Japan-EU Energy Business Seminar

Hitz Hitachi Zosen

The Use of Renewable Energy in the Form of Usable Fuel via Hydrogen

Hitachi Zosen Corporation

General Manager

Dr. Kouichi Izumiya

Hitachi Zosen Business Domains

Business domain 1

Green Energy

Energy-from-Waste systems
Renewable energy
Biomass technology
Energy systems
Environmental purification systems

Business domain 2

Social Infrastructure

Plants and process equipment
Power generation facilities
Industrial machinery
Food and medical machinery

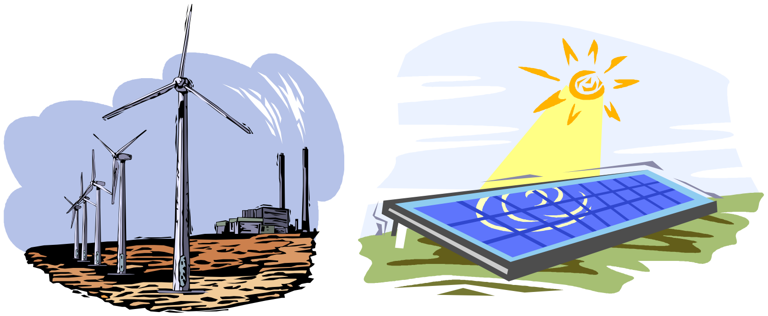
New Business and New Fields

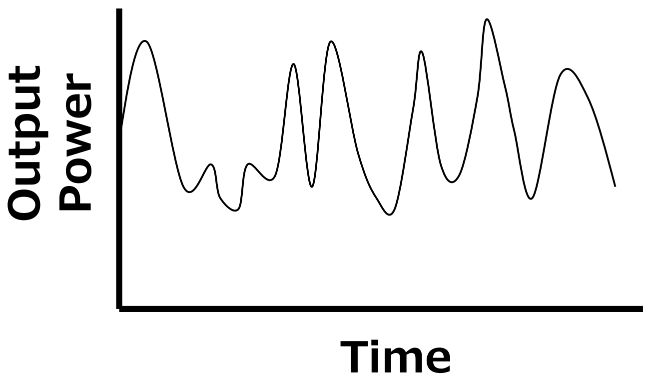
SCR system for marine engines

Offshore wind power generation

Solar heat power generation system

Utilization of large scale renewable energy





