



LUXEMBOURG
SPACE AGENCY



LUXEMBOURG
LET'S MAKE IT HAPPEN

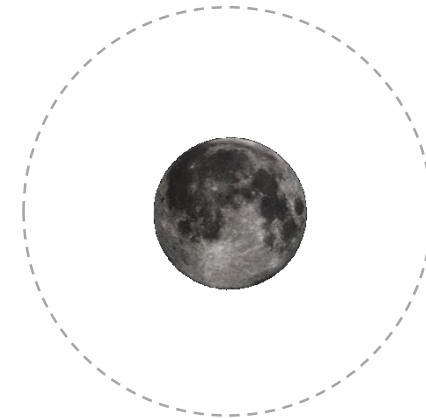
Luxembourg's SpaceResources.lu Initiative The Space Resources Value Chain and the Role of Robotics and Autonomous Systems



CZ-LUX Robotic Day

Bob Lamboray

Luxembourg, 13 March 2019





Luxembourg aims to contribute to the peaceful exploration and sustainable utilization of space resources for the benefit of humankind

Realizing the Potential Benefits of Space Resource Utilization Remains Challenging & Requires Global Partnerships

Key Challenges



TECHNICAL

Capabilities necessary to prospect and utilize resources from space still must be developed, tested, and matured



REGULATORY

International & domestic legal frameworks need to be established to protect entrepreneurs, assure investors, and ensure responsible activities



FINANCIAL

Significant investment with long-time horizons must be available to enable private firms to develop and deploy critical systems



BUSINESS

Identification of capabilities needed for space mining with near-term business potential is required to ensure incremental growth as the market today is nascent

Luxembourg is Implementing a Comprehensive Strategy to Realize Its Space Resources Vision

Five Strategic Pillars



- 1 Ensure national political support and promote international cooperation
- 2 Build clear legal framework and engage internationally
- 3 Promote long-term public support and workforce engagement through education and R&D
- 4 Provide dedicated support for industrial research and development activities
- 5 Develop investment instruments focussed on commercial space

Why is the Luxembourg Government Supporting and Promoting Commercial Space Resource Utilization?

1

Space Resources Are Available and Valuable

Large quantities of high-value resources, such as water and metals, exist in the Solar System and could enable Earth-independent system architectures

2

Space Resources Will Create the Future Space Economy

Utilization of space resources could play a foundational role in future in-space economies

3

Space Resources Will Enable Deeper Space Exploration

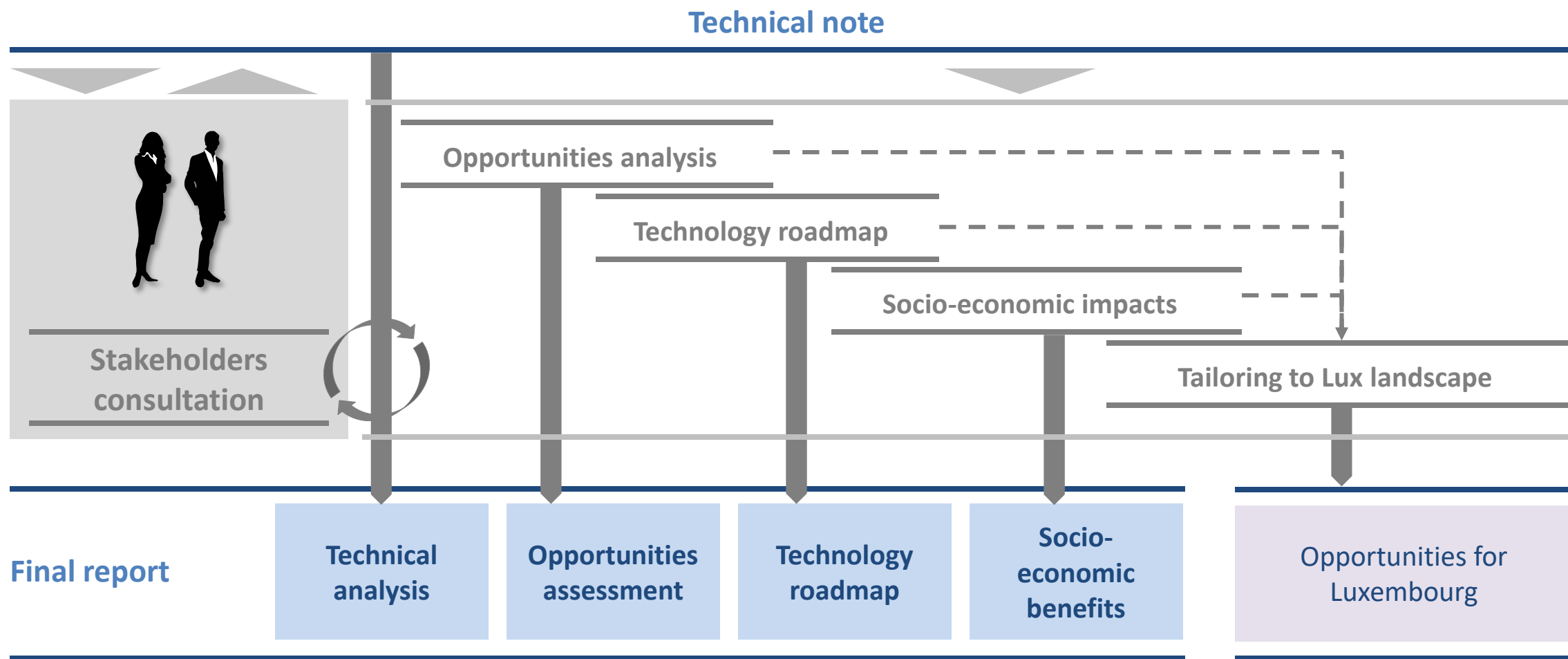
Incorporation of space resources into exploration architectures could reduce costs and improve the viability of future missions beyond LEO

