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Chiyoda's Hydrogen Business

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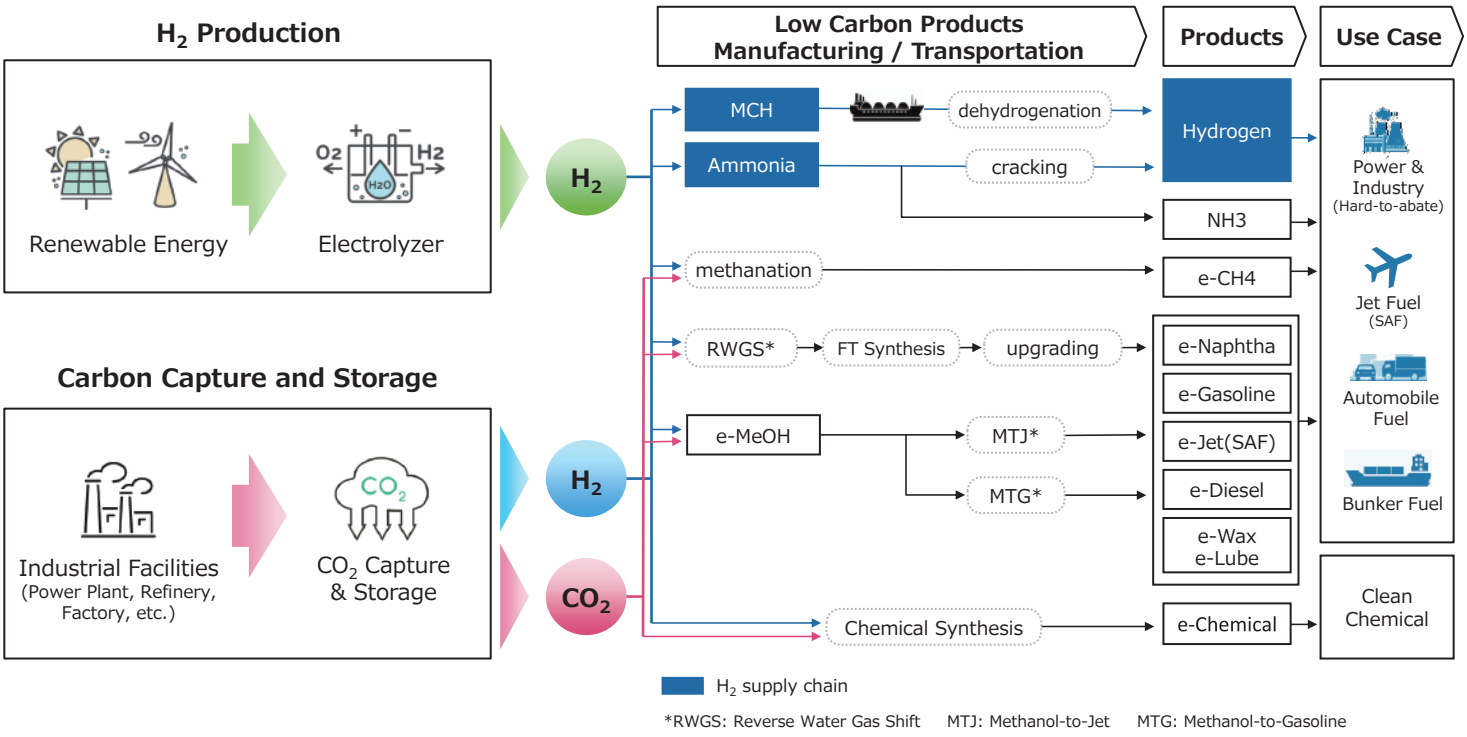


Chiyoda and Toyota jointly developing large-scale electrolysis system

TOYOTA

CHIYODA CORPORATION

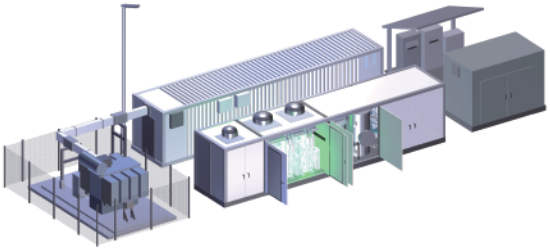
Chiyoda and Toyota Motor Corporation have agreed to jointly develop a large-scale electrolysis system and construct a strategic partnership and have signed a basic agreement on cooperation in December 2023.

