Promoting the Development of Carbon Recycling Technology by Utilizing CO_2-Free Hydrogen

— Opening of the Soma Lab, a research facility for renewable energy-derived hydrogen utilization —

In order to achieve a CO_2-free, recycling-oriented society, the Soma Lab was opened as a base for research and development of technologies to utilize hydrogen produced by using surplus renewable electricity. The Lab will promote effective use of renewable energy through the development of hydrogen production and utilization technologies. Research institutions and companies all over the world can make use of the Lab as a place for open innovation, which will contribute to regional revitalization through frequent visits of researchers or people interested in our efforts. We will also provide opportunities for local children to become familiar with science and energy-related technology such as hydrogen and its utilization through hands-on learning.

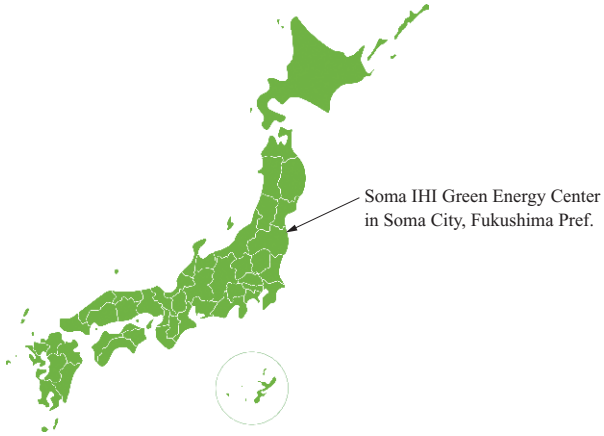
Soma Lab

In Soma City, Fukushima Prefecture, which was severely damaged by the Great East Japan Earthquake in 2011, IHI Corporation has been operating the Soma IHI Green Energy Center (SIGC), a smart community business base, since 2018 in order to develop a new town to achieve further regional economic revitalization. The concepts of SIGC are to locally produce and consume solar renewable energy as well as to enhance disaster prevention functions and achieve regional revitalization. We are pleased to announce that in September 2020, the Soma Lab, a research facility for renewable energy-derived hydrogen utilization, was opened within SIGC and started operation. The Lab promotes carbon recycling research to utilize CO_2-free hydrogen produced by using surplus renewable electricity.

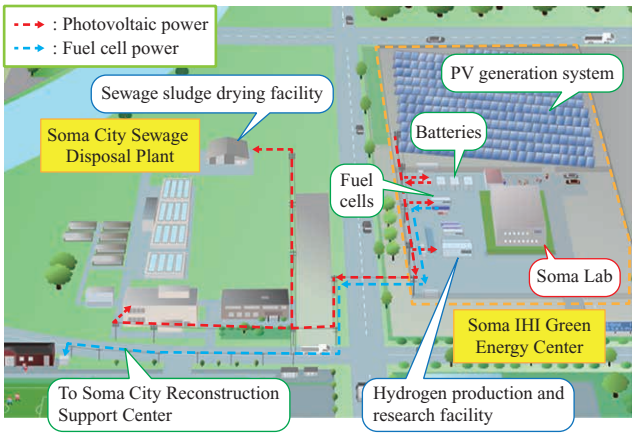
SIGC, with an area of 54 000 m^2, supplies electricity from its 1 600-kW photovoltaic power generation system to the sewage disposal plant and waste incineration plant of Soma City and other facilities. In addition, since solar power generation can generate more electricity than the demand when the sun shines, the surplus electricity is used to conduct the following demonstrations and developments:

(1) Demonstration and development of efficient hydrogen production and storage by feeding the electricity to a water electrolyzer; and

(2) Demonstration and development of recycling and volume reduction of sludge from sewage disposal plants



