

January 19, 2023

Honda Signs Research and Development Contract with JAXA Regarding “Circulative Renewable Energy System” Designed to Supply Electricity Supporting Living Space for People During Lunar Surface Exploration – Advancing original joint research agreement to a R&D contract to build a prototype by March 31, 2024 –

TOKYO, Japan, January 19, 2023 – Honda today announced that it has signed a research and development contract*¹ with the Japan Aerospace Exploration Agency (JAXA) regarding the “circulative renewable energy system” that is designed to supply electricity to maintain the functionality of the living space and various systems of lunar rovers. Based on this contract, Honda will be commissioned by JAXA to first conduct concept studies, then to develop a “breadboard model”², the early-stage prototype, by the end of the Japanese 2023 fiscal year (March 31, 2024).

The circulative renewable energy system combines Honda’s original high differential pressure water electrolysis system and a fuel cell system, and is designed for continuous production of oxygen, hydrogen and electricity from solar energy and water. After signing a joint research agreement with JAXA in November 2020, Honda pursued research on the circulative renewable energy system for use on the surface of the Moon. The signing of this new R&D contract represents another step forward for Honda.

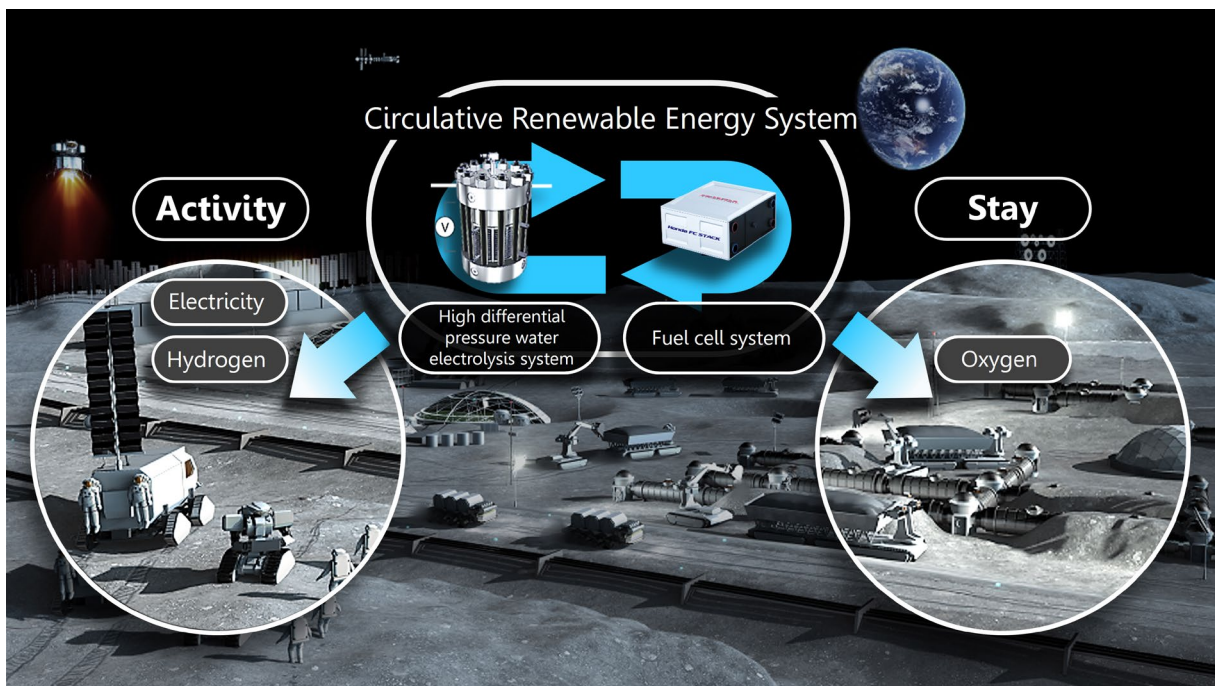


Image shows use of a circulative renewable energy system on the lunar surface ©JAXA/Honda

*1 A contract regarding concept study and prototyping of functional elements for the regenerative fuel cell system of a manned pressurized rover. A regenerative fuel cell system consists of a water electrolysis system and a fuel cell system. A water electrolysis system electrolyzes water to produce oxygen and hydrogen, and a full cell system generates electricity from hydrogen to oxygen. Honda's regenerative fuel cell system is called "circulative renewable energy system" as it features Honda's original high differential pressure water electrolysis system.

*2 Systems to be used in outer space are typically developed by building prototypes in stages, such as a "breadboard model," "engineering model" and "flight model," depending on the stage of development.

[Background of discussion for use of Honda's circulative renewable energy system]

The Artemis Program, the U.S.-led international space exploration program which Japan also participates in, is planning for a human lunar surface exploration to be conducted over an extended period of time in the second half of the 2020s. For people to stay on the Moon for long-term exploration it will be necessary to have 1) electricity to run the lunar roving vehicles and 2) **electricity to enable people to live inside the vehicles.**

In areas of the lunar surface with the lowest duration of sunshine, there is a repeating cycle of 14 days of light and 14 days of night. During the daytime when the sun is out, electricity can be generated through solar power generation and supplied to the living space inside the lunar vehicles; however, during at night, electricity must be secured in another way. One option would be to take secondary batteries onto the lunar surface and store the electricity generated by solar power. This method, however, would create an enormous cost issue to transport a large number of batteries from the Earth to the Moon.

