage and facilitate the use of investment instruments already present in Luxembourg, such as the Orbital Ventures fund, the Luxembourg Future Fund, the Digital Tech Fund, the SES Concession Fund and the SNCI funds. The LSA will also facilitate access to financial instruments in the context of European initiatives such as the European Union's CASSINI facility.

THE ROLE OF PRIVATE AND PUBLIC FUNDING IN DEVELOPING A SUSTAINABLE SPACE ECOSYSTEM

Space development is a priority for Luxembourg, were business ideas with commercial perspectives, aligned with the national strategy are welcomed.





3.2 Talent development and public research

› Talent development

The question of attracting and developing talent is key to assuring the stable long-term development of the Luxembourg space sector. The LSA and its partners will therefore continue to support and develop work in schools and higher education (ESERO, ISM, LuxYGT etc.) This will take place in close cooperation with national institutional partners and the ESA. These activities, which seek to support and inspire the younger generations, will do so in a spirit of promotion of diversity. Furthermore, employment opportunities in Luxembourg will be made more visible by setting up a dedicated web portal bringing together all job offers in the Luxembourg space sector. A proactive approach will also be followed with student associations, young graduates and certain universities where an LSA presence on certain careers days might be considered.
Finally, other possibilities will be studied, such as creating initiatives to facilitate the entry to Luxembourg of talents from less competitive markets than Europe and the USA. One possibility might be action to encourage cross-industry moves to attract talent from other business sectors into the space sector.

THEY ARE STRUCTURED AS FOLLOWS:

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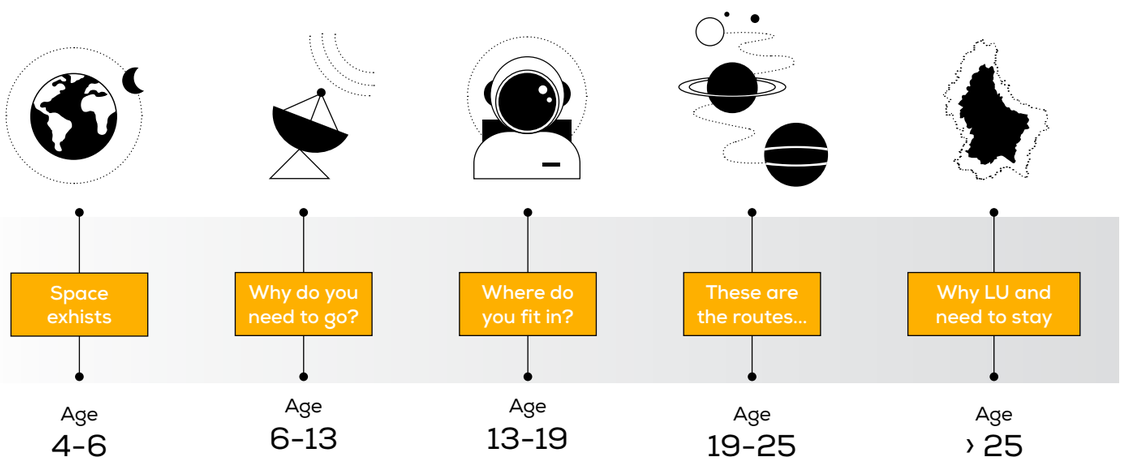

3.3 International cooperation

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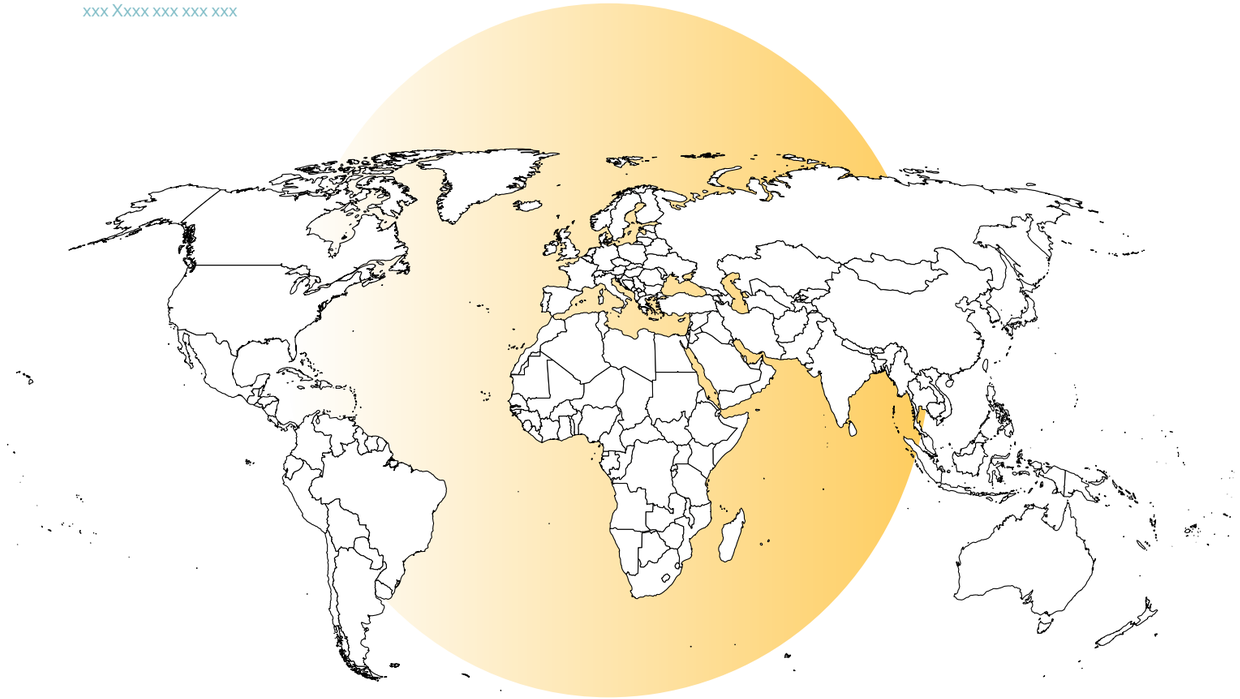

International cooperation is an essential part of the strategy. Luxembourg is open to an interconnected world where space technologies and their applications transform the economy and are emerging at ever-increasing speed.
International cooperation enables the country to rise better to the challenges prompted by economic and societal issues surrounding the sustainable use of outer space.
Luxembourg is recognised for its general multilateral and international engagement, especially in relation to space. International cooperation impinges on all aspects of the new strategy.