Location of Soma IHI Green Energy Center



Soma IHI Green Energy Center and related facilities of Soma City

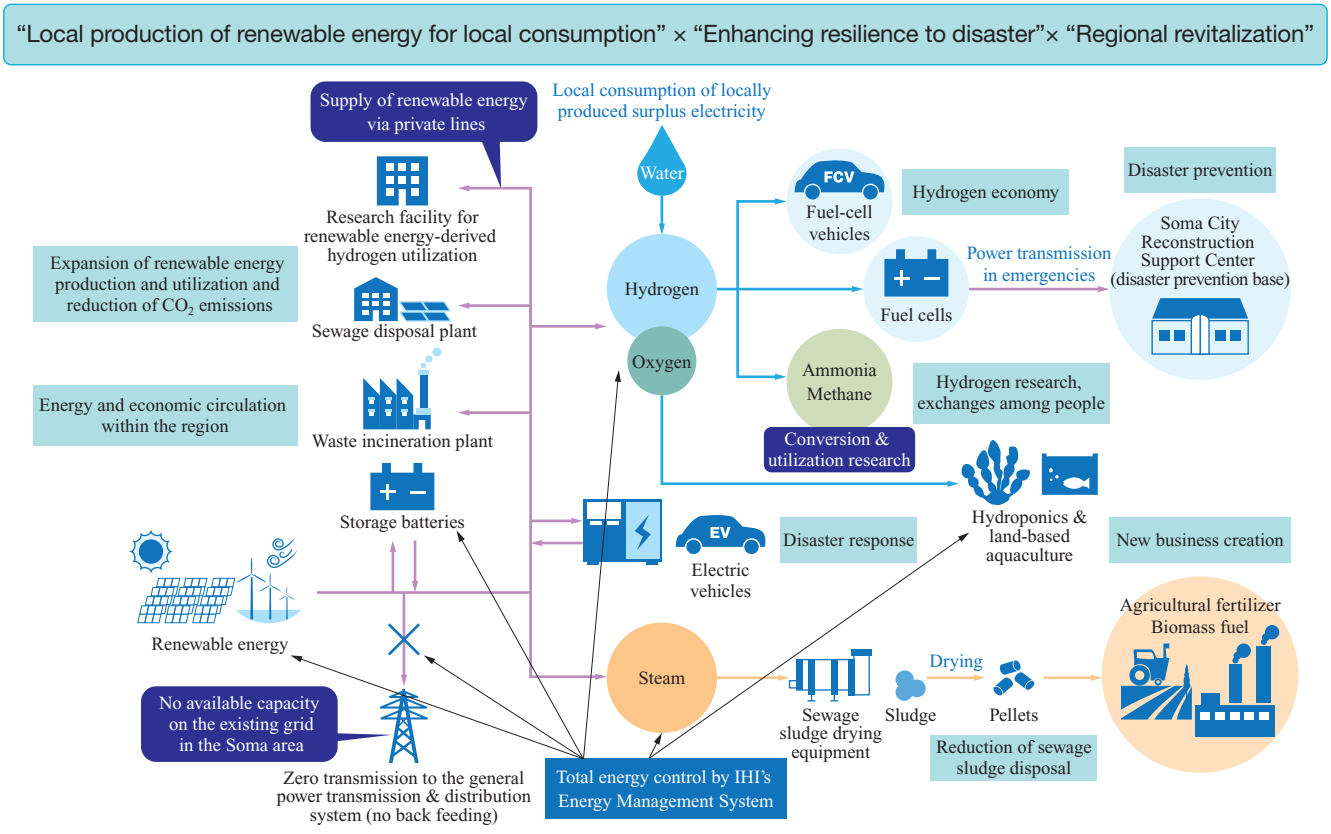
by drying it with steam produced by an electric boiler and stored in an accumulator.

The Soma Lab, as a center for the development of advanced technologies for hydrogen utilization, conduct various researches for the future hydrogen economy on technologies for hydrogen utilization and conversion to energy carriers with the use of the hydrogen produced in demonstration and development.

