

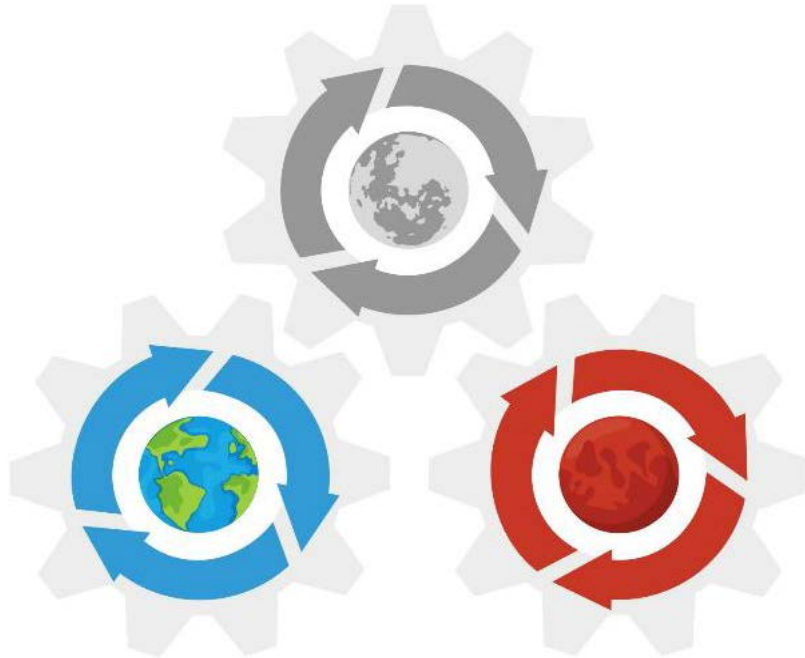
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# HARMONISE

## HARDWARE RECYCLING FOR MOON AND MARTIAN SETTLEMENT

Contribution to OHB presentation at Clean Space Industry Day

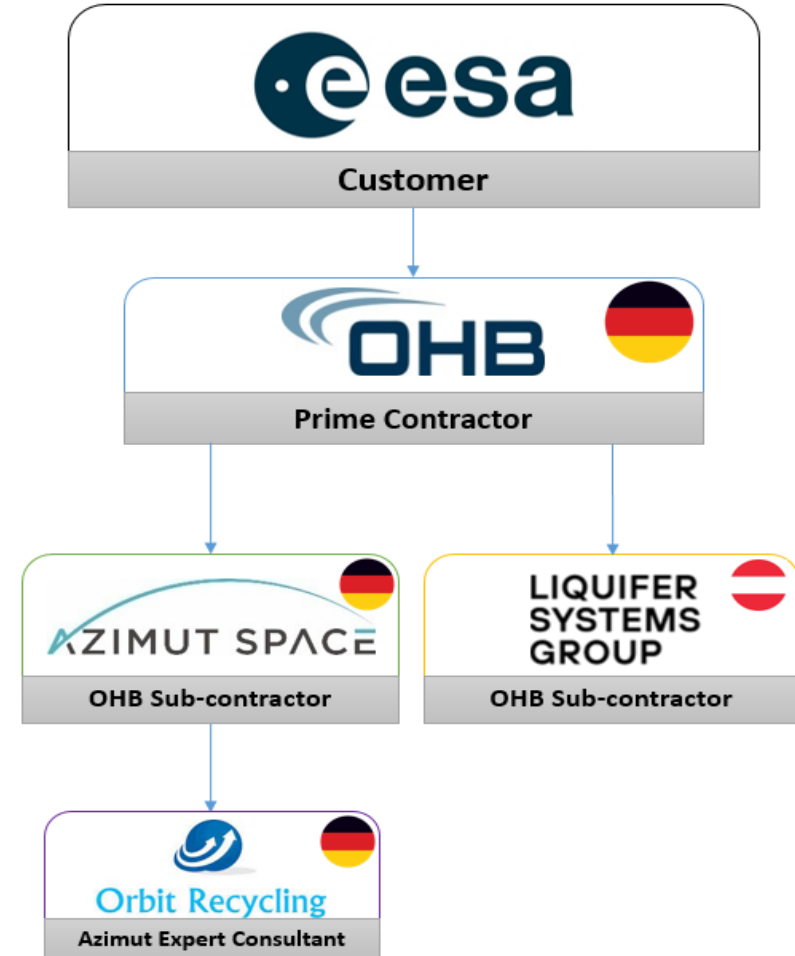
FRANCESCO CALTAVITURO, 12 SEPTEMBER 2022