This is why Honda's circulative renewable energy system, which is more compact and lightweight than secondary batteries, was selected as the potential means to supply electricity on the lunar surface.

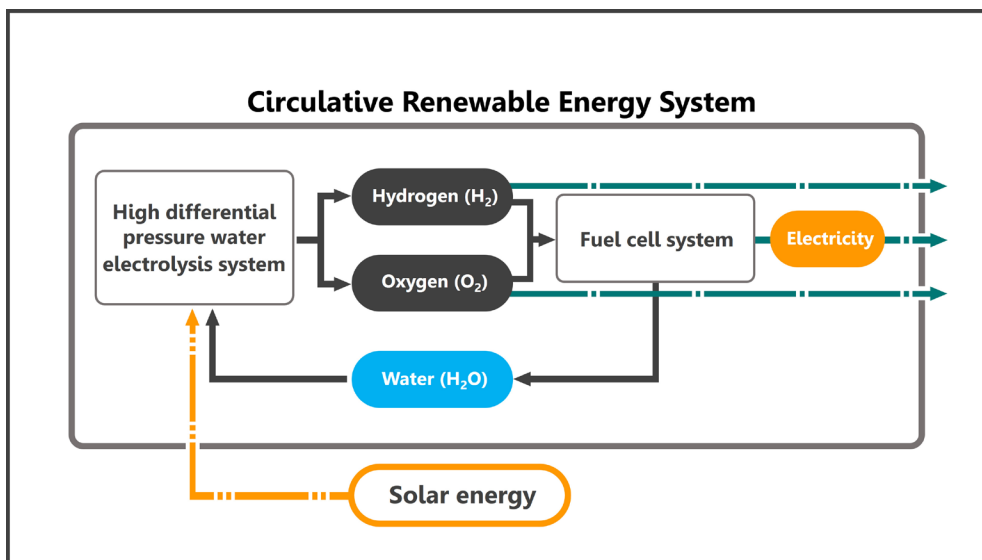
[How the circulative renewable energy system works, and key features of the system]

The circulative renewable energy system, which **combines Honda's original high differential pressure water electrolysis system and a fuel cell system, continuously produces oxygen, hydrogen and electricity from solar energy and water.** When used on the lunar surface, the high differential pressure water electrolysis system uses electricity generated from solar power during the daytime and electrolyzes water to produce oxygen and hydrogen, which will be stored in tanks. During the night, the fuel cell system uses the stored oxygen and hydrogen to generate electricity, which will be supplied to the living space for people.

Honda's high differential pressure water electrolysis system **is compact because it does not require a compressor, which typical systems need to compress hydrogen.** Moreover, the circulative renewable energy system has higher gravimetric energy density (energy per unit mass)^{*3} than a secondary battery, therefore it **requires smaller mass than a secondary battery** to store the same amount of energy. Due to such key features, Honda's circulative renewable energy system can **contribute to the reduction of payload capacity and mass, which is a major challenge in space transportation.**

Honda has been working on the research and development of hydrogen technologies for many years. In 2002, Honda became the first company in the world to start lease sales of fuel cell vehicles. Moreover, Honda has been developing and installing smart hydrogen stations using its high differential pressure water electrolysis systems. Jointly with JAXA, Honda will strive to realize a circulative renewable energy system by utilizing hydrogen technologies Honda has amassed to date.

*3 Energy density of 480Wh/kg or more for regenerative fuel cell systems (general technological term for Honda's circulative renewable energy system). Approximately 200Wh/kg for lithium-ion batteries designed for lunar exploration.
Source : "Energy Storage Devices for Space Exploration" by Hitoshi Naito, Japan Aerospace Exploration Agency, 2016 GS Yuasa Technical Report (Web)
https://www.gs-yuasa.com/jp/technology/technical_report/pdf/vol13_2/13_02_001.pdf (in Japanese)



Conceptual rendering of a circulative renewable energy system

【Additional potential for the utilization of a circulative renewable energy system】

Electricity is not the only thing Honda's circulative renewable energy system can generate; it also can produce oxygen and hydrogen as long as there is water and solar energy. Honda is assuming that **the oxygen will be used for people at the lunar outposts, and the hydrogen will be used as fuel for transfer spacecraft that will land on and ascend from the Moon.** At the same time, when it is used on Earth, the circulative renewable energy system **can serve as a carbon-neutral energy supply system, which generates electricity by utilizing solar energy and the abundant water resources available on Earth.** Honda will pursue research and development of its circulative renewable energy system with the initial goal to utilize it in outer space, then feed technologies amassed through this challenge back to Earth and strive to realize the company's 2050 carbon neutrality goals.

【For reference】

- News release: "JAXA and Honda to Begin a Feasibility Study on a Circulative Renewable Energy System – Enabling sustainable space activities by creating environment to sustain human life in space –"
<https://global.honda/newsroom/news/2021/c210614eng.html>
- Honda Future Technology (Website): The circulative renewable energy system
<https://global.honda/innovation/advanced-technology/circulative-renewable-energy-system.html>