

**Introduction:** The Luxembourg government launched in 2016 the SpaceResources.lu initiative with the aim to contribute to the peaceful exploration and sustainable utilisation of space resources for the benefit of humankind. This initiative is a broad effort led by the government to tackle the different challenges that come with space resources in an open and transparent way, with the goal of developing an environment where private and public actors can use space resources and build the future in-space economy. This abstract provides an update on the initiative and presents what Luxembourg has achieved since the launch of the initiative.

**The initiative:** At the beginning of the initiative four challenges were identified that must be addressed in parallel to create a viable environment for space resource utilization. These challenges are linked to the technical, regulatory, financial, and business aspects. On the technical side, the technologies to extract and use resources in space do not yet exist and must be developed incrementally over the next decades in line with the first use cases for space resources. On the regulatory side, there is no international framework in place today, which is a critical element for the future space resources industry, especially when the private side will be involved. On the financial side, the future space resources industry will need significant investment to develop these technologies. Finally, the business related to space resources is an important element for the long-term success of this new industry, and there must be clear use cases making the utilisation of space resources a viable endeavour.

To address these challenges, the SpaceResources.lu initiative developed a strategy around 5 strategic pillars: political support and international cooperation, legal framework, education and research, industrial R&D, and long-term financing.

**Political Support and international collaboration:** At the beginning of the initiative, it was important to make sure that the vision and the objective of the initiative were well understood, both nationally and internationally. Therefore, Luxembourg engaged with organizations of which it is a member of, such as the EU, ESA, and the UN, and encouraged them to address space resources in their respective programs and boards. In addition to that, the government, and the Luxembourg Space Agency (LSA) engaged on a

bilateral level with other countries and space agencies around the world. The government also established a High-Level Advisory Board, which includes members from China, Korea, Japan, the United States, and Europe. To support collaboration among the different actors and promote the topic among the non-traditional space industry, Luxembourg is organizing an annual conference dedicated to space resources since 2016. Today, this conference is known as the Space Resources Week and, including the virtual participants, gathers more than 1000 participants for three days, making it the largest event dedicated to space resources in Europe.

**Legal Framework:** Luxembourg has taken a step-by-step approach towards creating an international legal framework for space resources. In 2017, the country adopted a law on the exploration and utilization of space resources, becoming the second country in the world to do so. In parallel, Luxembourg is committed to support the creation of an international framework for the utilisation of space resources together with the global community and actively supported the creation of a working group on space resources at the UN COPUOS in 2023. Luxembourg has also contributed to the Hague International Space Resources Governance Working Group as well as the more recent Global Expert Group on Sustainable Lunar Activities and was one of the founding signatories of the ARTEMIS Accords.

**Education and Research:** In terms of education and research, the LSA has partnered with ESA and the Luxembourg Institute of Science and Technology (LIST) to establish the European Space Resources Innovation Centre (ESRIC). In support to ESRIC, the National Research Fund (FNR) provided a PEARL grant for the development of Solutions for the Sustainable and Responsible use of Space Resources (SolSR). The LSA has also collaborated with the University of Luxembourg to establish an interdisciplinary space master's program, that is teaching not only the traditional space technologies but also offers, with the support of the Colorado School of Mines (CSM), modules on Space Resources. To open the topic of space resources to a broader community, LSA developed together with the CSM, ISU, ESA and ESRIC a two-day professional course teaching the fundamentals of space resources.

**R&D activities:** LSA supports the national industry through R&D contracts in developing the future technologies to excavate, process and utilize space resources. This includes for example technologies to produce and use oxygen, hydrogen, and metals on the lunar surface, to store and produce energy in regenerative fuel cell systems or liquify, store and transfer liquid oxygen on the Moon to refuel spaceships. Furthermore, LSA joined the European Exploration Envelop program at ESA, to contribute to the European effort in this new field and allow Luxembourg industry to participate in European projects. In addition to this, Luxembourg conducted studies on the future market opportunities for space resources with ESA and supports challenges and an incubation programme on space resources through ESRIC.

**Long-term financing:** On the financial side, Luxembourg is offering a diverse set of funding scheme together with the private side. LSA can support companies through R&D contracts, the Luxembourg government established a space VC fund in a public private partnership and companies can get investment and loans through various national and European funding instruments.

**The conclusion:** The SpaceResources.lu initiative made continuous progress over the last years in all the pillars defined in its strategy and remains an important effort led by the Luxembourg government to contribute to the peaceful exploration and sustainable utilization of space resources for the benefit of humankind. Through this initiative, Luxembourg managed to become the leading country in Europe in the field of space resources and make significant contributions on an international level.