Hardware Recycling for MOON and Mars Settlement

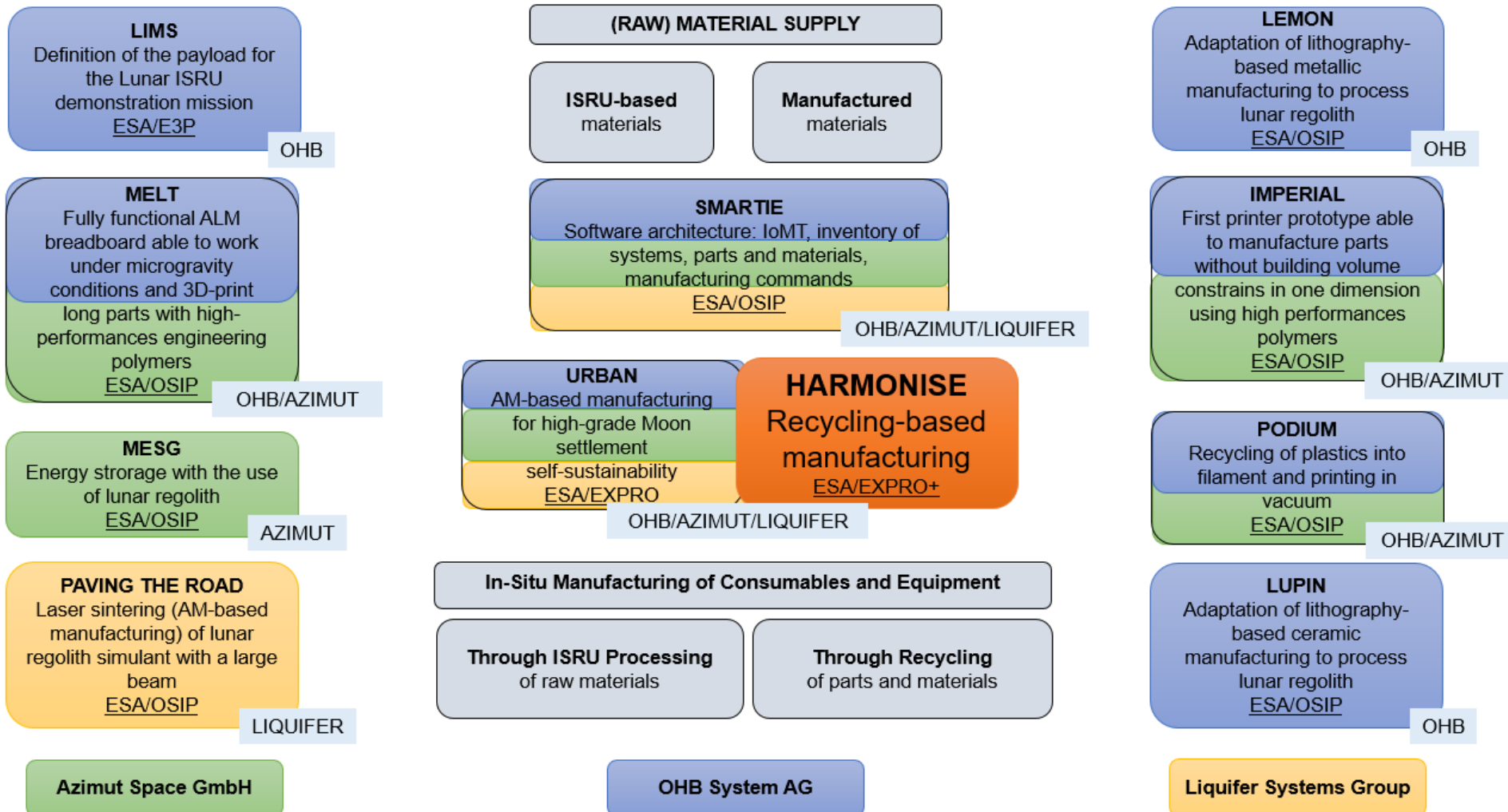


## TEAM COMPOSITION



This work will be performed under ESA contract No. 4000139104/22/NL/AR

# HARMONISE IN THE OFF-EARTH