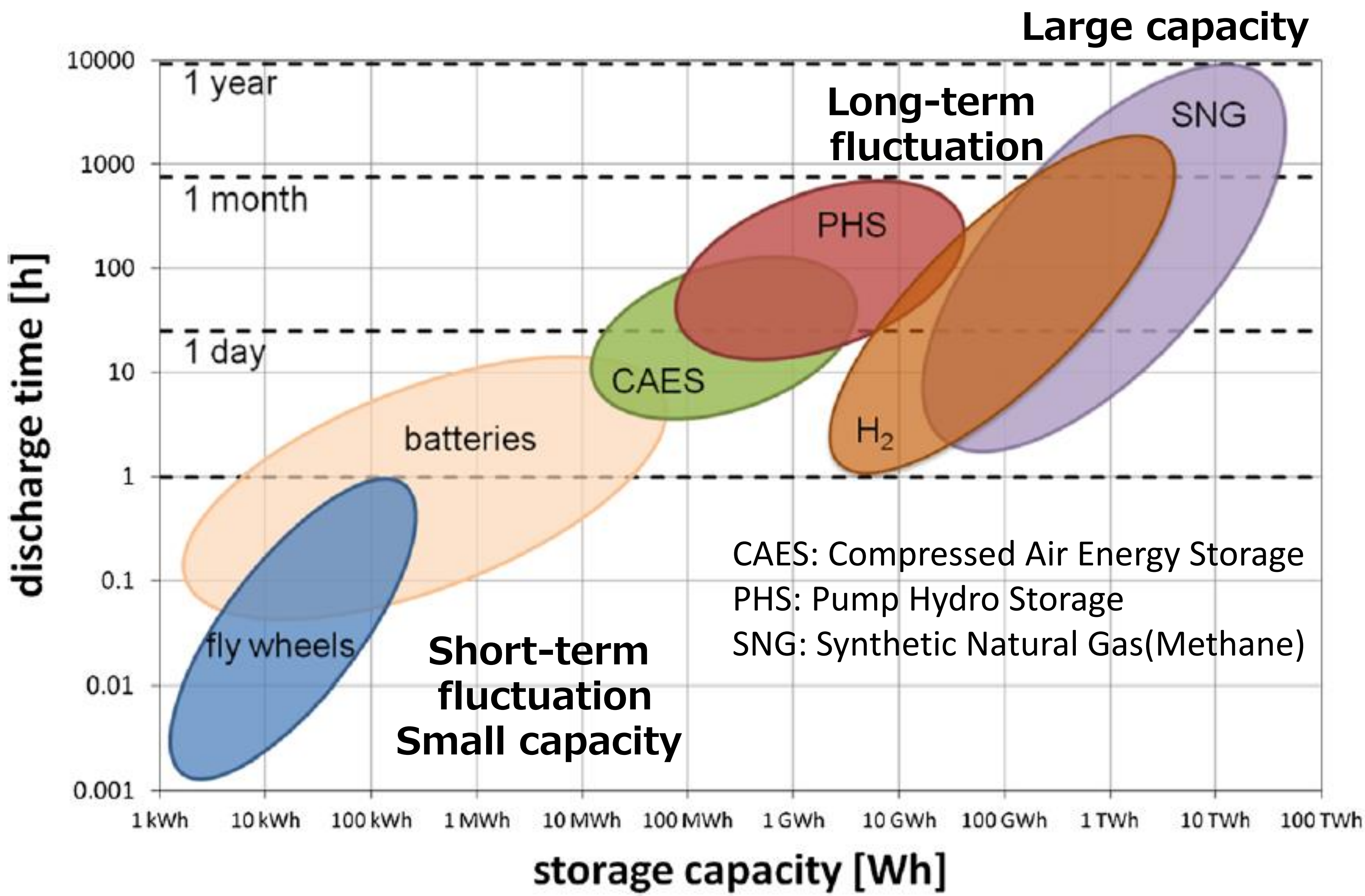
Output fluctuation (Short/Long term)
→Caused mismatch between Supply and Demand

Induce frequency drift/black out
→ Difficulty to depend on large Scale Renewable energy

Energy storage is required for stable use of power generated from renewable energy

Renewable energy varies by means of condition of wind and hours of daylight temporally/seasonally.

Charge/discharge period and storage capacity of different electricity storage systems



Hitz Electrolyzer for Renewable Hydrogen

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2010 Tsukuba University
2Nm^3/h

2012 FREA 5.5Nm^3/h, 2.6kW
Fukushima Renewable energy Institute, AIST

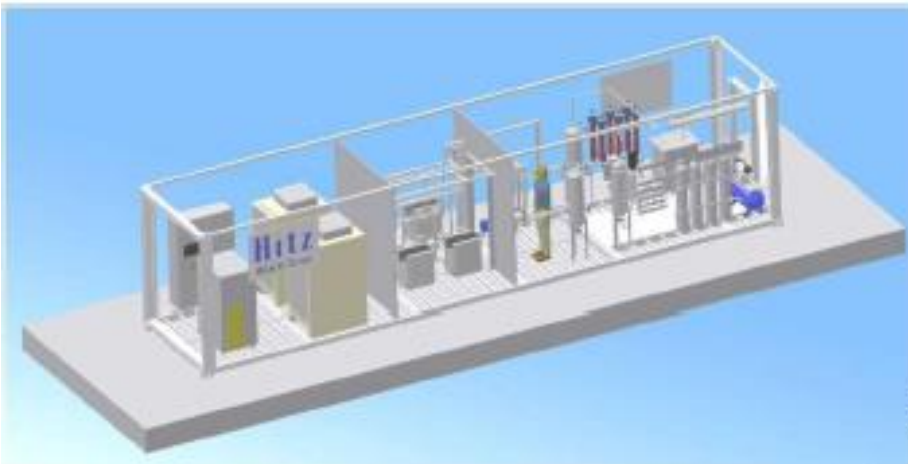
2015 Hydrogen station in Kyushu Univ. (1Nm^3/h)

