CONCEPT OF A LUNAR ISRU PLANT. J. Shimada[1](shimada.jun@jaxa.jp), H. Meguro[1], N. Fujioka[1], N. Ikeda[1], K. Fukaura[1], T. Iwaki[1], S. Mori[2], Y. Tanaka[2], T. Yokoyama[2] and M. Hatanaka[2], [1]Japan Aerospace Exploration Agency (JAXA), Tsukuba Space Center, Ibaraki, Japan, [2]JGC Corporation, Kanagawa, Japan.

Introduction: This paper shows the concept of a lunar ISRU plant for reusable transportation architecture in JAXA's future space exploration scenario. The feasibility study of a whole plant system is of the essence not only to identify the technical issues from a system integration standpoint but to optimize the designs and operations of lunar ISRU plant elements. This work is carried out under the cooperation agreement on the conceptual study of a lunar ISRU Plant between Japan Aerospace Exploration Agency (JAXA) and JGC Corporation, one of the world's largest total engineering companies.

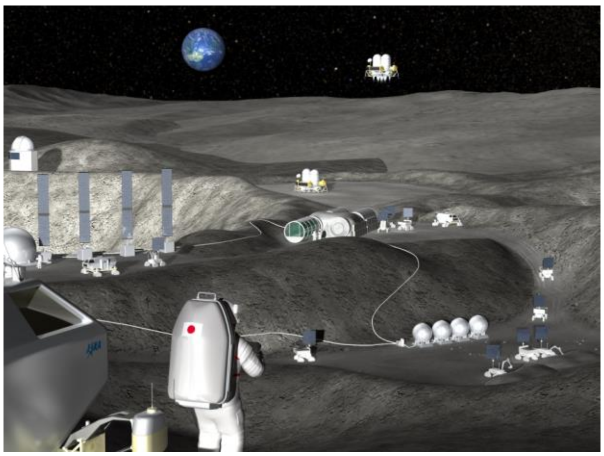

Figure 1. Moon base and a lunar ISRU plant.

Background: In accordance with Artemis program, JAXA plans to accelerate lunar exploration activities through various missions such as Smart Lander for Investigating Moon (SLIM) mission to demonstrate accurate landing technology and Lunar Polar Exploration (LUPEX) mission. Figure 2 illustrates LUPEX mission in which JAXA sends a lunar rover to explore the south pole region to obtain knowledge regarding availability of lunar water-ice resources and to demonstrate lunar surface exploration technologies such as vehicular transport and overnight survival.

For the future transportation architecture on the Moon, JAXA plans to deploy reusable landers and lunar hoppers on the Moon as shown in Figure 3. Formulating long-term broad strategies to reduce launch mass of propellant for these transportation systems is critically important to ensure sustainability of future exploration, accomplished by in-situ production of liquefied hydrogen (LH2) and liquefied oxygen (LOX) from lunar regolith with water contents.

Figure 2. Lunar Polar Exploration (LUPEX).

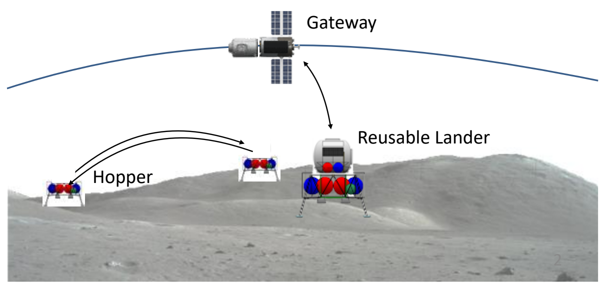

Figure 3. Reusable landers and lunar hoppers.

Baseline Requirements: Table 1 shows baseline requirements on production rates of LH2 and LOX at a lunar ISRU plant to be consumed by reusable landers and hoppers on the lunar surface.

Process Flow: Figure 4 illustrates a process flow schematic diagram to produce LH2 and LOX from lunar regolith with water contents in a lunar polar region. Lunar regolith excavated in permanent shadow (Permanently Shadowed Regions or PSRs) is transported to a lunar ISRU plant located in highly illuminated area. Water is extracted from regolith and condensated, then purified. Gaseous hydrogen and oxygen produced by electrolysis are transferred to GH2/GOX liquefaction element. Subsequently, LH2 and LOX are stored in cryogenic storage tanks to be filled into reusable landers and lunar hoppers on demand.

Table 1. Requirements on yearly production rates of LH2 and LOX at a lunar ISRU plant

Substance	LH2	LOX
Production Rate	8.3 ton/year	49.3 ton/year

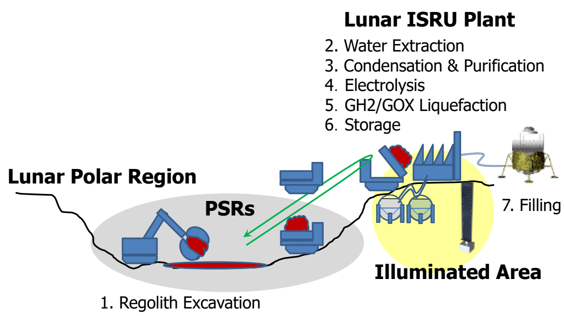

Figure 4. Process flow of production of LH2/LOX.

Discussions: Five categorized issues are discussed.

Whole plant system. Conceptual study of a lunar ISRU plant system from an optimization perspective.

Element. Technical assessments of each subsystem from regolith excavation to filling process.

Construction & Infrastructure. Technical issues during construction phase and necessitated infrastructure. In-situ manufacturing of construction materials by 3D printing technology.

Operation. Technical issues from launch operations to nominal phase including maintenance and study of reusability after mission accomplishment.

Project Management. Managemental issues to formulate long-range strategies including appropriate project management and international cooperation.

References: [1] JAXA (2022) *International Space Exploration Scenario Draft*. [2] ISECG (2022) *Global Exploration Roadmap (GER)*. [3] NASA (2020) *Cross-Program Design Specification for Natural Environments (DSNE)*.