MANUFACTURING *BIG PICTURE*

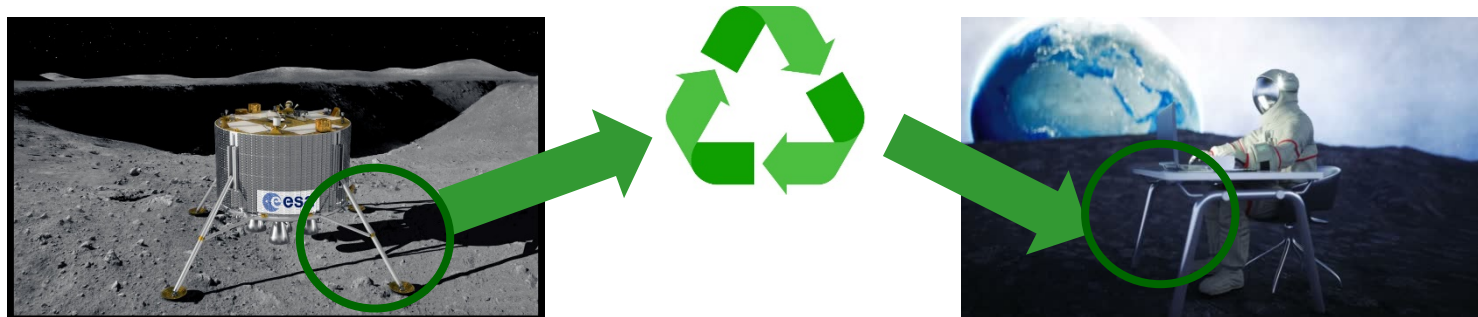


**Figure:** Overall scenario of ISRU-related topics studied and developed through ESA contracts with the participation of the HARMONISE proposal partners