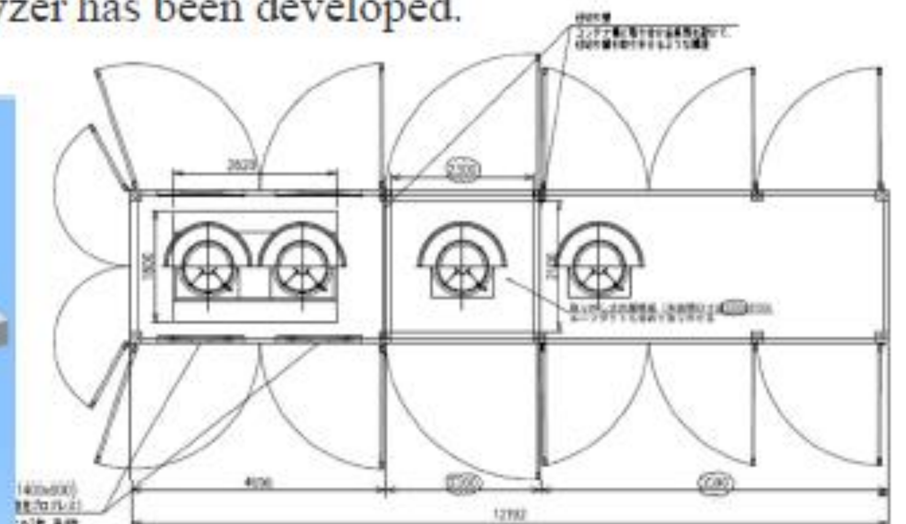
2016 FREA
(5Nm^3/h)

2017 Toyota Kyushu Miyata Works for FC Folk Lift (24Nm^3/h)

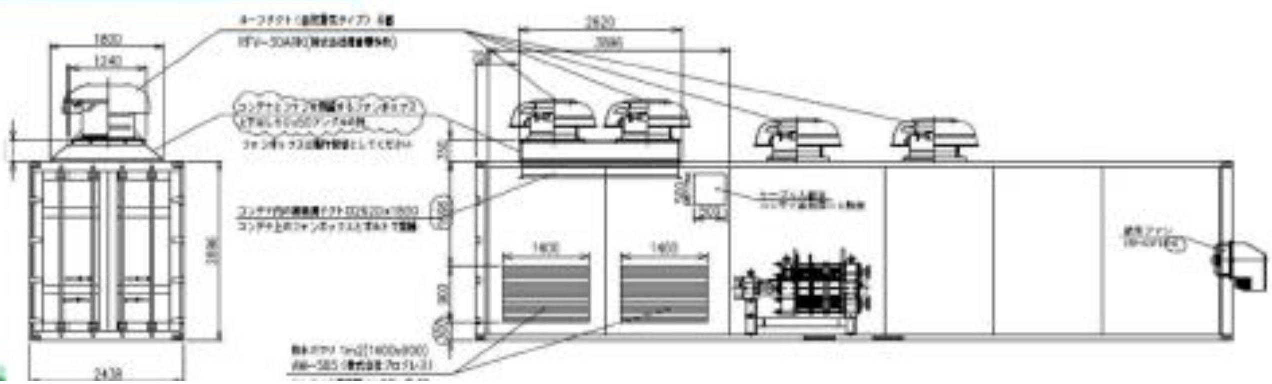
MW class PEM water electrolyzer

MW class (200 Nm^3/h) PEM water electrolyzer has been developed.
⇒Demonstration will be started in 2017.