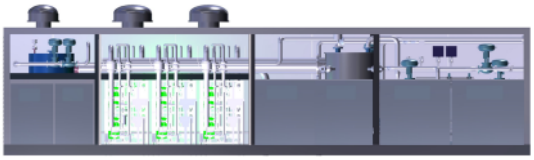
The production and mass production technologies for electrolysis cell stacks using the fuel cell technology held by Toyota and the processing plant design technologies and large-scale plant construction technologies held by Chiyoda will be combined and optimized, allowing benefits such as lower costs, increased production efficiency, and more stable quality for the electrolysis systems required to produce green hydrogen.

The introduction of an electrolysis system in Hydrogen Park at the Toyota Honsha Plant will start in FY2025. It will be expanded in the future to the 10 MW class and used for verification and development.

Electrolysis System Development

5MW electrolysis system





High Reliability

Over 30 years development of fuel cell technology by Toyota

High Efficiency

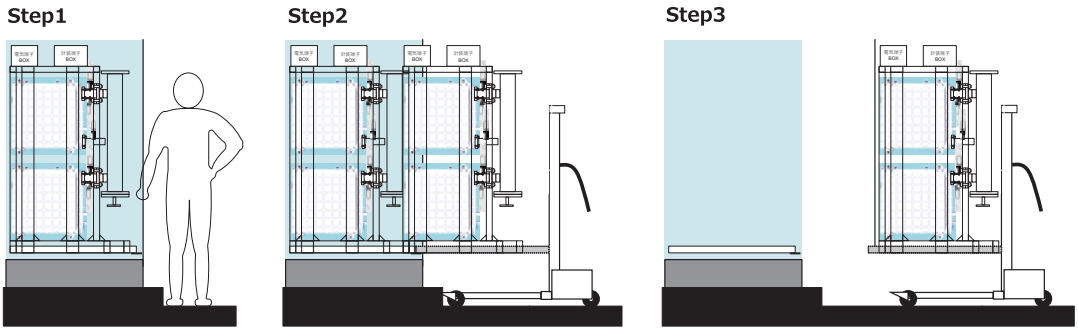
World-leading high efficiency in power consumption

Compact System

Containerized 5MW electrolysis system

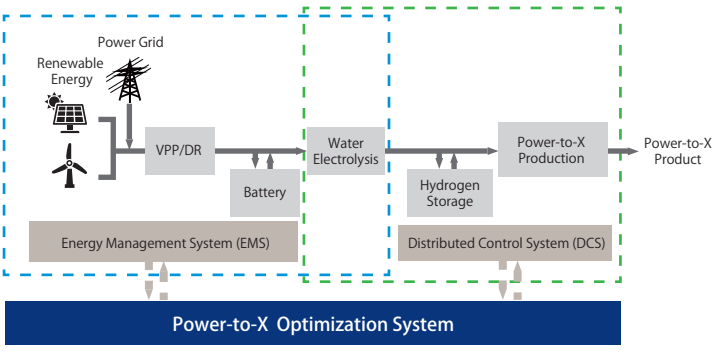
Cartridge-structured cell stacks enable easier replacement

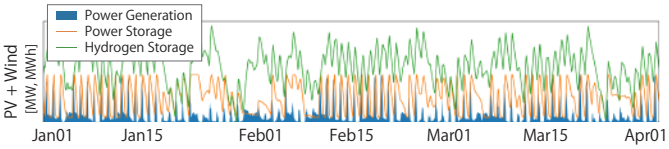
Chiyoda developed patent-pending cartridge-structured cell stack, which provides easier management of cell-stack.



Most efficient hydrogen production system utilizing the expertise of engineering company

Chiyoda provides the optimized LCOH (Levelized Cost of Hydrogen)!