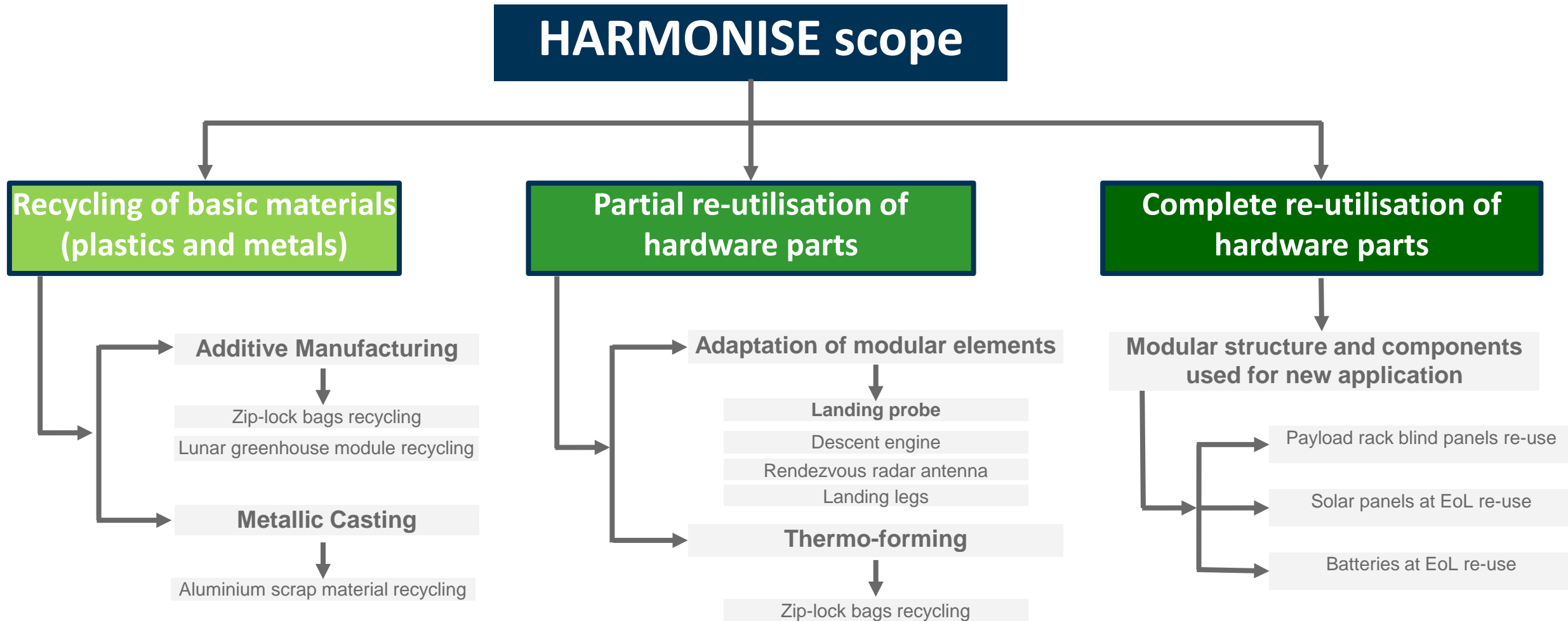
# WHY HARMONISE?

Have you ever thought about converting a useless lander landing system leg into a charming leg for a work table?

Do you know that the solar panels system of a descending module won't die after what is known to be their lifetime for the primary mission, rather, their power can still be used to provide power for small and not-essential payloads and lab experiments?



If the answer is “not at all”, it is perfectly normal, don't worry **you are in the right place at the right time, which is typically the ideal condition to create something that can make a difference.**