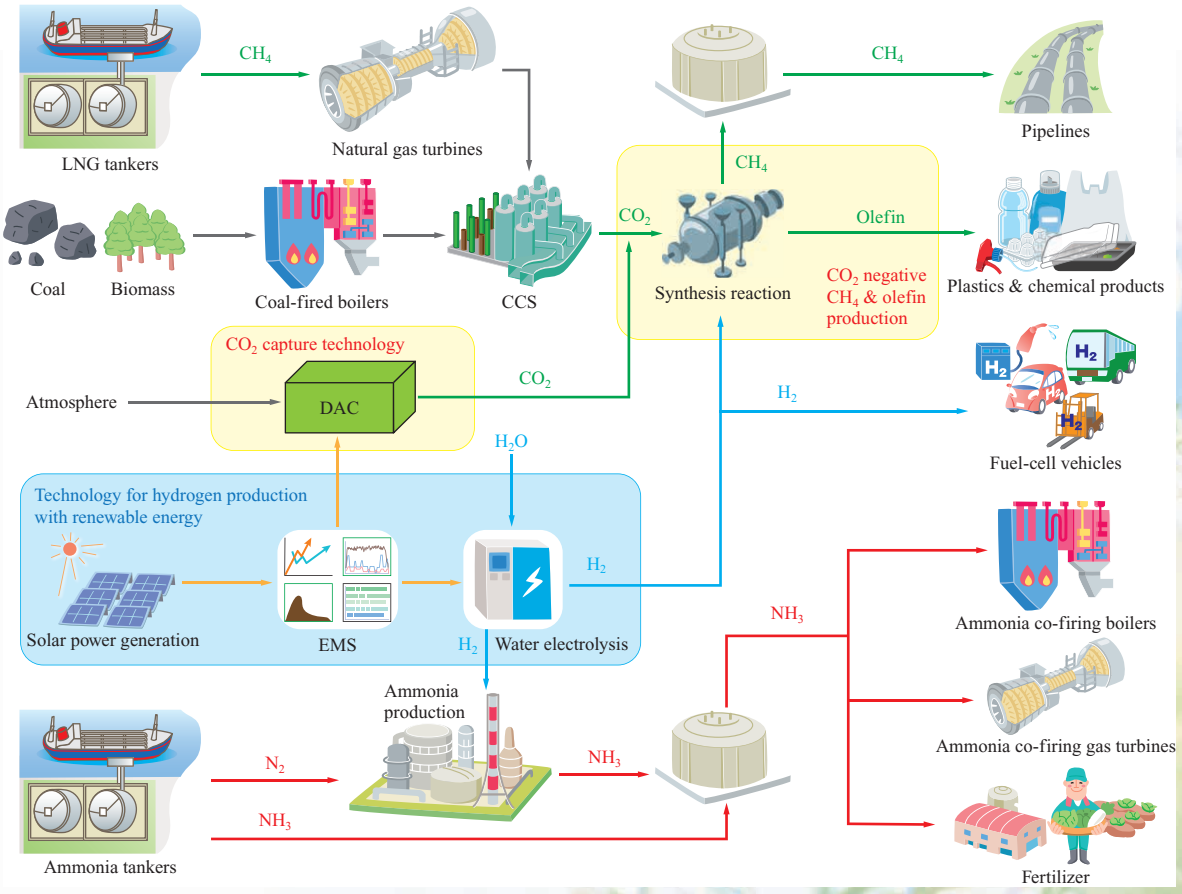
In recognition of these efforts for the smart community business at SIGC, IHI received the Minister of Economy, Trade, and Industry Award, which is the highest award at the "New Energy Awards" in 2020, jointly with Soma City and Pacific Power Co., Ltd.

Hydrogen production using renewable energy and carbon recycling technology

To make renewable energy an economically self-sustaining primary power source and to realize the decarbonization of economy by 2050, hydrogen is attracting attention because it can stably store surplus electricity from renewable energy for a long period of time and can be introduced on a large scale.



Concept of the smart community business



Power to X hydrogen utilization technology researched and developed by the Soma Lab

The hydrogen produced by electrolysis of water using surplus solar power can be used directly or stored. Furthermore, this hydrogen can be converted into more usable materials by synthesizing it with CO_2 or nitrogen (N_2). There is a need for the Power to X technology as well as technologies not only to efficiently produce hydrogen but also to transport it in large quantities and to convert it into an energy carrier that can be used more easily. The Soma Lab will also conduct research on technologies for converting CO_2-free hydrogen produced by using surplus renewable electricity into energy carriers.

The diagram above shows the Power to X technology for efficiently storing and utilizing renewable energy. Hydrogen is efficiently produced by electrolysis of water by using surplus renewable electricity transmitted according to a command from the energy management system (EMS). The produced hydrogen is then synthesized with CO_2 and converted into methane (CH_4) and raw materials for plastics (such as olefins). Methane can be easily transported through existing pipelines, and conversion into raw materials for plastics allows CO_2 to be fixed. The CO_2 to be used as a raw material can be recovered from the exhaust gas of power plants using CCS (Carbon dioxide Capture Storage) technology or directly from the atmosphere using DAC (Direct Air Capture) technology.

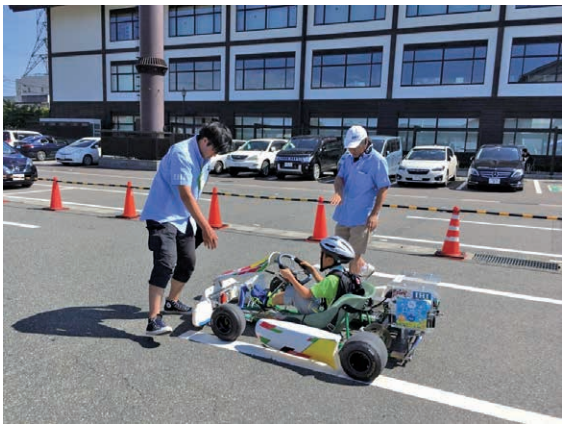
DAC technology, which separates and captures CO_2 directly from the atmosphere, can be used to capture CO_2 using surplus renewable electricity at the same location as hydrogen production anywhere on the planet. In other words, if renewable energy can be used at a given location, it is possible to convert water and air into high value-added substances at that location without using additional energy sources and without transporting hydrogen or CO_2.