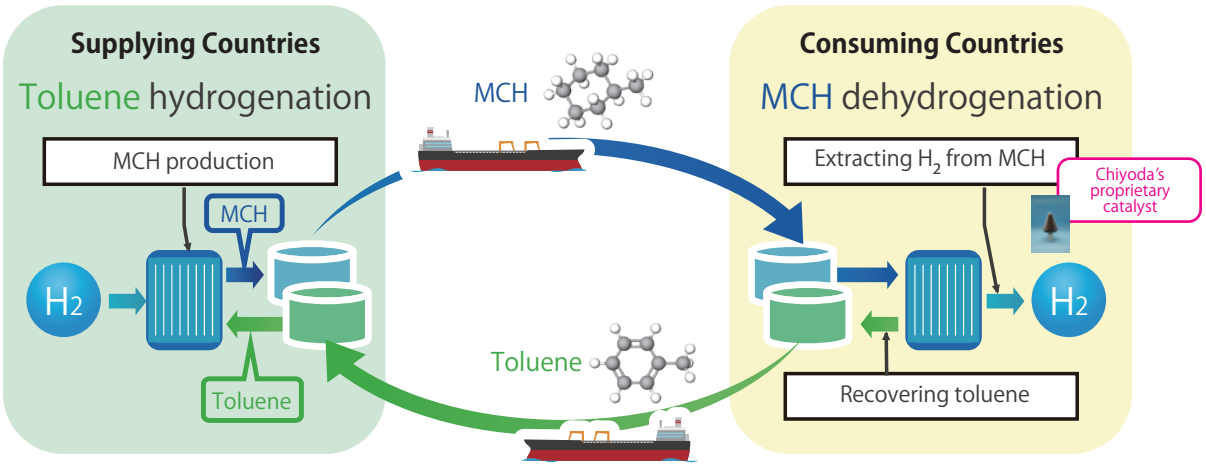
Optimization of operation profiles in response to fluctuations in renewable power generation

About LOHC-MCH (SPERA Hydrogen™)

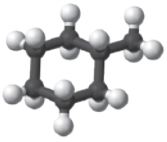
LOHC-MCH (SPERA Hydrogen) System

Chiyoda uses MCH as the hydrogen carrier, enabling the safe, efficient and commercially viable storage and transportation of hydrogen on a global scale.
Toluene is initially converted into MCH through hydrogenation in the hydrogen-rich supply country. Following transportation overseas using existing conventional tankers, hydrogen is extracted from the MCH in the consuming country for delivery to consumers, through dehydrogenation using Chiyoda's 'in-house' developed, proprietary catalyst. The toluene is recovered through the dehydrogenation process and transported by tanker back to the supply country in a continuous loop, to be re-used as feedstock for further hydrogenation.

Chiyoda has named the system: SPERA Hydrogen (SPERA: Latin for 'HOPE').

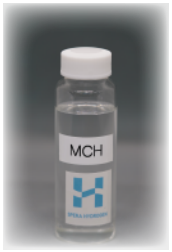


Key features of SPERA Hydrogen



MCH (methylcyclohexane)

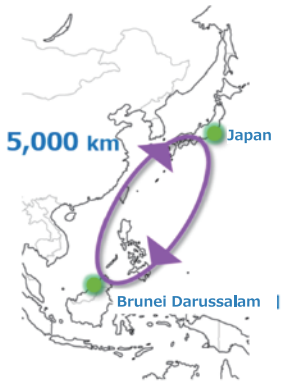
- Liquid under ambient conditions
- Chemically stable
- Easy to handle
- Utilizes existing infrastructure



Global Hydrogen Supply Chain Demonstration Project

Global hydrogen supply chain demonstration project between Brunei Darussalam and Japan

In December 2020, the Advanced Hydrogen Energy chain Association for technology Development (AHEAD)* successfully completed the world's first 'Global Hydrogen Supply Chain Demonstration Project', an important milestone for the construction of an international hydrogen supply chain towards realizing a decarbonized society.

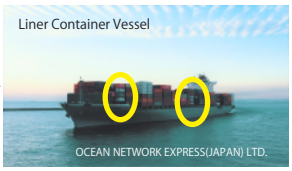


Facility Scale :	Maximum 210 tons/year
Hydrogen Supply :	Brunei Darussalam (Hydrogen production)
Hydrogen Uses :	Kawasaki City, Japan (Fuel for gas turbine power generation facilities)
Transportation :	ISO tank container (container vessels and trailers)
Scheme :	- Funded by the New Energy and Industrial Technology Development Organization (NEDO) - Operated by AHEAD

MCH Production in Brunei Darussalam

Land Transportation

Marine Transportation



MCH Dehydrogenation at Kawasaki, Japan

Fuel for Power Generation

Dehydrogenation Reactor

Chiyoda's Proprietary Dehydrogenation Catalyst

Hydrogen transportation in the form of MCH by chemical tanker

In 2022, AHEAD achieved the world's first milestone of transporting hydrogen in the form of MCH overseas using a chemical tanker. This achievement demonstrates the viability of long-term storage and transportation of MCH on a global scale.