› Bilateral cooperation

" We want to bring Luxembourg technologies to the Moon. "

Luxembourg has signed a number of bilateral agreements at governmental level and with space agencies. These agreements deal with various aspects and objectives, especially:

- economic development: easier access to foreign markets, attraction of investment and new businesses to Luxembourg, access to technologies, promotion of the Luxembourg ecosystem;
- legal/regulatory: better coordination to help to reinforce the international legal framework. This may, in particular, entail an exchange of good practices.
- Talents: identification and attraction of new talents to Luxembourg.

Priority will be given to identifying and deploying specific action with existing partners, e.g. via workshops or conferences. Special attention will be paid to the possibilities of accessing exploration programmes, so that Luxembourg technologies can be taken to the Moon. NASA's Artemis programme is one example.

› Multilateral cooperation

" We want to activate the dialogue at EU level."

Beyond the cooperation at ESA and EU level, Luxembourg will remain involved in a number of discussion platforms, especially but not only at the UN, to strengthen Luxembourg's position on the international scene, enhance its profile and offer solutions conforming to our vision.
In general, this means contributing to the establishment of a clear international regulatory framework as a level playing field. Luxembourg will get actively involved in dialogue at EU level and with the European agencies concerned with the priority subjects. Luxembourg will also contribute to certain multilateral programmes, the subjects of which will be aligned with the priorities of its space policy. It will try to participate in relevant working groups, e.g. on the regulatory aspects of space resources or the sustainability of space activities.

3.4

Development of the legal and regulatory framework

The legal and regulatory framework plays a key role in the development of space activities at national and international level.
At national level, the legal and regulatory framework will be more precise following the adoption of the law of 20 July 2017 on space exploration and the use of space resources, and the law of 15 December 2020 on space activities. A system of authorisation of new operators is being set up and will be backed by Grand Ducal regulations and corresponding procedures. By the end of 2022, the activities of the current operators, authorised and supervised by the SMC via the law on electronic media, will be revised in line with the law of 2020.
In the past five years, Luxembourg has seen powerful growth in the number of objects registered. The LSA will maintain its national register of Luxembourg space objects and will undertake to notify them to the UN. The experience gained will lead to improvement and streamlining of registration applications to take account of the international nature of space activities and the new technological developments in this context.
Two draft laws will be proposed: one on sensitive very high-resolution Earth observation data; and another approving the **Agreement on the Rescue of Astronauts, the Return of Astronauts and the Return of Objects Launched into Outer Space.**
At international level, Luxembourg will remain involved in discussions seeking to **develop the international framework for exploration and sustainable use of space, at the UN and in other multilateral fora,** in close cooperation with private enterprises.

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LAW 20 JULY 2017

Space exploration and the use of space resources

LAW 15 DECEMBER 2020

Space activities

3.5 Promotion and communication

Communication activities play a key role in implementing the strategy defined at national level. They are also vital to the exploitation and positioning of Luxembourg's ecosystem. In future years, several objectives will guide the development of communication activities.
In line with the efforts made since 2018, communication will seek to consolidate Luxembourg's positioning as a European cluster of space industry development. The international promotion of SpaceResources.lu will remain a priority. This will run parallel to the development of other key strategic issues, such as sustainability. Besides, the emphasis will be on raising the awareness of non-specialist professional audiences of the potential, opportunities and attraction of the space sector. There will be a willingness to create synergies between space and terrestrial sectors. The aim is to work to increase space's input to the management of world problems and foster better economic sustainability in the sector. Finally, communication efforts will concentrate on raising public awareness, especially that of young people, about the space sector, with the aim of encouraging the emergence of talent for the space industry.
All these objectives will be pursued through a variety of communication activities and resources, including digital communication, the press, events and the use of objects in communication.

3.6 Strategic projects

› LSA Data Center

Created in 2017, the LSA Data Center is a key component of the LSA. It seeks to facilitate access to Copernicus data of observations of the Earth from space. This will expedite the development of the downstream sector of value-added applications and services. The LSA Data Center's overriding and ongoing purpose is to support the development of commercial services.
Its development must respond to the trends and challenges of future data platforms, including intelligent storage of a constantly growing data volume, cloudification and easy access to high-performance computing (HPC).
Thus the Center will try to cooperate with the national data exchange platform and the HPC initiative.
This will also further Luxembourg's transition to a digital economy and advance the sustainability objectives of our strategy.

› Space Campus

On 8 July 2022 the Council of Government of Luxembourg gave outline consent to the creation of a space campus in Luxembourg, spread across two sites: the Poudrerie site in Kockelscheuer, Luxembourg, and the Belval campus.
This Space Campus will serve multiple purposes. It will offer an attractive working environment for the best talents, a place for discussion and encounter which favour cooperation and synergy, a platform for public-private cooperation in the field of space and shared research infrastructure accessible to all participants.
The Space Campus will help to make this sector permanent in Luxembourg.