Pressure :0.85 MPa
Electric Capacity :1000 kWel
Dimension:40ft container



Conversion of hydrogen to usable fuel

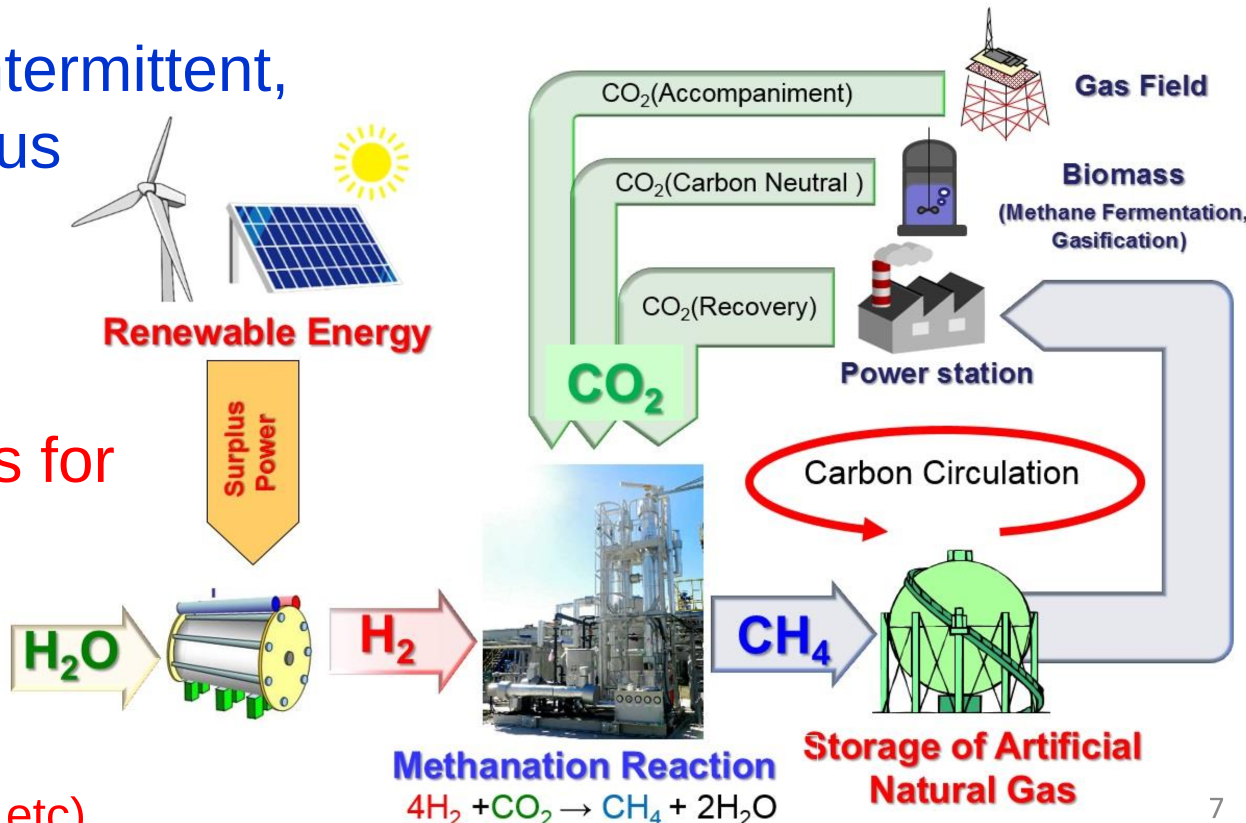
Converting hydrogen to methane makes it easier to use fuel, and CO_2 can also be reduced.

Power to SNG(Methane)
= Carbon Circulation by using of Renewable Energy

Renewable Power Intermittent,
Fluctuation and Surplus

Methane: Worldwide
Existing Infrastructures for

- Transportation
  (Gas grids, LNG Tankers)
- Storage
  (LNG Tanks, Grids)
- Utilization
  (Gas Engine/Turbine/ CHP etc)



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Energy Conversion Efficiency for methanation

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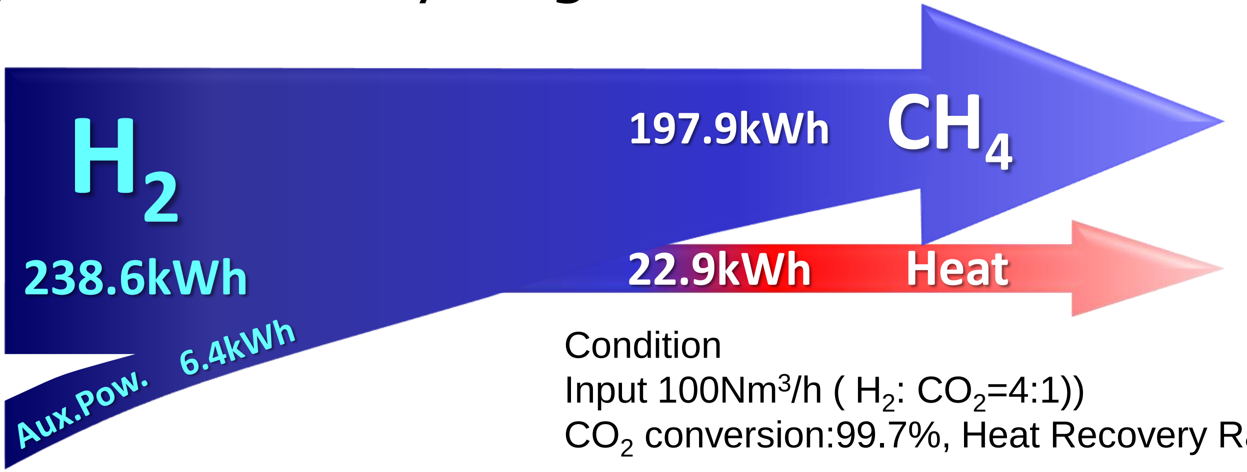
Energy flow from Hydrogen to Methane



