JAXA'S STUDY OF A LUNAR ISRU PILOT PLANT. J. Shimada[1](shimada.jun@jaxa.jp), H. Meguro[1], N. Fujioka[1], T. Iwaki[1], K. Fukaura[2], S. Mori[2], Y. Tanaka[2], T. Yokoyama[2], M. Hatanaka[2], M. Nii[3], H. Ichida[3] and H. Hotta[3], [1]Japan Aerospace Exploration Agency (JAXA), Tsukuba Space Center, Ibaraki, Japan, [2]JGC Corporation, Kanagawa, Japan, [3]Chiyoya Corporation, Kanagawa, Japan.

Introduction: This paper summarizes JAXA's study of a lunar ISRU pilot plant with aims to investigate the feasibility of sub-scale production of water and oxygen from lunar regolith. The study is of the essence not only to identify the key technical issues regarding water extraction and electrolysis but to obtain knowledge to optimize the designs and operations of the ISRU pilot plant from a system integration standpoint. This work is led by Japan Aerospace Exploration Agency (JAXA) in cooperation with JGC Corporation and Chiyoda Corporation, two of the world's largest total engineering companies.

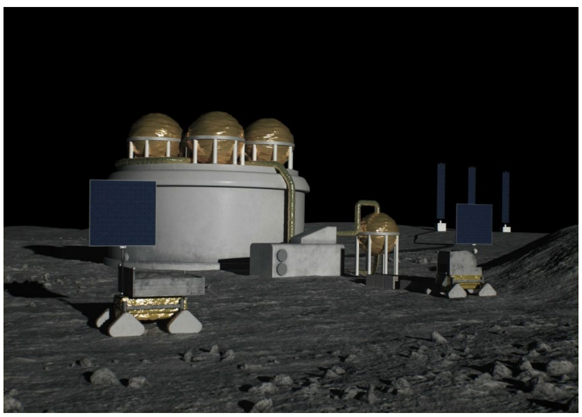

Figure 1. Lunar ISRU Plant.

Background: In accordance with Artemis program, JAXA plans to accelerate lunar exploration activities through various missions. Smart Lander for Investigating Moon (SLIM) successfully landed on the moon on January 20 in 2024 achieving 100m precision landing. In Lunar Polar Exploration (LUPEX) mission, JAXA plans to send a lunar rover to explore the south pole region to acquire the data of water ice resources and to demonstrate lunar surface exploration technologies such as vehicular transport and overnight survival.

Figure 2. SLIM to deploy a small robot.

Objective: Formulating long-term broad strategies to reduce launch mass of propellant for reusable spacecrafts is critically important to establish reusable transportation architecture on the Moon. Figure 3 illustrates on-site production of liquid hydrogen (LH2) and liquid oxygen (LOX) from lunar regolith. Lunar regolith excavated in Permanently Shadowed Region (PSR) or extracted water is transported to a ISRU plant located on illuminated crater rim. Hydrogen and oxygen produced by electrolysis are transferred to liquefaction element. LH2 and LOX are stored in cryogenic storage tanks to be filled into spacecrafts on demand. The main objective of this study is to investigate the feasibility of water and oxygen production from lunar regolith as intermediate products of LH2 and LOX.

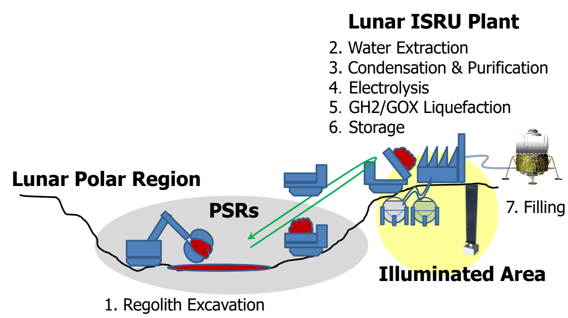

Figure 3. Full-scale production of LH2/LOX.

Baseline Requirements: Table 1 shows baseline requirements on production rates of liquid hydrogen (LH2) and liquid oxygen (LOX) at a full-scale ISRU plant to fuel reusable landers and hoppers on the lunar surface. Table 2 summarizes baseline requirements on production rates of water and oxygen at a pilot plant.

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

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

Table 2. Requirements on yearly production rates of Water and Oxygen at a ISRU pilot plant

Substance	Water	GOX
Production Rate	>340kg/year	>150kg/year

Results: Table 3 shows a result of a ISRU pilot plant, which is studied by JGC Corporation based on the requirements shown in Table 2.

Table 3. Summary of Feasibility Study on a Lunar ISRU Pilot Plant (JGC Corporation)

Configuration	(i) Rover Installation -ISRU Experimental equipment is installed on excavator. (ii) Lander Installation -ISRU Experimental equipment installed on lander.
Operation Scenario	(i) Rover Installation -Deploy excavator with experimental equipment to a targeted area. -Excavate and process regolith near excavation point. (ii) Lander Installation -Deploy excavator to a targeted area. -Return to the landing site with regolith or extracted water. -Transfer regolith or extracted water to experimental equipment on lander.
Resource Estimation (exc. regolith excavator)	Mass: < 250kg Size: < $2m^3$ Power: < 2kW (peak)

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)*.