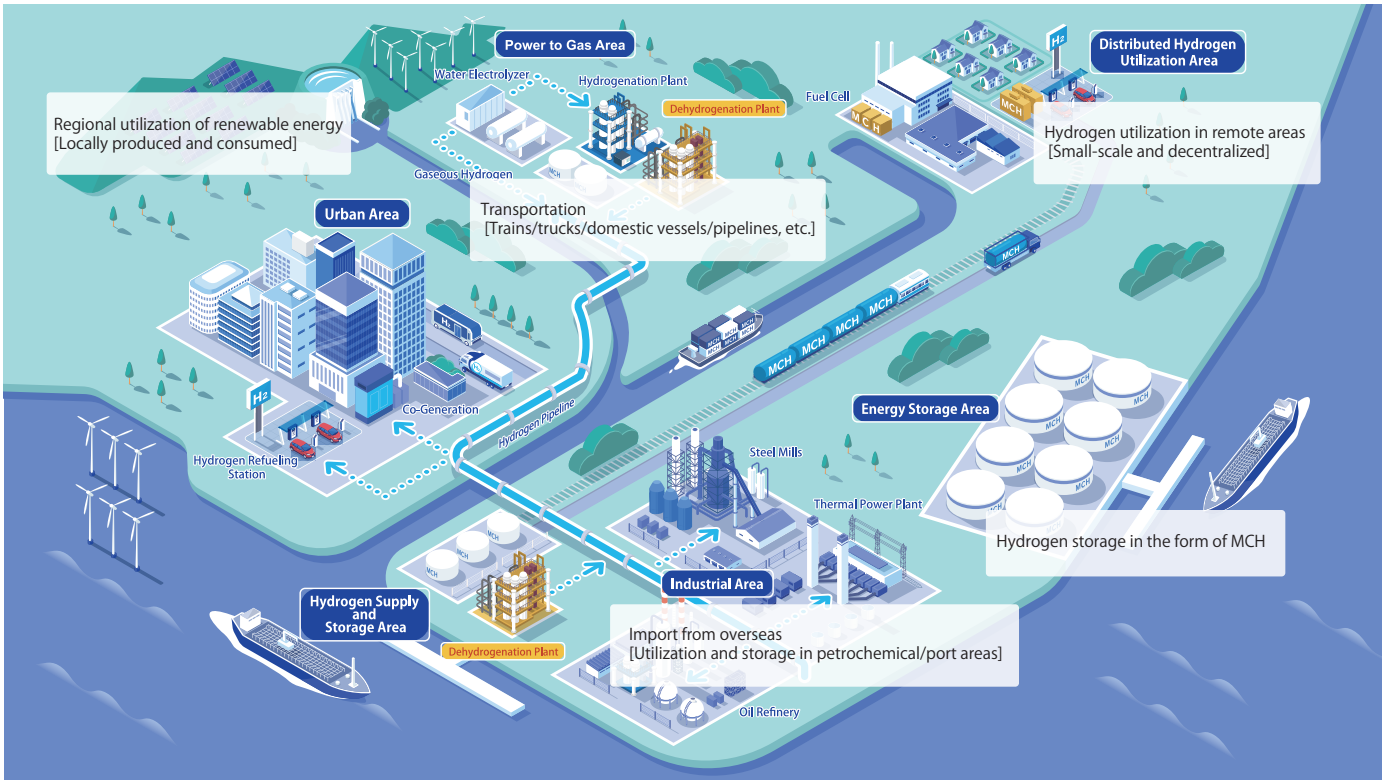
https://www.chiyodacorp.com/media/20220208_E_R1_1.pdf

AHEAD

* Association members of AHEAD: Chiyoda Corporation, Mitsubishi Corporation, Mitsui & Co. Ltd and NYK Line https://www.ahead.or.jp/en/