Condition
Input 100Nm^3/h (H_2: CO_2=4:1))
CO_2 conversion:99.7%, Heat Recovery Ratio:58%

Energy Efficiency for Methanation

$H_2 \rightarrow CH_4$	80.8% (LHV)
$H_2 \rightarrow CH_4$ with Heat recovery	90.1% (LHV)

Energy efficiency for methanation is enough high in compared with other energy carriers

History of Methanation Development

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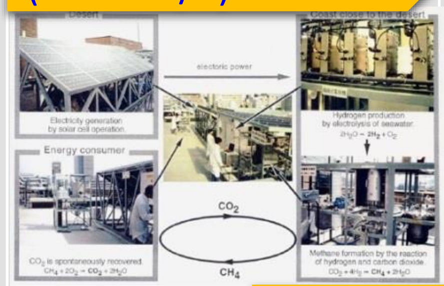
Age	1995～	2005～	2010～	2015～

R&DS stage & Plant scale

JSPS PJ(Model Plant) (0.1 Nm^3/h)



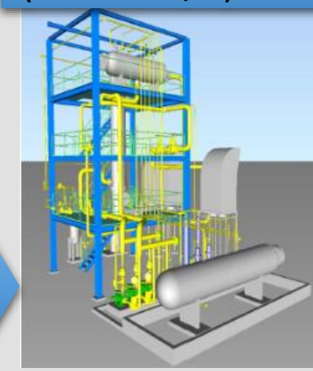
Millennium Pj (1Nm^3/h)

Joint-research with Tokyo Gas(6 Nm^3/h)

Joint-research with PTTEP (2 Nm^3/h)

NEDO PJ for SNG from Biomass(18Nm^3/h)

Basic Designging (250 Nm^3/h)



NEDO PJ for Energy Carrier(12.5 Nm^3/h)

Model(Fundamental)

