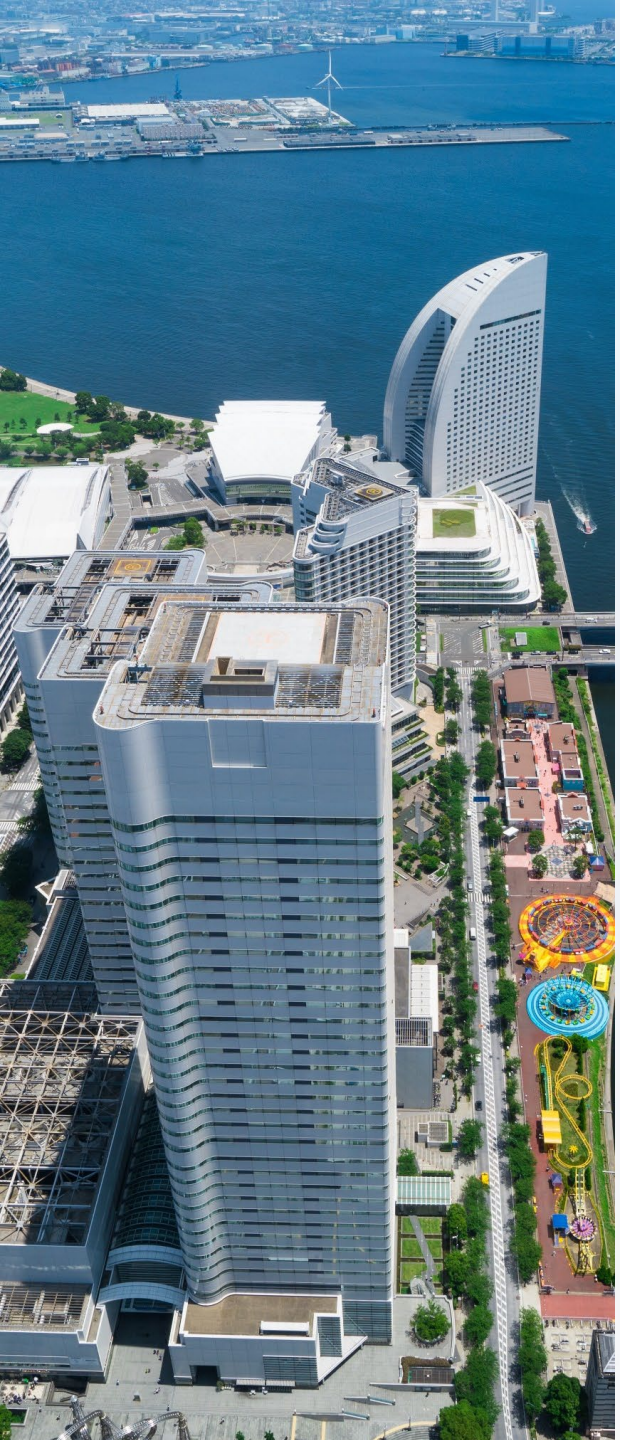


# JGC's Vision for a Lunar Society

## ~ Lumarnity® (Lunar Smart Community®) ~

Enhancing planetary health

Kiho FUKAURA

Unit Leader
Lunar Plant Unit
Digital Project Delivery Dept.
JGC CORPORATION

18-May-2024
44th Virtual UNISEC-Global Meeting



↑At the summit or Mt. Kilimanjaro Elevation 5895 m)


↑Completed Sahara Desert Marathon (252km, 7 days)

# FUKAURA Kiho

- **The 2nd UNISEC-Global Meeting (2014)**
  - ✓ Participated in the student management
- **Project Manager on Student Rocket Project**
  - ✓ Student organizer of Noshiro Space Event
- **Combustion Laboratory**
  - ✓ Study of Non-Contact Temperature measurement Method
- **Participation in Exchange Program**
  - ✓ Department of Aerospace Engineering, College of Engineering, Purdue University
- **Likes/Pastime**
  - ✓ Running, Mountain Climbing, Diving, sake, travel ..etc

# After Starting the Career at JGC Corp.

【 Apr. 2015 – Nov 2020 】

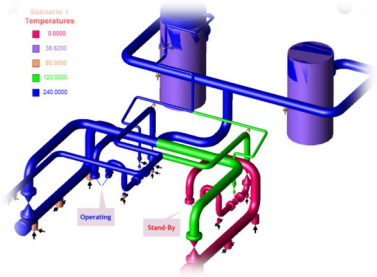
□ Affiliation：Piping Design Department (Plant Engineer)

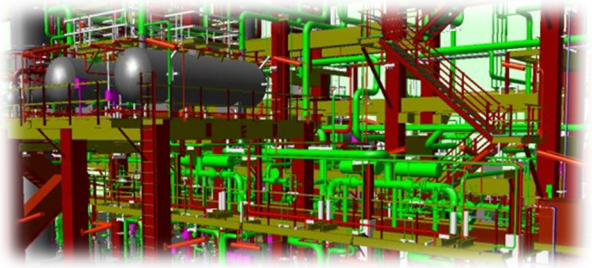
Design Work

- ✓ Gas Treatment Plant (Bahrain, 2 years)
- ✓ Gas Pressure Boosting Plant (Algeria, 1.5 years)
- ✓ LNG Plant (Canada, 2 years)

On-Site Work

- ✓ LNG Plant (Thailand, Module yard, 6 month)
- ✓ Oil Refinery Plant (Okayama Pref., SDM work, 3 month)





【 Dec. 2020～ 】

□ Affiliation: DPD Department, Lunar Plant Unit (Unit Leader)

New Business Development

- ✓ Cooperation Agreement/Project with JAXA related to Lunar ISRU Plant
- ✓ Selected in Government Project on “Space Utilization Acceleration Program”
- ✓ Other space-related projects

Seconded to JAXA, Human Spaceflight Technology Center (Jun. 2021 - May 2023)

- ✓ Operation of the International Space Station "Kibo“
- ✓ Development of pumps for Gateway
- ✓ Lunar ISRU Plant (hydrogen and oxygen production plant)



# About Us

## JGC Holdings Corporation

**Establishment** 1928

**Number of Employees** 7,275 [consolidated]
(As of March 31, 2022)

**capital stock** 23,672.78 million yen
(As of March 31, 2022)

**Number of shares outstanding** 259,336,682 shares
(As of March 31, 2022)

**Business (Segment)**

### Comprehensive Engineering Business

EPC (engineering, procurement, and construction) and maintenance services for various plants and facilities

### Functional Materials Manufacturing Business

Manufacture and sale of various catalysts, fine chemical products, and fine ceramics products