4

Space Resource Tech Has Near-Term, Commercial Value

Technologies developed for space resources utilization could have multi-sector, near-term applicability in terrestrial markets

THE STUDY WAS ARTICULATED AROUND 5 MAIN DELIVERABLES, 4 AT GLOBAL SCALE AND 1 STAND ALONE ON SPECIFIC OPPORTUNITIES FOR LUXEMBOURG



THE POTENTIAL VALUE CHAINS FOR SRU WERE CHARACTERIZED ON THE BASIS OF APPLICATIONS, RESOURCES AND MISSION PROFILES

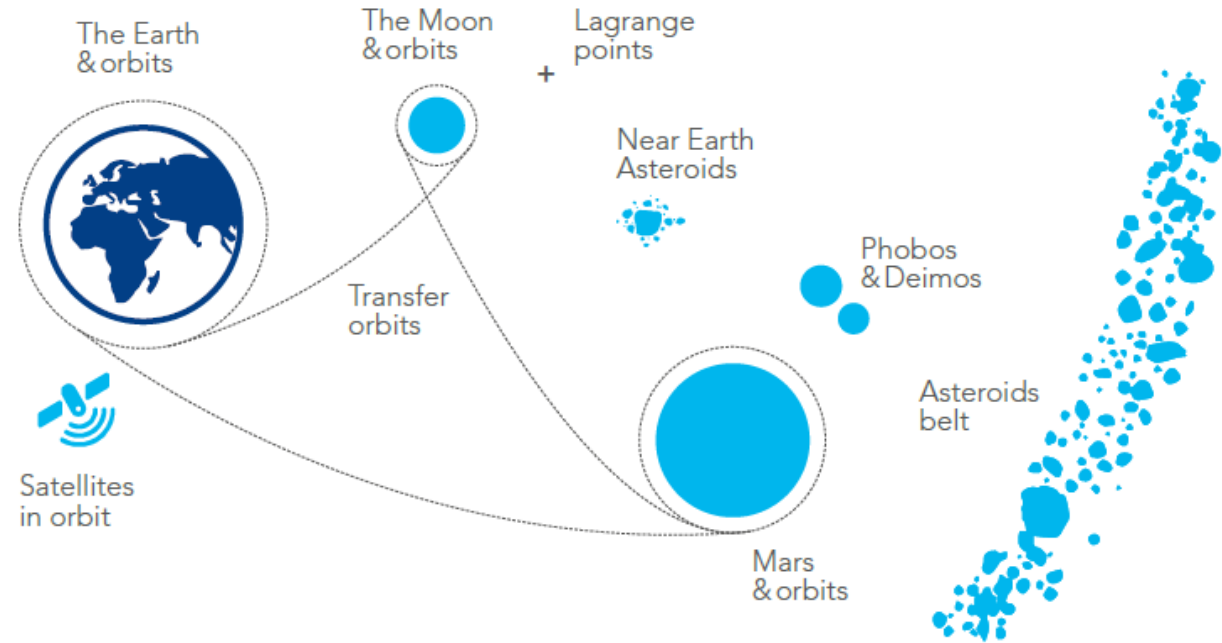
1 Applications considered

- Life support to astronauts
- Propellant for launch vehicles and other space vehicles
- Construction of in-situ infrastructure
- Radiation shielding
- Manufacturing of equipment in space
- Earth-based use of Platinum Group Metals (PGM)

2 Resources considered

- Water, and others: H, O, N, C
- Methane
- Metals (Fe, Ni, Co)
- Regolith
- Platinum Group Metals (PGMs)

3 Mission Profiles



Celestial bodies considered for the assessment of the space resources utilization value chains.