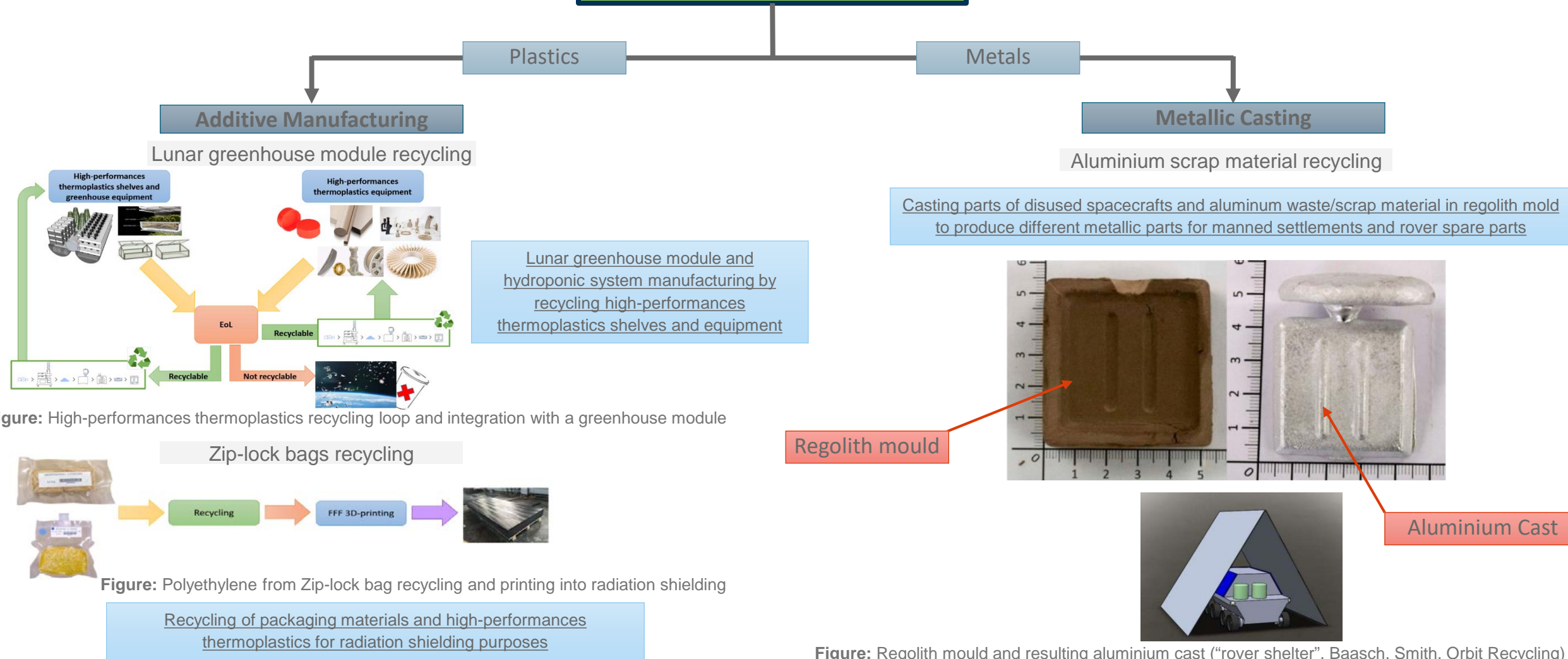




# HARMONISE SCOPE

## RECYCLING OF BASIC MATERIALS

### Recycling of basic materials



# HARMONISE SCOPE

## PARTIAL RE-UTILISATION OF HARDWARE PARTS

### Partial re-utilisation of hardware parts

#### Adaptation of modular elements

##### Landing probe

Propulsion system and landing structure modular elements re-use

If the ascent module is available

Rendezvous radar antenna

If the descent module is available

Landing legs

Descent engine

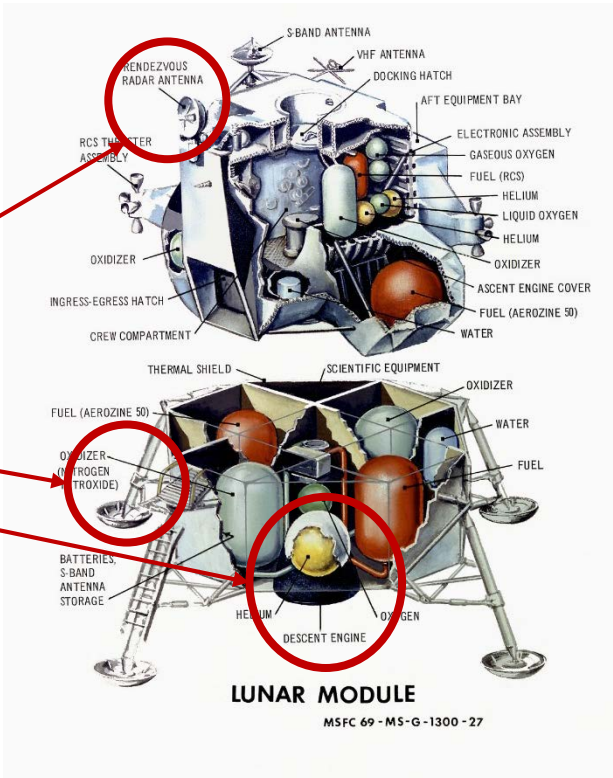


Figure: NASA Apollo Missions Lunar Module

#### Thermo-forming

Zip-lock bag thermo-forming and multilayer sandwiches made of clothes, tissue and wipes, for both thermal and radiation shielding purposes