# History

**1928** — **Establishment of JGC Holdings Corporation (formerly Japan Gasoline Corporation)**

The original purpose of the company was to operate an oil refinery

**1930s ~ 50s** — **Started full-scale engineering business and catalyst manufacturing business**

Built numerous petroleum refining and petrochemical plants in Japan in the 1950s

**1960s ~ 70s** — **Expand into overseas markets, particularly in South America, Africa, and Southeast Asia**

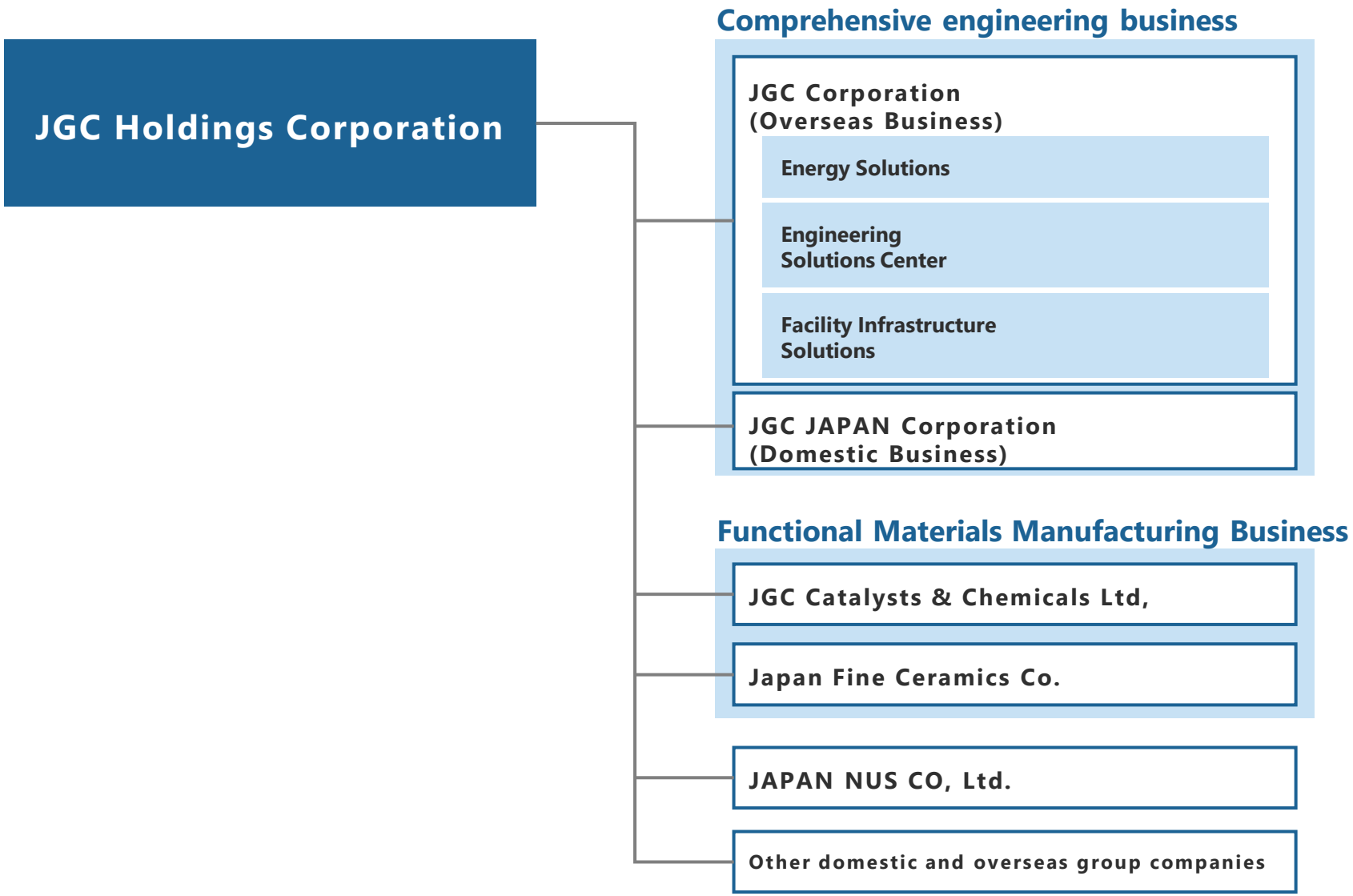
**1980s ~ 90s** — **Establishment of world-class engineering company status**

Promoting the globalization of project execution in cooperation

**2000s** — **Expanding business performance against a backdrop of global resource development progress**

**2010s** — In October 2019, the company will transition to a holding company structure, **Company name changed to JGC Holdings Corporation**

# Organization Chart



# Business Field

## Comprehensive Engineering Business


Energy Transition


Health Care & Life Sciences


Industrial and Urban Infrastructure


Resource Recycling

## Functional Materials Manufacturing Business


Catalyst


Fine Chemical


Fine Ceramics

## Energy & Environment consulting

# Business Field

## Comprehensive Engineering Business

### Energy Transition

- LNG (Liquefied Natural Gas)
- CCS
- Offshore
- LNG/LPG receiving terminal
- Renewable energy generation
- Hydrogen & Fuel Ammonia
- Nuclear Power Generation
- Thermal power generation
- Petrochemical, gas chemical, chemical
- Oil refining
..etc

### Health Care & Life Sciences

- health care
- life science

### Industrial and Urban Infrastructure

- Nonferrous Refining
- Railroad
- Airport
- Smart factory
- Water treatment
- Complex Urban Infrastructure
- Agriculture

### Resource Recycling

- Waste Plastic Gasification Chemical Recycling
- Waste Plastic Oil Chemical Recycling
- Polyester chemical recycling
- Sustainable Aviation Fuel (SAF)

## Functional Materials Manufacturing Business


Catalyst


fine chemical


Fine Ceramics

## Energy & Environment consulting

# Previous Space Related JOBs（1980～2000）

- **Space Environment Utilization**
  - Agency : Russia space station　MIR
  - Agency : Novespace（Micro Gravity test）
  - Mission management for ISS
- **Activity for Human in Space**
  - Safety analysis for JEM
  - EPC for waste treatment in CEEF
  - Study of lunar base
  - Development of robot arm
- **Lunar exploration**
  - Study for utilization of lunar source

Got more than 100 JOBs.


日本産エスカルゴ 宇宙へ

ロシア「ミール」で来月実験

将来は 惑星旅行の食糧に

日揮・高冷地農業研が共同事業

宇宙に送られる日本産エスカルゴ。

4（火）朝日新聞

過酷な環境下においてすぐれた性能を発揮する

「ペリカン」ロボットアーム

「ペリカン」ロボットアームは宇宙空間における船外作業のために、日揮がロシアのRSCエネルギア社と共同で開発に取り組んでいる多関節タイプの遠隔作業用ロボットアームです。本装置は、マスタースレーブタイプの遠隔操作ロボットであり、RSCエネルギア社が長年にわたり宇宙分野で蓄積してきた技術とノウハウがつぎ込まれています。

宇宙空間はもとより、原子力施設での複雑な遠隔作業、一般産業における超真空下、隔壁メカニカルセル、グローブボックスなどでの遠隔作業にもすぐれた性能を発揮する、汎用性の高いロボットです。

また、近い将来、実際にロシアの宇宙ステーション“ミール”に搭載することが計画されています。

装置外観

ROBOT ARM

# Group Company sells materials for satellite and rocket

JAPAN FINE CERAMICS CO., LTD.

## Space

### Artificial Satellite／Rocket


Thin Film Integrated Circuits ›


Si/SiC (Infiltration Method) —SS501/SS701/SS702— ›


Silicon Carbide (SiC) [SCP,HEXOLOY] ›

### Satellite Mounting Mirror


Silicon Carbide (SiC) [SCP,HEXOLOY] ›

### High Temperature Material Testing Equipment


Silicon Carbide (SiC) [SCP,HEXOLOY] ›

## Si/SiC (Infiltration Method) —SS501/SS701/SS702—

Composite materials in which a porous body of SiC is infiltrated with metallic silicon.Manufactured by the pressureless infiltration method. It has an overwhelming low thermal expansion and high thermal conductivity, and it is a material ideal for heat sink parts.

### Features

- Lightweight : Equivalent to aluminum !
- High rigidity : The Young's Modulus is 1.6times of SUS !
- Low thermal expansion : Equivalent to silicon !
- High thermal conductivity : Higher than SiC !