Pilot

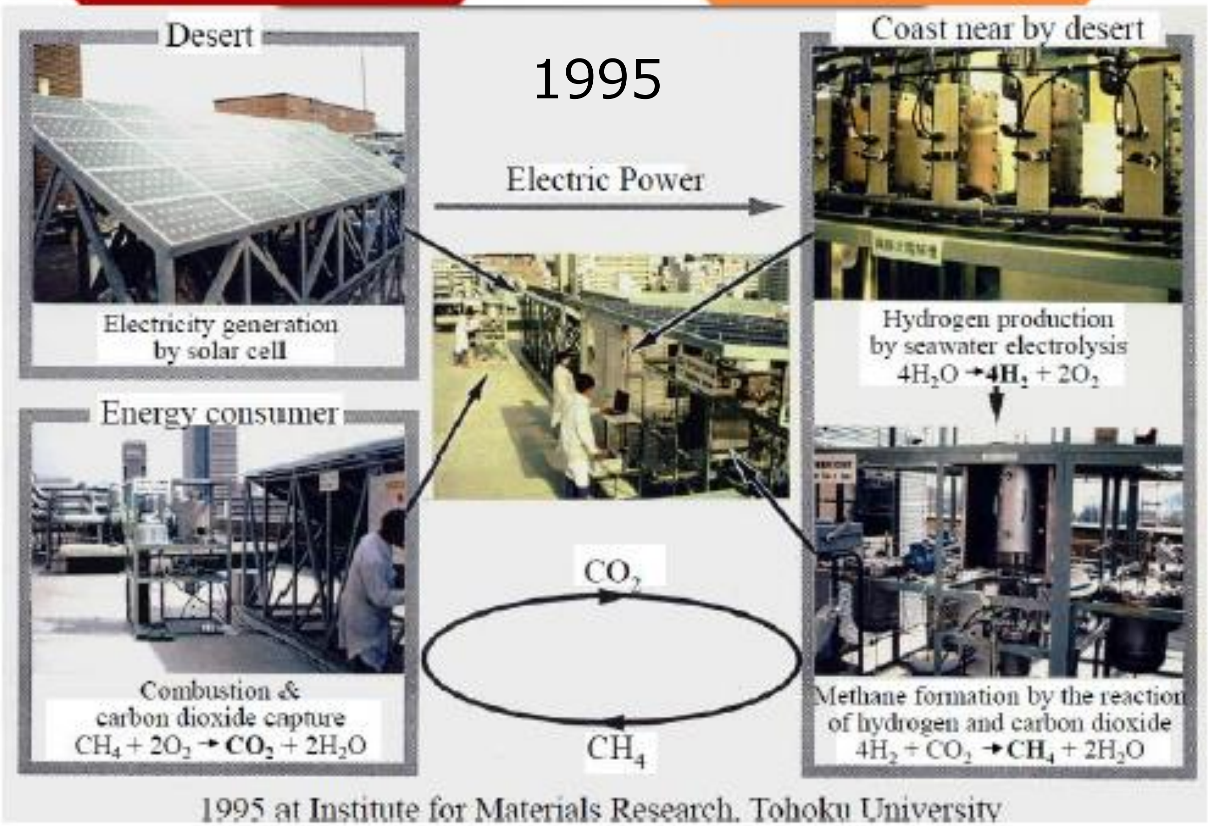
First demonstration PtG plant in the world

Concept of Power to X :

2016 5th Dec in Grenoble "Energy storage technologies by power to fuels and chemicals event"