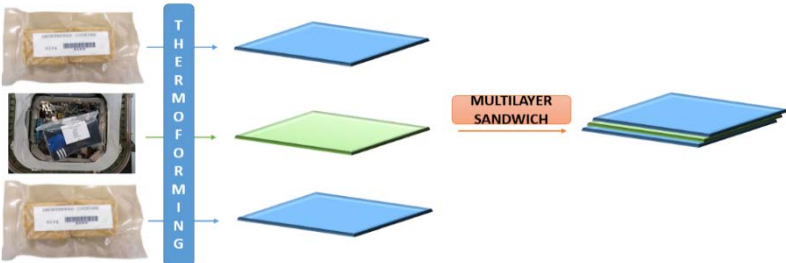


Figure: Schematic of multilayer sandwich made of polyethylene derived from food packaging alternating with waste clothes, tissue and wipes



Figure: Idea of radiation shield made of thermo-formed polyethylene derived from wasted food packaging bags and filled with wasted water

# HARMONISE SCOPE

## PARTIAL RE-UTILISATION OF HARDWARE PARTS

### Complete re-utilisation of hardware parts

Modular structure and components  
used for new application

Payload rack blind panels re-use

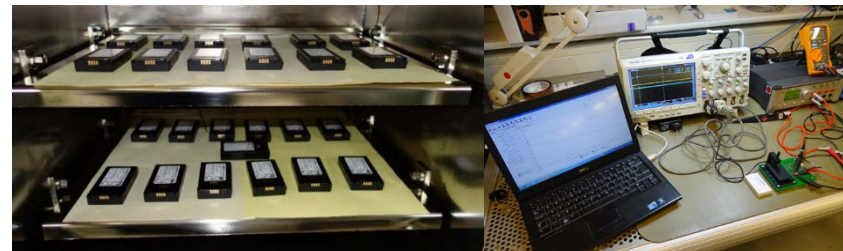
Payload rack blind panels and/or stowage containers to be completely re-used to build furniture such as chairs, shelves or cabinets



**Figure:** Standard close-out panel rear side covered with noise dampening foam (on the left), and stowage container (on the right)

Batteries at EoL re-use

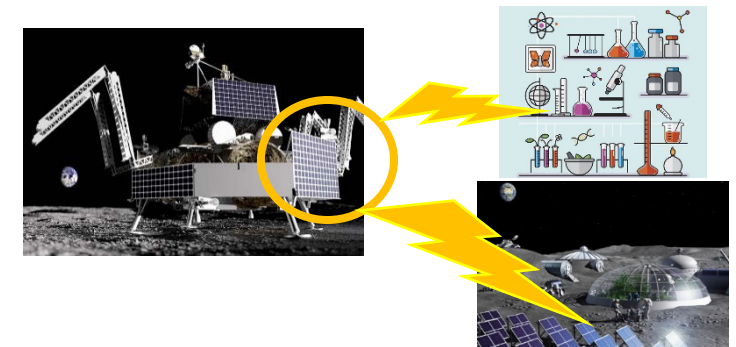
The concept for battery lifetime extensions established for ISS use can be applied for Moon/Mars utilization scenarios



**Figure:** Vacuum test for ISS qualification (left), battery lifetime extension test set-up (right)

Solar panels at EoL re-use

Solar panels of the lunar descent module at the end of their lifetime for the primary mission can be used to provide power for the payloads or lab experiments on the Moon/Mars base