### Applications

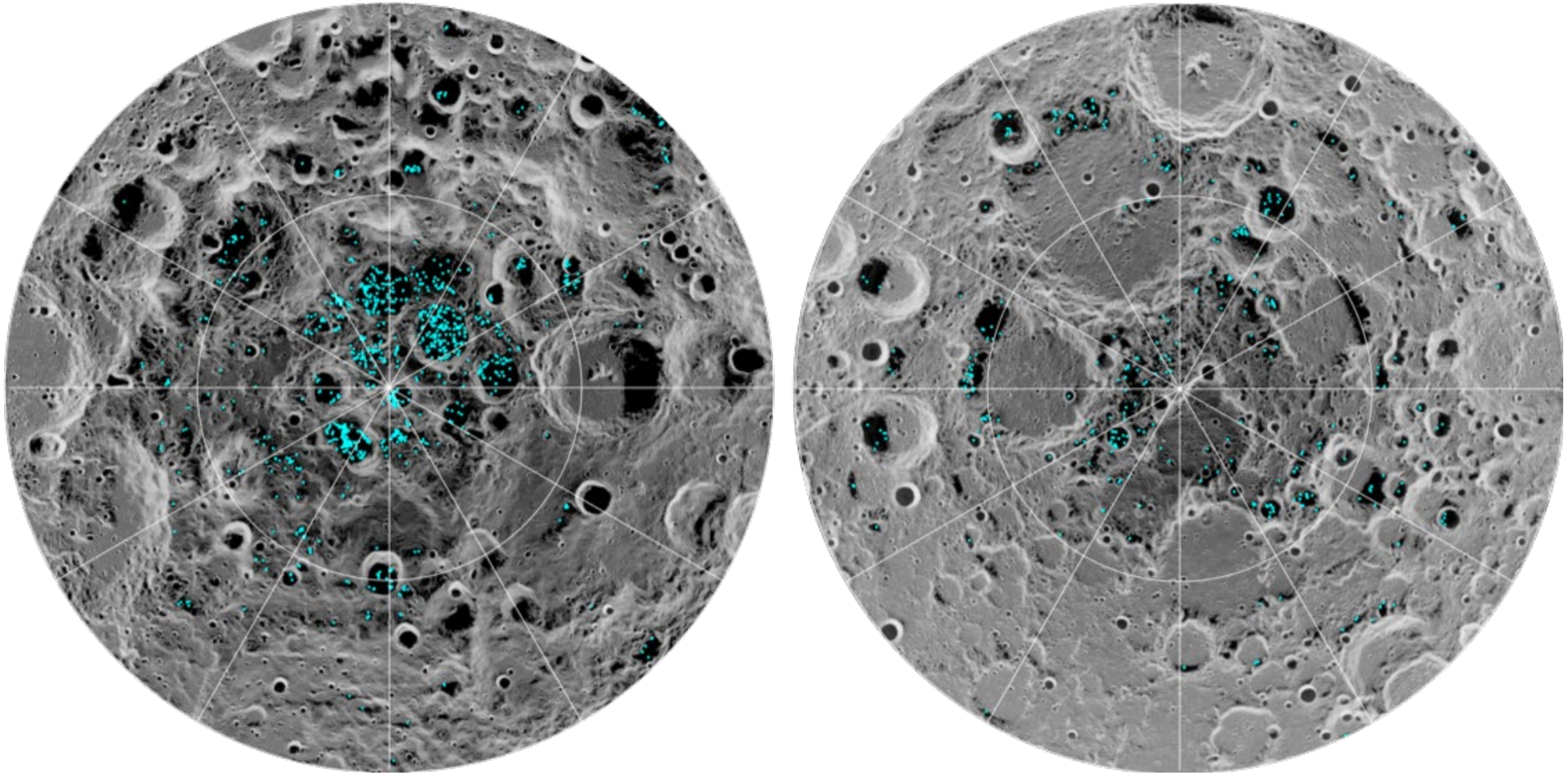
- Heat sinks
- Structual material for LCD manufacturing equipments
- Transport hand parts (LCD,Semiconductor)

▶ SS501/SS701/SS702 Details
▶ Physical Properties of MMC

# Our Next Challenge ~to the Moon~

# The Key is Existence of Water Resource

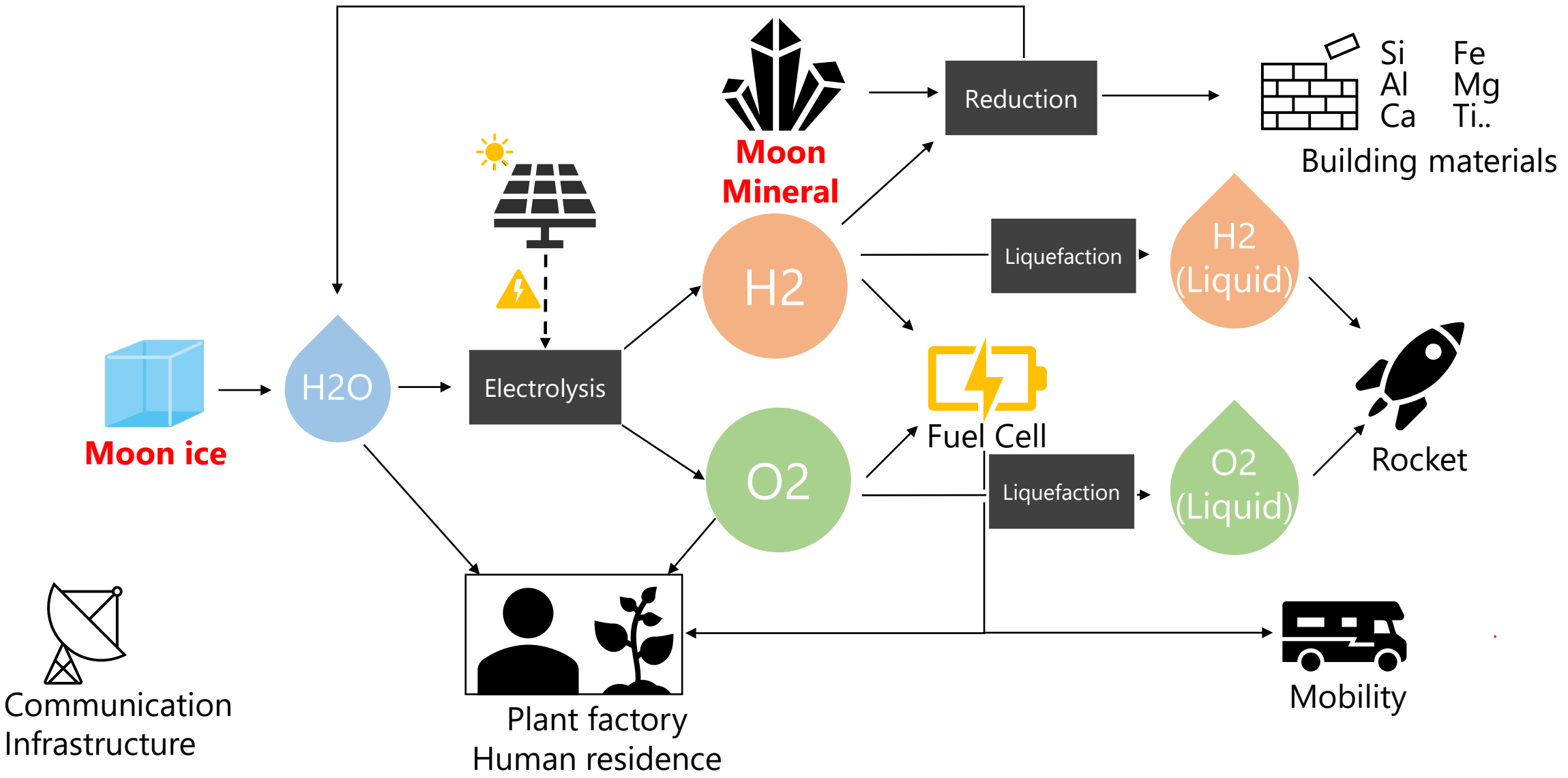
- Potential Area that exist water resources