SRU value chain

Prospect

Establish

Mine

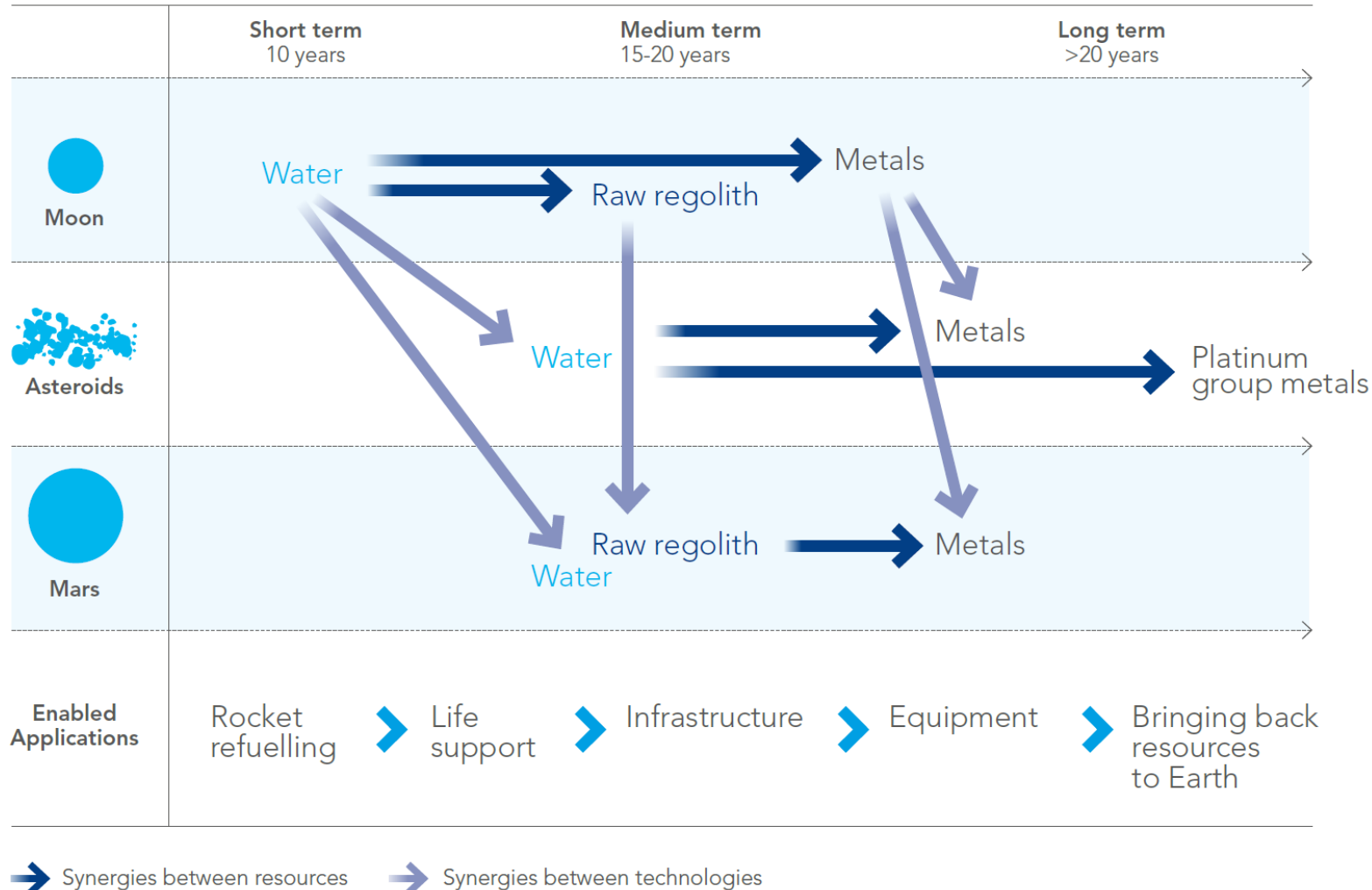
Transport

Refine

Manufacture

Supply

THE MAIN DRIVERS AND RISKS HAVE BEEN DISCUSSED WITH STAKEHOLDERS, LEADING TO CONCLUSIONS WHICH REFLECT THE HIGHEST CONSENSUS WITHIN EXPERTS



- SRU will support **exploration** missions feasibility, cost efficiency and autonomy
- Provision of **propellant** should be the first application to target
- Scientific missions led by space **agencies** would be the first customers
- Earth mining industry needs to be involved for their expertise and practical understanding of extracting and processing techniques



- The challenge in refining the “geological” **knowledge** remains a strong barrier
- Strong scepticism on the realism of bringing back **PGM**

For further information, including the study, please contact the
Luxembourg Space Agency



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