**Figure:** Solar panel re-use for payload and lab experiments



# HARMONISE SCOPE

## ROADMAP TO SPACE SUSTAINABLE EXPLORATION

### OHB 3D-Printing projects and future in-Space applications

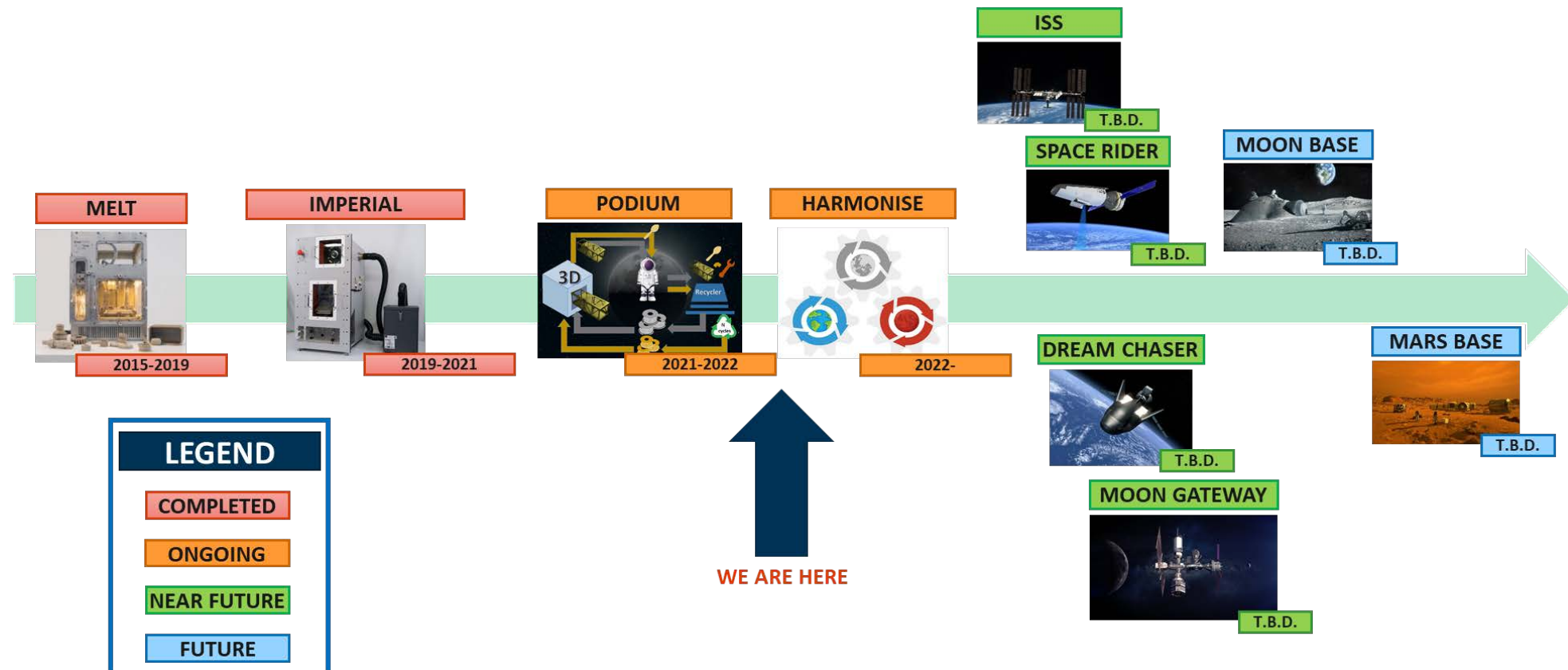


Figure: OHB 3D-Printing projects and future in-Space applications.

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# THANK YOU FOR YOUR ATTENTION

FRANCESCO CALTAVITURO, 12 SEPTEMBER 2022



LIQUIFER  
SYSTEMS  
GROUP