NASA： https://www.nasa.gov/feature/ames/ice-confirmed-at-the-moon-s-poles

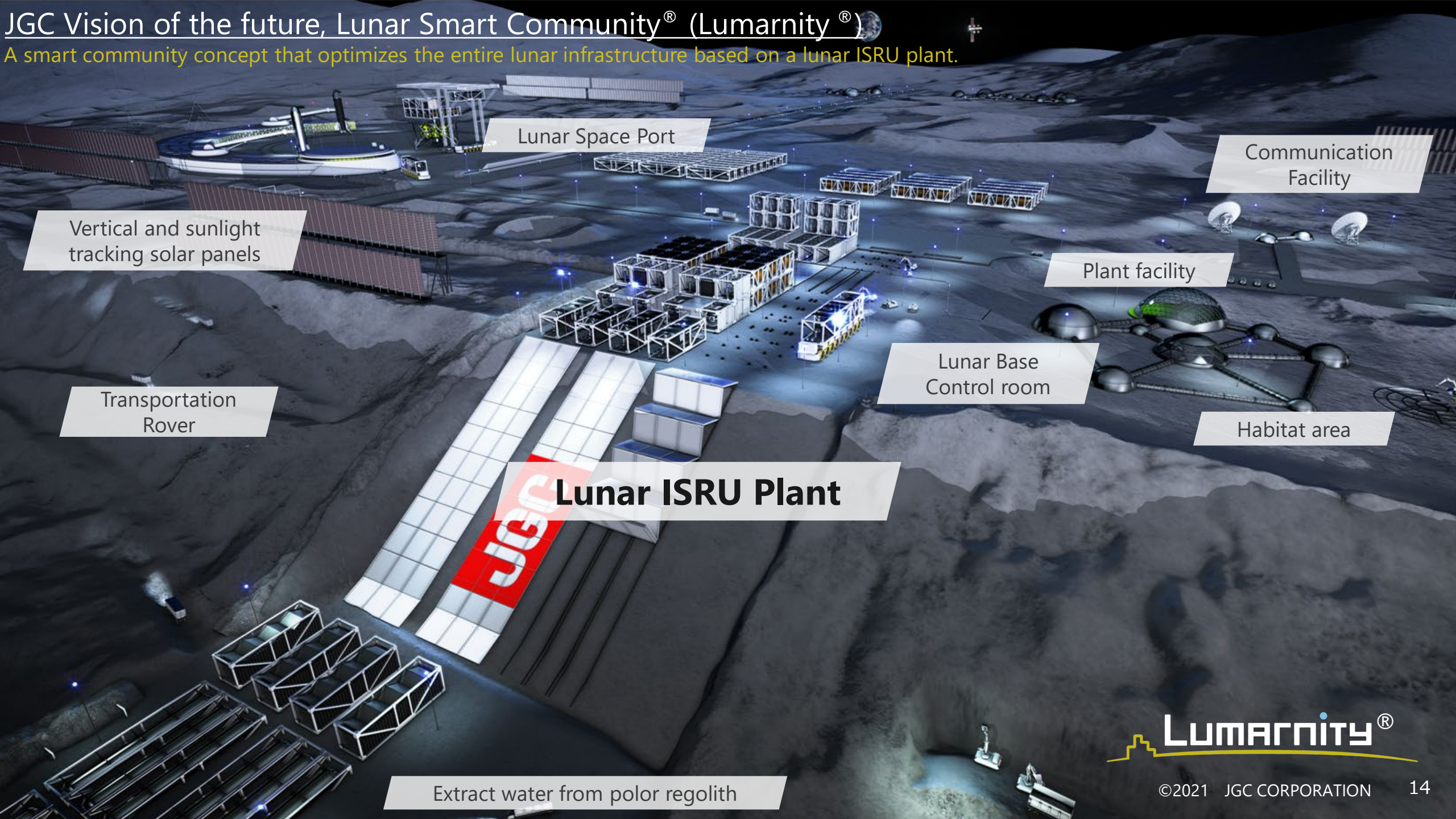
Source： 国際宇宙探査シンポジウム2019

# Water Resource Utilization for Lunar Infrastructure Development



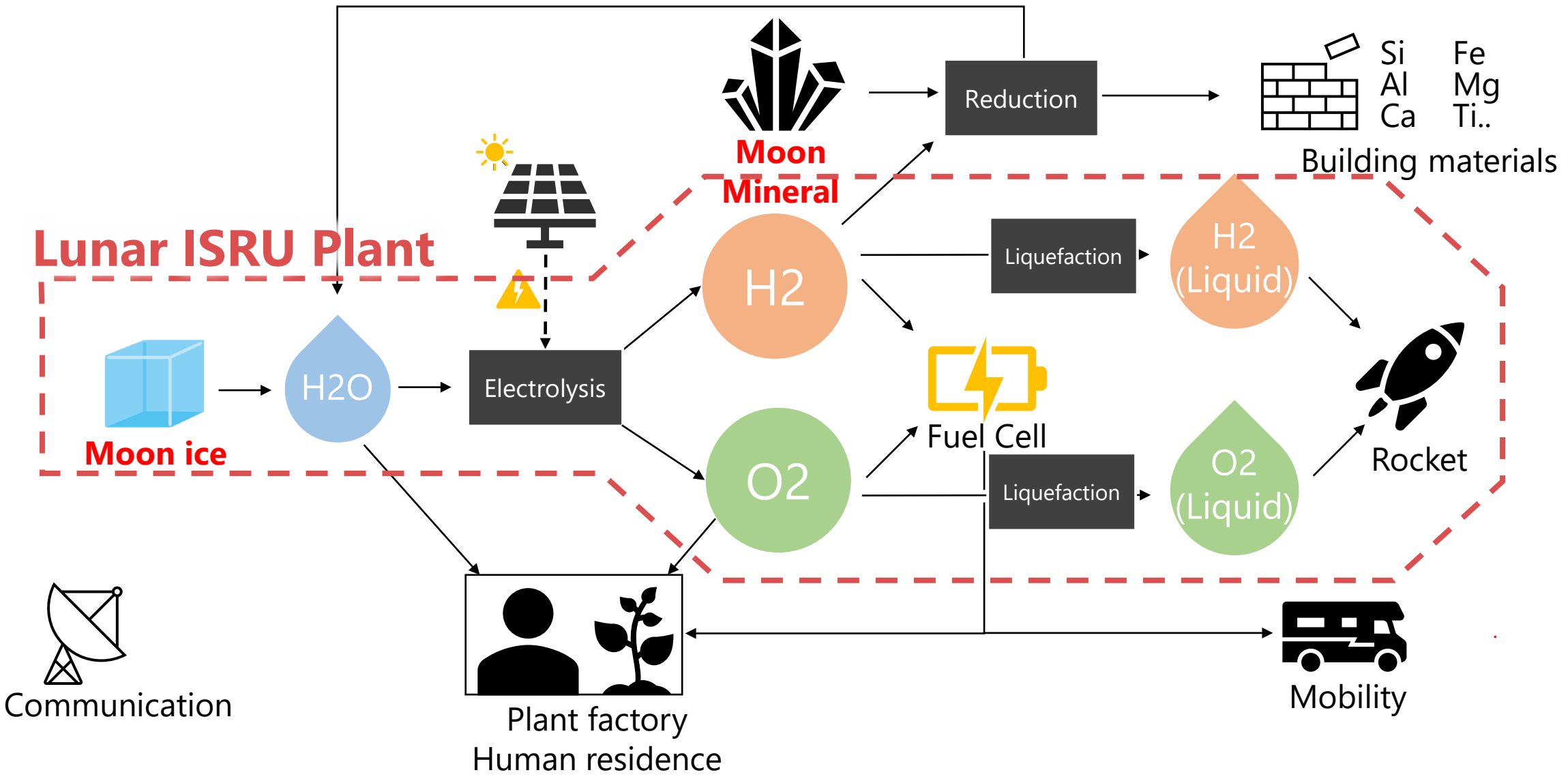
# JGC Vision of the future, Lunar Smart Community® (Lumarnity ®)

A smart community concept that optimizes the entire lunar infrastructure based on a lunar ISRU plant.