In addition, it is possible to synthesize ammonia (NH_3), which is expected to be a new CO_2-free fuel, by reacting atmospheric N_2 with hydrogen. Since ammonia is already used as a fertilizer and the infrastructure is already in place, it has high potential as an energy carrier that can be converted from hydrogen.

Soma Lab

As a research facility suitable for advanced hydrogen utilization research, the Soma Lab will demonstrate technologies for the effective use of renewable energy in a manner that includes hydrogen production and utilization. The hydrogen for the demonstration is produced by using surplus renewable energy in SIGC. The production output of the water electrolyzer is controlled according to weather fluctuations and up to 400 Nm^3 of hydrogen is stored in two tanks. The hydrogen in the tanks will be used for research

Methane synthesis test equipment installed in Cell No. 1



Children's Science Festival at Soma City Hall

and development of hydrogen utilization at the Soma Lab.

The Soma Lab has the following specifications.

Site area : approx. 1 200 m^2 (including utility space)

Total floor space : approx. 900 m^2
Experimental cells (4 indoor & 1 outdoor, 40 to 100 m^2)
Conference room (Max. of 42 people)
Community space (Max. of 16 people)

Equipment : 2 hydrogen pressure boosters (4 Nm^3/h·10 MPa, 55 Nm^3/h·1 MPa)
Air compressor
Exhaust gas incineration system

If the hydrogen stored in the tanks is used for experiments as is, the tank pressure will drop due to the consumption. If this happens, hydrogen cannot be supplied to the experimental cells. Therefore, the hydrogen is pressurized with a booster and then supplied to each experimental cell at a constant pressure through a buffer tank. There are two booster systems, one at 1 MPa and the other at 10 MPa, thus enabling testing of both low-pressure and high-pressure hydrogen. A buffer tank has been installed to absorb the pressure fluctuations caused by the booster and to provide a constant supply of hydrogen at a stable pressure. An exhaust gas incineration system has also been installed as an important utility. Materials synthesized in the experiments and unreacted hydrogen pass through the exhaust gas line to be safely disposed of by the exhaust gas incineration system.

Cell No. 1, the largest of the experimental cells, has an area of 100 m^2 and a height of 12 m. The photo shows the methane synthesis test equipment installed in Cell No. 1. It has successfully synthesized 12 Nm^3/h of methane from 0.9 MPa hydrogen at a maximum flow rate of 55 Nm^3/h.

Contribution to the community

The Soma Lab is intended to be widely used as a space for open innovation related to hydrogen utilization technologies by research institutes and companies around the world. The participation of various researchers will enable us to accelerate the market launch of hydrogen utilization technologies and to contribute to the realization of a hydrogen economy in Fukushima. We can contribute to regional revitalization by inviting a variety of researchers from all over the world to Soma City in Fukushima for deeper exchanges. We have also prepared a community space so that researchers with different fields of expertise can have exchanges with one another as well as have discussions with researchers in remote locations. The community space, with the view of a PV generation system, is mainly used for providing visitors with an overview of SIGC. The community space and the conference room are also used for presentation of visitors and discussion on the concept of the future.

In addition, we are planning activities for local children in order to deepen their understandings of science and the whole picture on energy, such as hydrogen. We have also begun discussions with Soma City about an experiential learning program for local children in the Lab's conference room, which can accommodate up to 42 people. We are also participating in events such as the Children's Science Festival in order to get children interested in the hydrogen economy. At these events, we bring go-karts that run on hydrogen fuel cells and energetically explain to the children about hydrogen and the mechanism of fuel cells.

As mentioned in the Fukushima Plan for a New Energy Society with the aim of creating a model for realizing a new energy economy for the future in Fukushima, the Soma Lab is being developed as a hydrogen innovation center to realize a hydrogen economy as well as a place to build a global research network centered around Fukushima Prefecture.

INFORMATION

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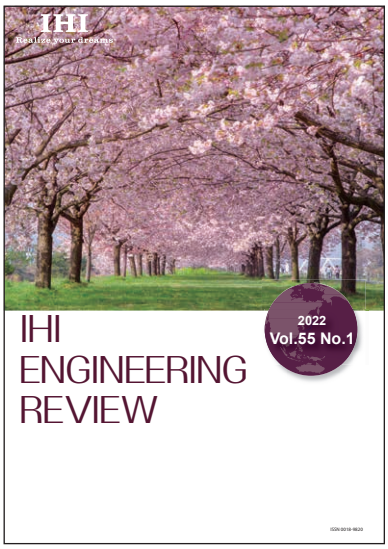

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IHI Challenges with Society

Technologies supporting IHI

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