LOHC-MCH Utilization

Hydrogen transportation and storage technology



Singapore demonstration project utilizing compacted dehydrogenation package

The MCH Compacted Dehydrogenation Package in use for decentralized applications of imported hydrogen – in early 2024, Chiyoda and partners commenced an MCH Dehydrogenation Refueling Station demonstration project in Singapore, to operate heavy duty Fuel Cell Vehicles (FCV) with imported hydrogen at Pasir Panjang Terminal.

https://www.chiyodacorp.com/media/240712_e.pdf

Partnerships

Commercial cooperation with Axens on a global licensing business

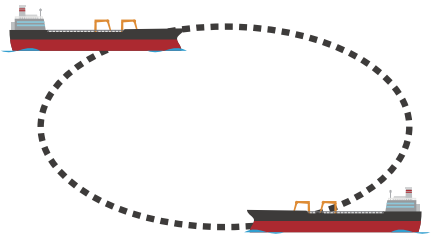
Chiyoda announced a commercial cooperation agreement with Axens, a major technology licensor in the Oil & Gas and Petrochemical industries, in 2022.
By combining Chiyoda's MCH Dehydrogenation technology and Axens Toluene Hydrogenation technology, the two companies provide end-to-end solutions for the development of hydrogen supply chains using MCH as the LOHC.

https://www.chiyodacorp.com/media/221128_e_1.pdf

Axens-Chiyoda Commercial Package

Axens
Powering integrated solutions

- Hydrogenation
- Licensor's expertise



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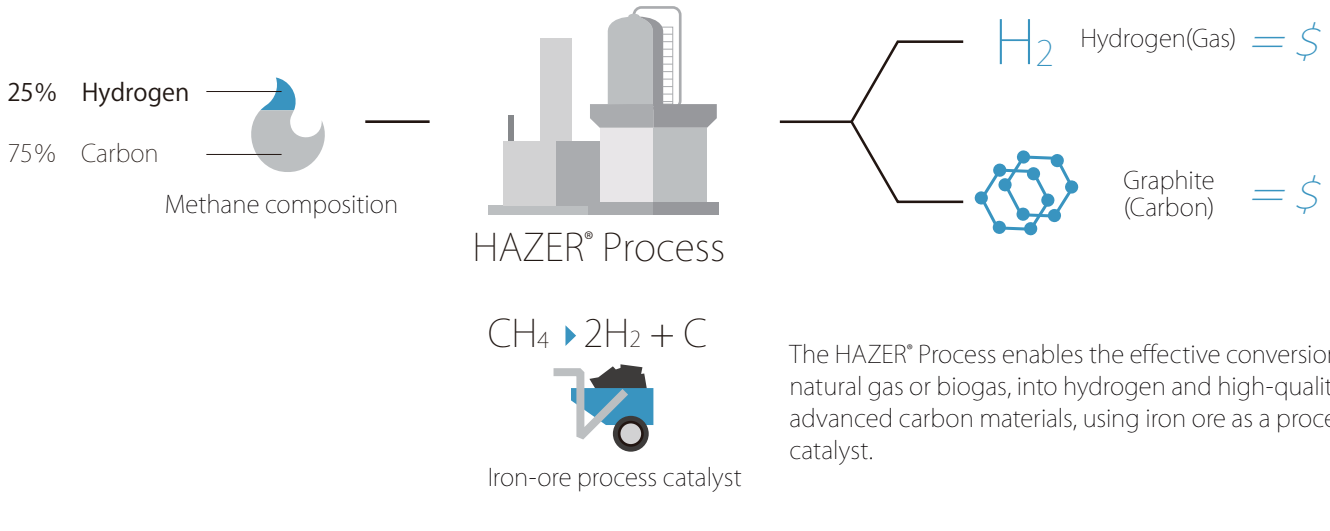
- Dehydrogenation
- Engineering expertise

Hydrogen production by HAZER® Process with Hazer and Chubu Electric

In 2023, Hazer, Chubu Electric and Chiyoda have agreed to work collaboratively to prepare the Project Development Plan for a clean hydrogen and graphitic carbon production hub in the Chubu region of Japan, based on Hazer's proprietary technology.

https://www.chiyodacorp.com/media/230411_e_1.pdf



The HAZER® Process enables the effective conversion of natural gas or biogas, into hydrogen and high-quality advanced carbon materials, using iron ore as a process catalyst.

Chiyoda Corporate Website
http://www.chiyodacorp.com/en

Enriching Society through Engineering Value

CHIYODA CORPORATION