Lumarnity®

# Water is essential for lunar infrastructure development.



# Cooperation Agreement with JAXA (2021,2022)

## Cooperation Agreement on the Conceptual Study of a Lunar ISRU Plant

- Conceptual study of a lunar ISRU plant using lunar water resources
- Identify the technological elements and research issues necessary for its realization and study the R&D plan.


(Left: Junichi Sakai, Director of the Human Spaceflight Technology Center from JAXA,
Right: Fumio Sakamoto, Executive Officer and Vice President of the Engineering Solutions Center from JGC)

Source: JGC News Release "Online Ceremony Held to Conclude a Cooperation Agreement on the Conceptual Study of a Lunar ISRU Plant"

# Selected for the JAXA Project (2023/12/06)



## JGC Selected for the JAXA Project "Conceptual Study of a Pilot Plant toward the Realization of a Lunar ISRU Plant"

## JAXA事業「月面推薬生成プラントの実現に向けたパイロットプラントの概念検討」に採択

**Yokohama, Japan-** JGC Holdings Corporation has announced that its overseas EPC operating company JGC Corporation (JGC) was selected by the Japan Aerospace Exploration Agency (JAXA) for its proposal-based competitive-bidding project "Conceptual Study of a Pilot Plant toward the Realization of a Lunar ISRU Plant[*1]" ("the Study") on December 6, 2023.

Amid the currently accelerating global trend of lunar exploration, as exemplified by the Artemis program led by NASA in the United States, JAXA has released "Future Space Exploration Scenario 2021"[*2]. Aiming to realize the utilization of lunar water resources, the scenario lays out JAXA's plans to study the concept of the entire system of a lunar ISRU plant along with element technologies and conduct ground demonstration, etc. in the 2020s, to start preliminary surveys of the plant construction site (subsurface exploration and measurement) as well as construction of a lunar demonstration plant in the 2030s, and to launch full-scale operation of an ISRU plant by 2040. As part of these plans, JAXA publicly solicited bids for the Study in October of this year.

JGC is mainly considering the following two aspects of the Study and plans to submit a proposal to JAXA by March 31, 2024.

1) Demonstration planning
   - Study of the entire system of a lunar ISRU plant, as well as demonstration planning for its realization
2) Study of a pilot plant concept
   - Study of a lunar demonstration plant toward the realization of lunar water-resource utilization
   - Study of a ground verification system toward the realization of the lunar demonstration

For more than ninety years since its founding, the JGC Group has been involved in the EPC of plants and facilities in a wide range of fields, from energy-related fields to social and industrial infrastructure. It has completed more than 20,000 projects in a variety of environments, including deserts, jungles, the far north, and offshore. From the 1980s to the early 2000s, it was also involved in space-related businesses, such as the provision of microgravity environment utilization services as well as safety and quality assurance analysis using the International Space Station.

Source: JGC News Release "JGC Selected for the JAXA Project "Conceptual Study of a Pilot Plant toward the Realization of a Lunar ISRU Plant""

# Selected for the JAXA Project (2023/12/06)

JGC HOLDINGS CORPORATION

About Us | Our Business | Projects | Sustainability | News Releases | Investor Relations | Careers | Contact Us

## JGC Selected for the JAXA Project "Conceptual Study of a Pilot Plant toward the Realization of a Lunar ISRU Plant"

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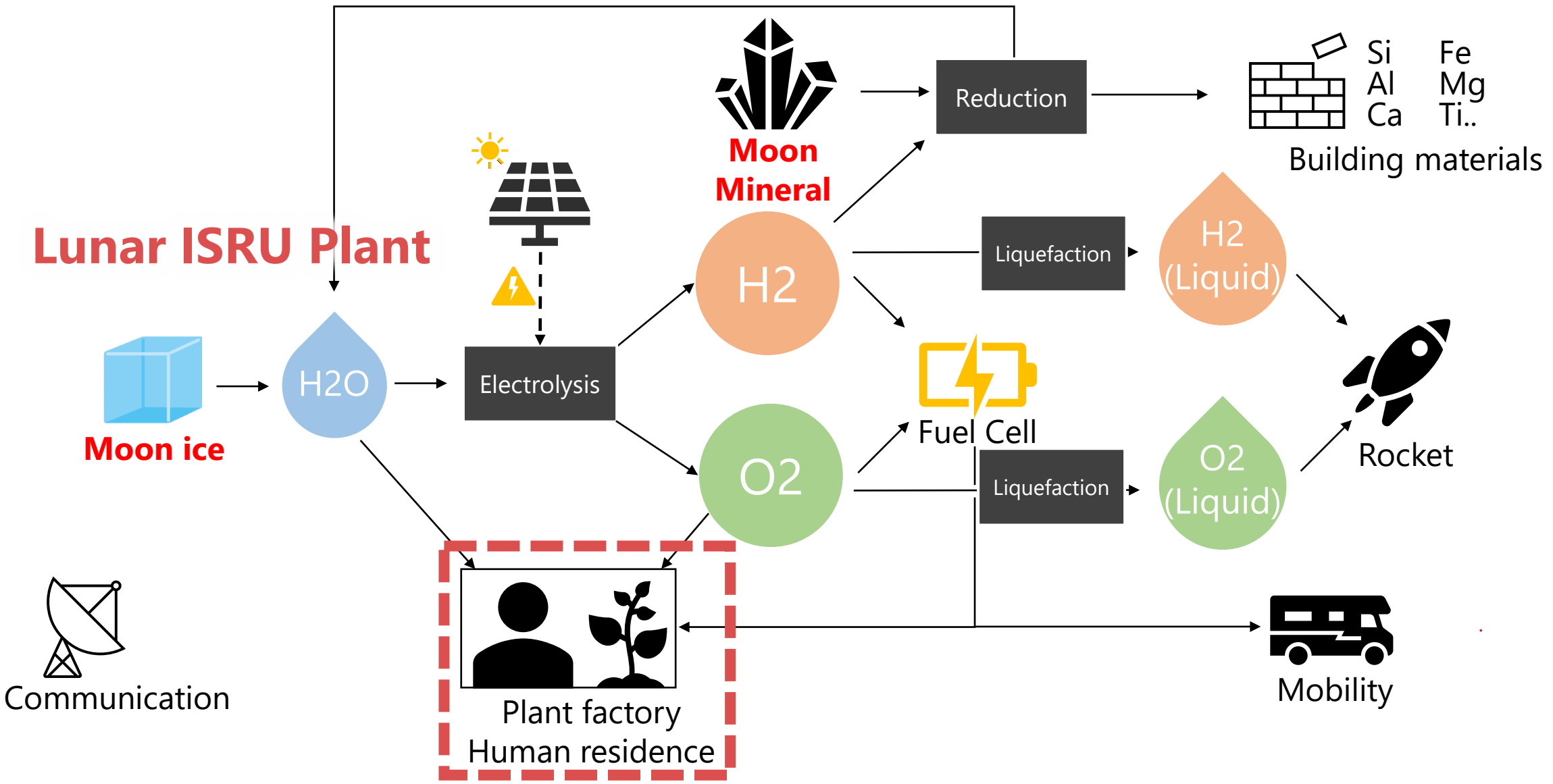
# Water is essential for lunar infrastructure development.



# Participation in the Stardust Program (MAFF Project, 2021~Current)

SPACE FOODSPHERE selected as a government-sponsored R&D project in the area of space food consortium.

