"ALCHEMIST" - Lunar ISRU Demonstration Payload. D. A. Urbina[1], H. K. Madakashira[1], A. Munteanu[1], G. Fau[1], M. Franceski[1], S. Corbett[1], R. Aked[1], T. Denk[2], A. Gonzalez[2] , R. McGlen[3], Yoan Boue[4], A. Abbud-Madrid[5], C. Dreyer[5], D. Binns[6], A. Borgraeffe[6], J. Carpenter[6], B. Hufenbach[6].

[1]Space Applications Services N.V./S.A, Belgium diego.urbina@spaceapplications.com (corresponding author); [2]Plataforma Solar de Almeria, Spain; [3]Aavid Thermacore, UK; [4]Ariane Group, France; [5]Colorado School of Mines, USA; [6]European Space Agency, The Netherlands,

Introduction: The world's space agencies, including ESA, have been considering various strategies, architectures and mission concepts to explore the solar system in the frame of international cooperation. There is a consensus in that the lunar vicinity is the most appropriate next step for sustainable exploration. Key principles in said exploration are affordability, exploration value, partnerships, capability evolution, human/robotic partnership and robustness. Private sector interest in Lunar exploration and resource utilization is also on the rise.

Oxygen is a resource of the utmost importance, and potentially the most immediate candidate for ISRU. It serves as fuel oxidizer (and is therefore one of the resources brought to space from Earth in the largest quantities) and as part of the air and water used by crews to breathe and use in ECLSS. Oxygen is abundant in the Lunar Regolith.

Hydrogen reduction of FeO, the process of choice for ALCHEMIST, relies on the endothermic reaction of the feedstock with hydrogen in order to produce water. One of the advantages of hydrogen reduction over other processes is that its chemistry is not complex and it has been verified extensively in industrial processes and laboratory testing.

The Lunar ISRU Demonstration Mission Definition Study aims to perform a first definition and design of a payload (down to the sub-system level) using hydrogen reduction of FeO, and to define costs, risks and development plan for the demonstrator (supporting a future hardware development), while taking into account inputs from, and iterations with, segments providing a delivery and communications service. The present study is running in parallel with a second study using instead Carbothermal Reduction.

The payload has as an objective to produce at least the minimum amount of water on the Moon before 2025, to obtain better information of feedstock properties in order to inform design of a large plant, and to constitute part of a mission enabled through commercialization and partnerships.