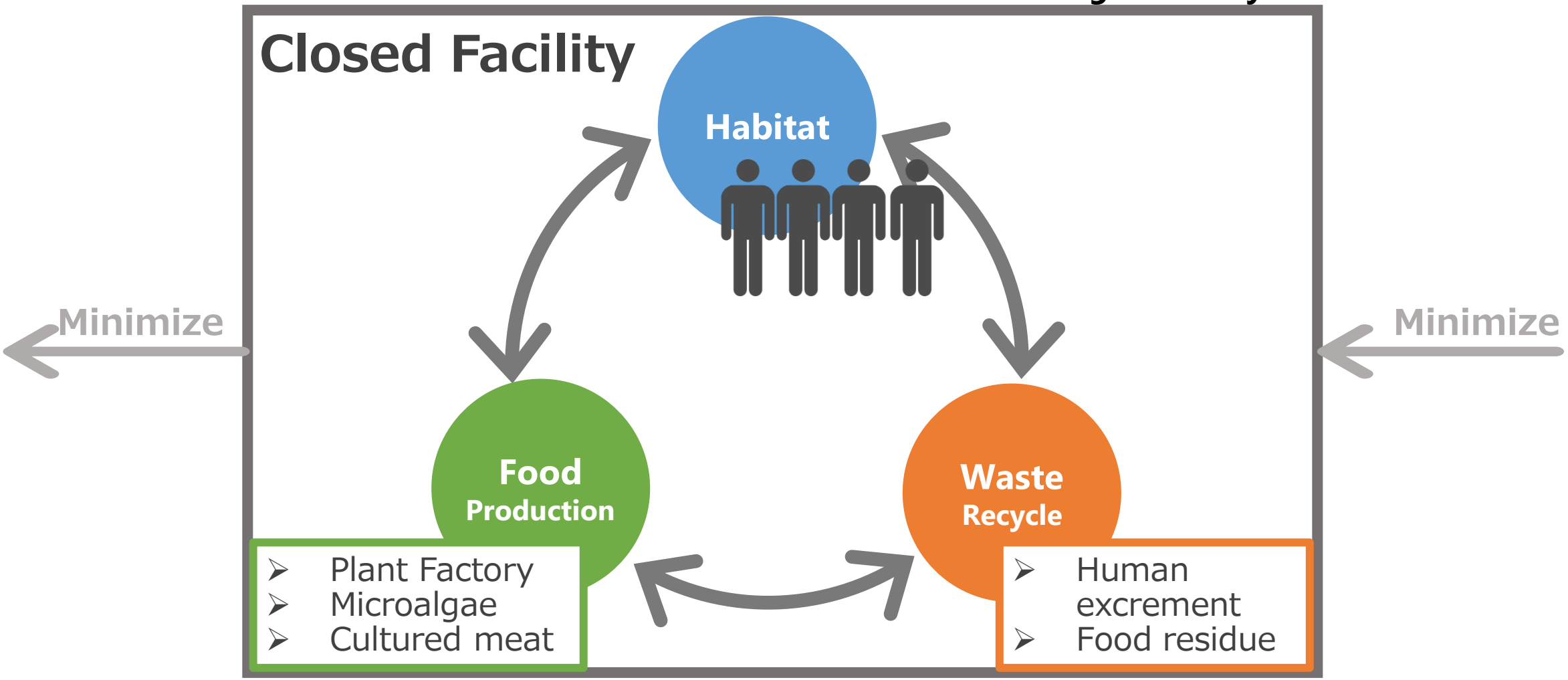

**JGC participate as System Integrator**

SPACE FOODSPHERE (Sumida-ku, Tokyo; Representative Director: Mizuki Komasa ) announces that a consortium led by SFS has been selected by the Ministry of Agriculture, Forestry and Fisheries as a contractor for the government-led strategic project to develop an advanced resource recycling food supply system to support long-term stays on the Moon and other bodies. The consortium has been selected by the Ministry of Agriculture, Forestry and Fisheries (MAFF) as a contractor for the government-led project.

Source: SPACE FOODSPHERE news release, "Consortium with SPACE FOODSPHERE as representative organization selected for government-led R&D project in space food domain.
JGC News Release "Consortium Participating in JGC Global Selected for Government-sponsored R&D Project in the Space Food Domain

# Participating in MAFF Project

**The Moon is Extremely Isolated.**
**Supplies from Earth are limited in both of frequency and quantity.**
**Sustainable habitation infrastructure is essential for long-term stay.**



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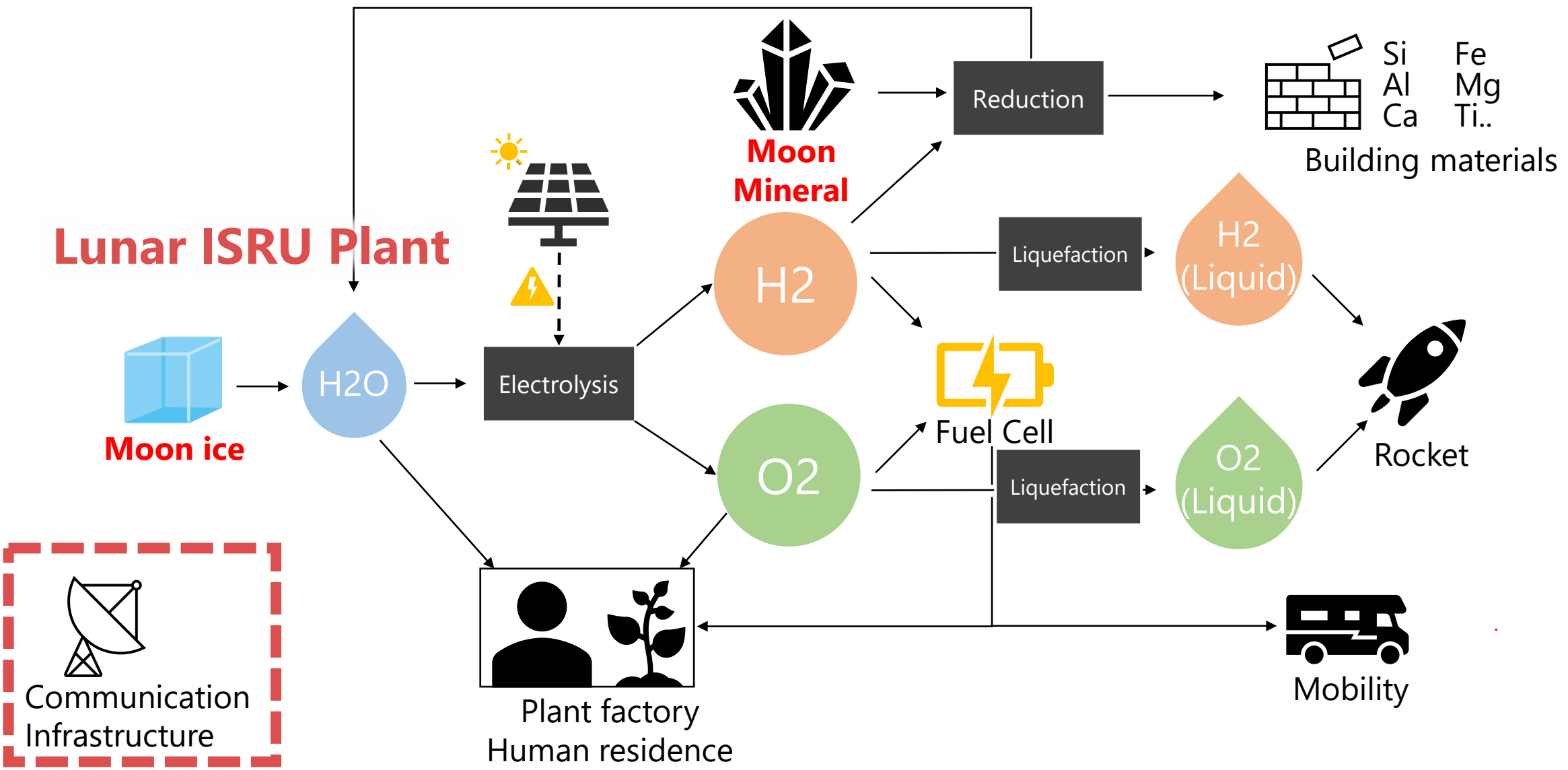

# Team up with Yokogawa Electric Corporation (2023/12/04)

Yokohama and Tokyo, Japan – December 4, 2023

JGC Corporation
Yokogawa Electric Corporation

**JGC and Yokogawa Team up to Develop Lunar Plant Control System That Will Support Ultra-remote Communications**

JGC Corporation and Yokogawa Electric Corporation (TOKYO: 6841) announce the signing of an agreement on November 15 to jointly develop a control system that will support the ultra-remote communications required for the operation of plants on the lunar surface.

Initiatives aimed at exploring and developing the moon are already underway in many countries. For example, the Artemis project, a US-led manned lunar exploration program, is proceeding in partnership with 32 countries, including Japan (as of December 4, 2023). In addition, the Japan Aerospace Exploration Agency (JAXA) is considering a concept for a plant that will utilize water resources on the moon to produce hydrogen and oxygen for use by spacecraft and manned facilities. Considering the possibility that such a plant might be built on the lunar surface, JGC and Yokogawa have decided to leverage their technology and experience in terrestrial plant operation, remote monitoring, and control to research and develop the core underlying technology for a control system that will support communications at extreme distances.

Source: JGC News Release "JGC and Yokogawa Team up to Develop Lunar Plant Control System That Will Support Ultra-remote Communications"

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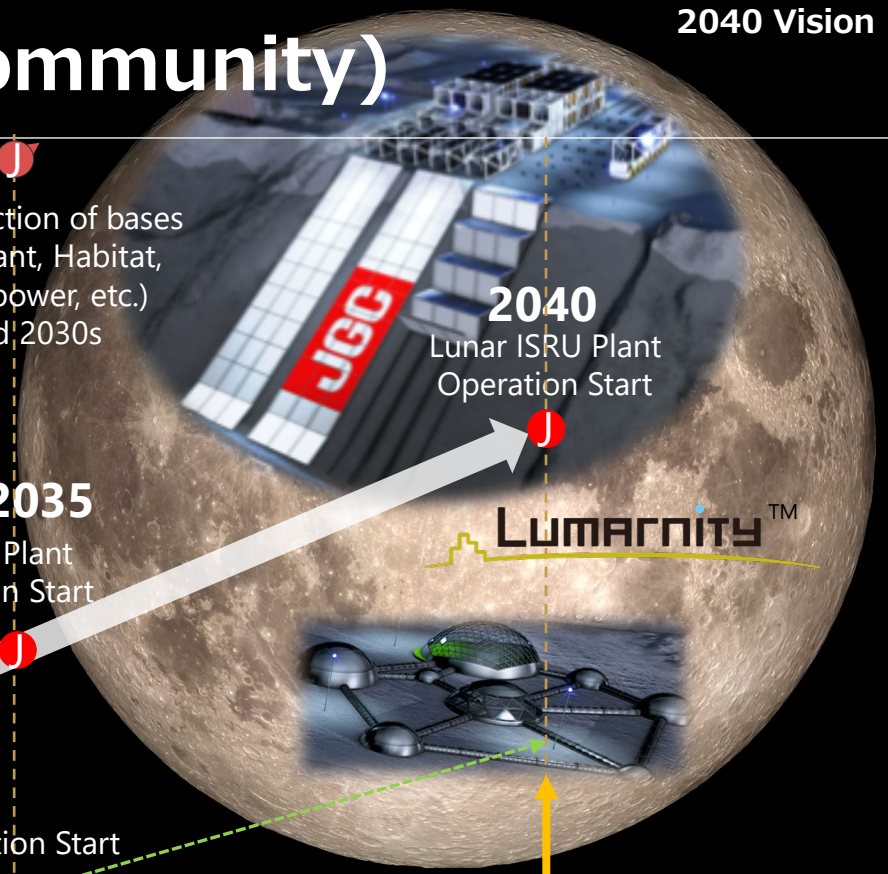
The construction of such a system, which will be located at a ground station and integrate the communications, process control, and operation monitoring for a plant on the lunar surface, will need to take into account constraints such as the communication delay between the earth and the moon. This joint development will make use of JGC's know-how of energy plant control/operations and knowledge gained through the conduct of lunar plant studies, and Yokogawa's remote monitoring and control technology. The two companies plan to quickly move ahead with the design and construction of experimental equipment that can simulate these delays, then complete by the end of 2024 a study that will identify an optimal solution for a control system that will be capable of handling ultra-remote communications.

- JGC and Yokogawa have decided to develop the core underlying technology for a control system that will support communications at extreme distances
- Design and construct the experimental equipment that can simulate communication delay between the earth and moon
- Aiming to utilize the outcome on the earth as well

Source: JGC News Release "JGC and Yokogawa Team up to Develop Lunar Plant Control System That Will Support Ultra-remote Communications"

# Roadmap for Lumarnity® (Lunar Smart Community)

2040 Vision




2040
Lunar ISRU Plant
Operation Start

Lumarnity™

2035
Lunar ISRU Plant
Construction Start

Construction of bases
(ISRU plant, Habitat,
electric power, etc.)
from mid 2030s

Pressurized
Rover #2

Pressurized
Rover #1

Mars Ice Mapper
(MIM)

Artemis III
(2025~)

2033
Completion of Detail
Engineering

2028
EPC Start

2027
Proposal

Artemis II

LUPEX
MMX

SLIM

Artemis I

2023
FS/FEED

2021
Conceptual Design

Lunar Simulation
Base Design

Lunar Base Model
Development Start
(2025~)

Lunar Base Operation Start
(2035~)

On Earth

Complex infrastructure（Development（Smart Community））

2020 2025 2030 2035 2040

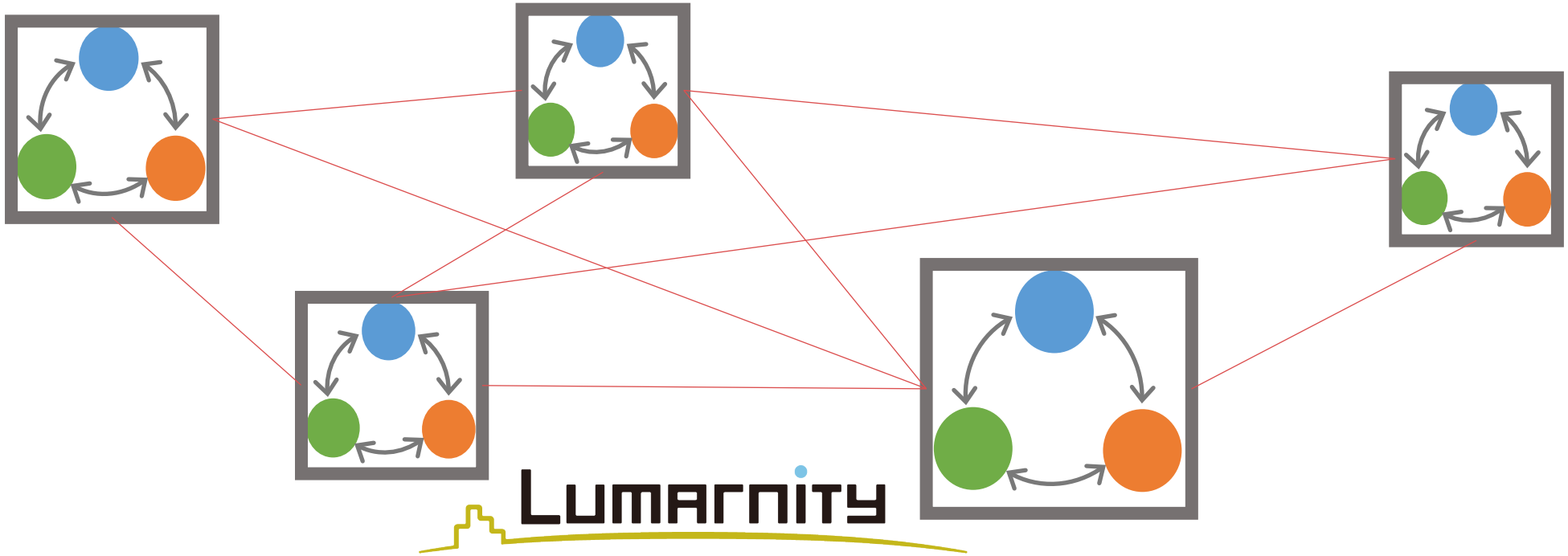
# JGC's vision: development into a Lunar Smart Community (Lumarnity : Lunar Smart Community )®

**Smart Community @ Earth**

Self-sufficient in energy needs at home and at work, using mainly renewable energy sources.
A regional community in which surplus energy is then shared within the community to make effective use of energy.

**Smart Community @ Moon**

A community that is self-sufficient and regenerates resources such as electricity, hydrogen, oxygen, carbon dioxide, food, and excrement, and makes effective use of resources by mutually accommodating each other.
Not only electricity, but also oxygen and food, as well as carbon dioxide and excrement, are considered valuable infrastructure resources.



# Outreach Activities (Exhibition)

- **International Space Industry Exhibition(ISIEX)2023 1~3 Feb. 2023　@Tokyo Big Sight, Japan**



# Outreach Activities (Exhibition)

- **NEO Living on the Moon Exhibition 28 Apr. to 3 Sep. @Miraikan, Japan**


# Outreach Activities (Education)

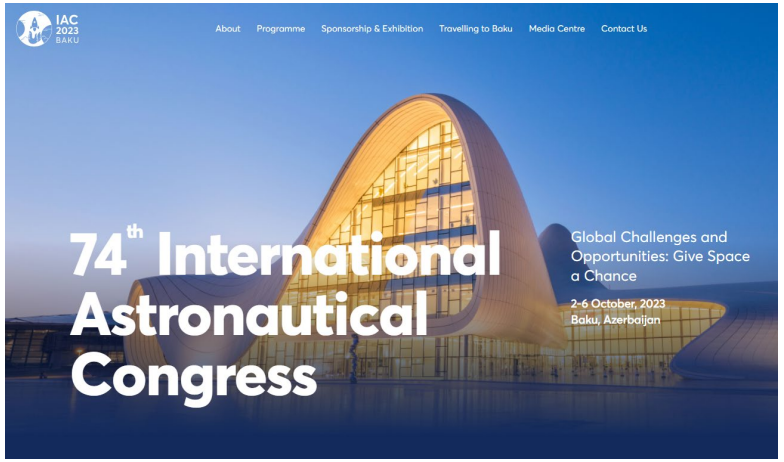
Handa Junior High School,
Handa City, Aichi Prefecture

Kawakami Junior High School,
Kawakami Village, Nagano Prefecture

Junior High School
Attached to Minami High School

# Outreach Activities (Exhibition)

- **IAC2023(International Astronautical Congress) Azerbaijan 2~6 Oct. 2023**
  **Bronze Sponsor & Booth**







# Outreach Activities(Presentation)

- **2nd Lunar Industry Vision Council (LIVC2023)　2nd Aug. 2023**
  **Industrial architecture forming the lunar economic zone**


**宮下 俊一（みやした としかず）**

日揮グローバル株式会社
*Digital Project Delivery部 Digital Transformation Manager*

1975年大阪府生まれ。1998年大阪大学工学部を卒業し、JGC Corporation (現・日揮グローバル株式会社)に入社。サウジアラビア・オマーン・マレーシア・ベトナム・カナダなど9か国のOil & Gasプラント (16 Large & Complex Projects)のエンジニアリング業務に従事。2018年よりIT Grand Plan2030策定・推進メンバー、2020年からエンジニアリングDXのプログラムリーダーを担当。エンジニアリグDXを実現した未来の姿として、Lunar Smart Community (Lumarnity®)を提唱し、技術開発を管掌。


# Outreach Activities(Publication)

## “Japan’s easiest to Understand Space Business 2050” In early Spring 2024!

新刊企画説明書

23/11/12
書籍編集部　桂木

| | | | |
|---|---|---|---|
| 書　名 | 日本一わかりやすい宇宙ビジネス 2050（仮） | | |
| サ　ブ | 宇宙に希望を託す人びと | 版元 | プレジデント社 |
| 著者名 | 中村　尚樹 | | |
| 編著者の略歴・肩書・著作等 | なかむら・ひさき<br>■ジャーナリスト。著書に『最先端の研究者に聞く日本一わかりやすい 2050 の未来技術』(プレジデント社)ほか。 | | |
| 仕様・体裁 | ソフトカバー | ページ数 | ？ |
| 定価 | ？ | 刊行予定期日 | 2024 年 3 月？ |
| キャッチフレーズ | 月面都市生まれの“かぐや姫”も夢じゃない！ | | |

【企画仮帯コピー】この一冊で 30 年後の宇宙利用がわかる。

目次・内容

**はじめに**

有人民間ロケット打ち上げで、誰でも宇宙旅行に行ける時代が夢ではなくなりそうだ。
日本の宇宙開発は糸川教授が先鞭をつけたが、糸川に続く研究者や企業も独創的な取り組みを積み重ねてきた。過去からいまに至る最前線のリーダーが取り組む「夢ではない」宇宙開発が、これからの“New Space”を創り出す。

**第1章◆宇宙へ行こう！～多様な移動手段～**

(0) 前説 ロケット開発総論。
(1) 観光丸構想…宇宙科学研究所教授の故・長友信人はペンシルロケットを開発した糸川英夫の弟子。日本の宇宙開発をリードした。日本初の液体ロケットを開発し、イオンエンジン研究に着手。宇宙観光ニーズを先取りする観光丸構想は、世界的に見ても画期的。
(2) 日本版スペースプレーン…川重の技術者だった米本浩一は長友の理念を受け継ぎ、SPACE WALKER を設立してサブオービタル宇宙旅行に挑戦。
(3) いつでも好きな軌道に…スペースワン。ロケット組み立てから発射まで、通常は数ヶ月単位でかかるのを 1 週間に短縮。本体の製造を担うのは、長友の弟子が元社長の IHI エアロスペース。
(4) 日本で民間初の宇宙到達…インターステラテクノロジズ。エコ燃料で一日一本ロケットが飛ぶ社会を目指す。
(5) 新発想の小型ロケット…将来宇宙輸送システム。観光丸構想を下敷きに、宇宙往還を可能とする輸送システムの実現をめざす。P2P も。
(6) スペースエレベーター構想…大林組が世界の先陣を切る。

**第2章◆宇宙の目～リモートセンシング～**

(0) 前説 現状は地球周辺が宇宙ビジネスの中心。ハイパースペクトルセンサー開発でリード。
(1) 小型光学衛星…アクセルスペースは新分野を開拓。
(2) アマゾンから衛星へ…アークエッジ・スペースは、世界の未開拓地の課題解決を目指して創業。暴力がはびこる世界をなくすことに貢献。
(3) 九州の下町衛星…QPS 研究所は町工場が協力。
(4) 第 3 のアンテナ方式…シンスペクティブはアンテナに工夫。

**第3章◆宇宙で過ごす～宇宙インフラ構築～**

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