End of 80's and beginning of 90's – Pr Hashimoto in Japan

First demonstration of P2G on the roof of Tohoku University



0.1Nm^3-Ch$_4$/h

3D Image of 250 Nm^3-CH_4/h plant

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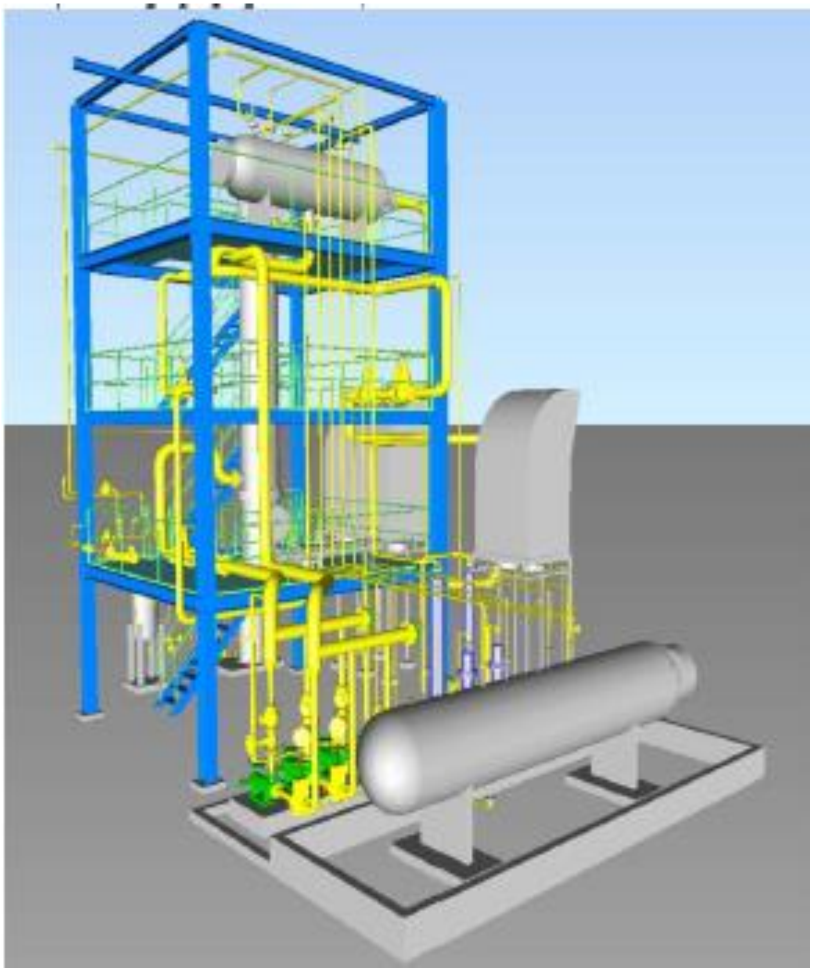
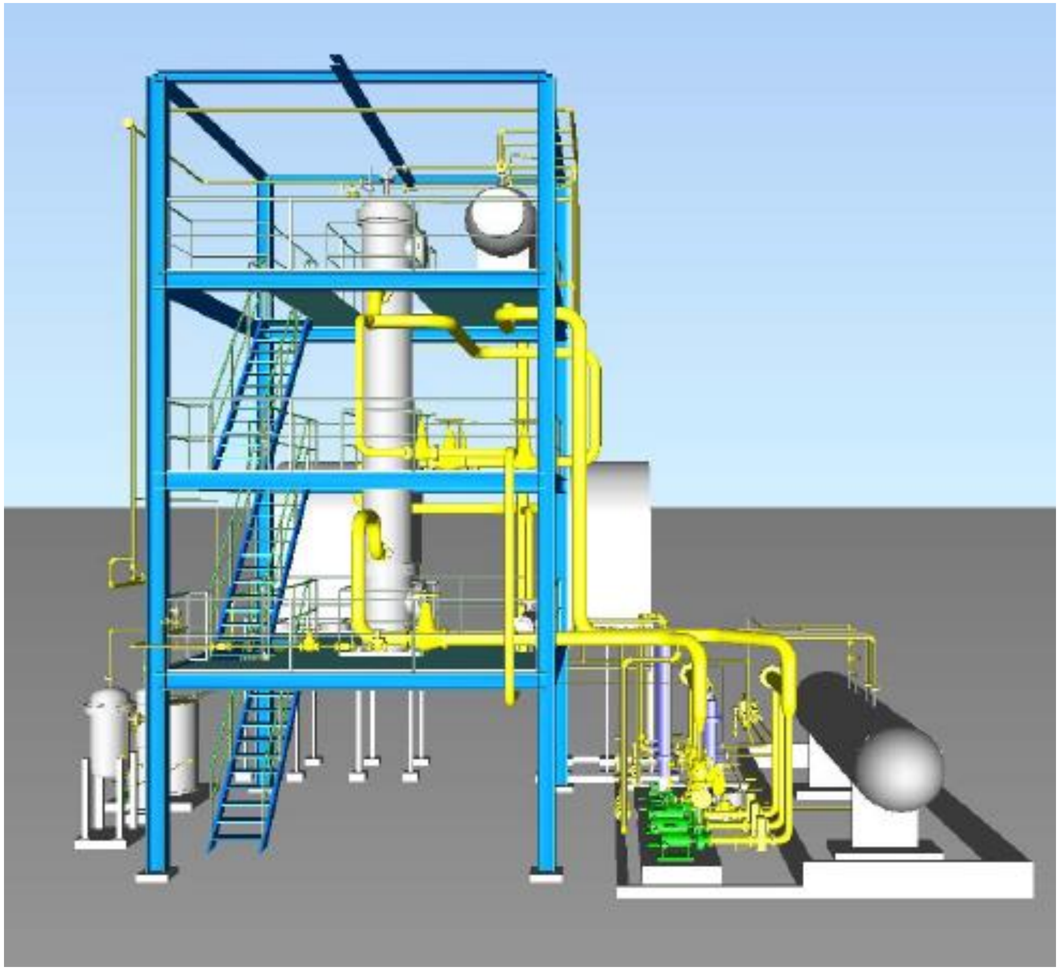
250Nm3/h 250Nm3/h

$$CO_2 + 4H_2 \rightarrow CH_4 + 2H_2O$$

1,000Nm3/h ⟶ Equivalent to 5MW





Largest Methanation plant in the world

Audi e-gas plant

Max 6.3MW

Max 1,260Nm^3/h

Max 315Nm^3/h

Designed by Etogas in 2013

Production of Renewable Fuel

Methanation ⇒ Final Destination

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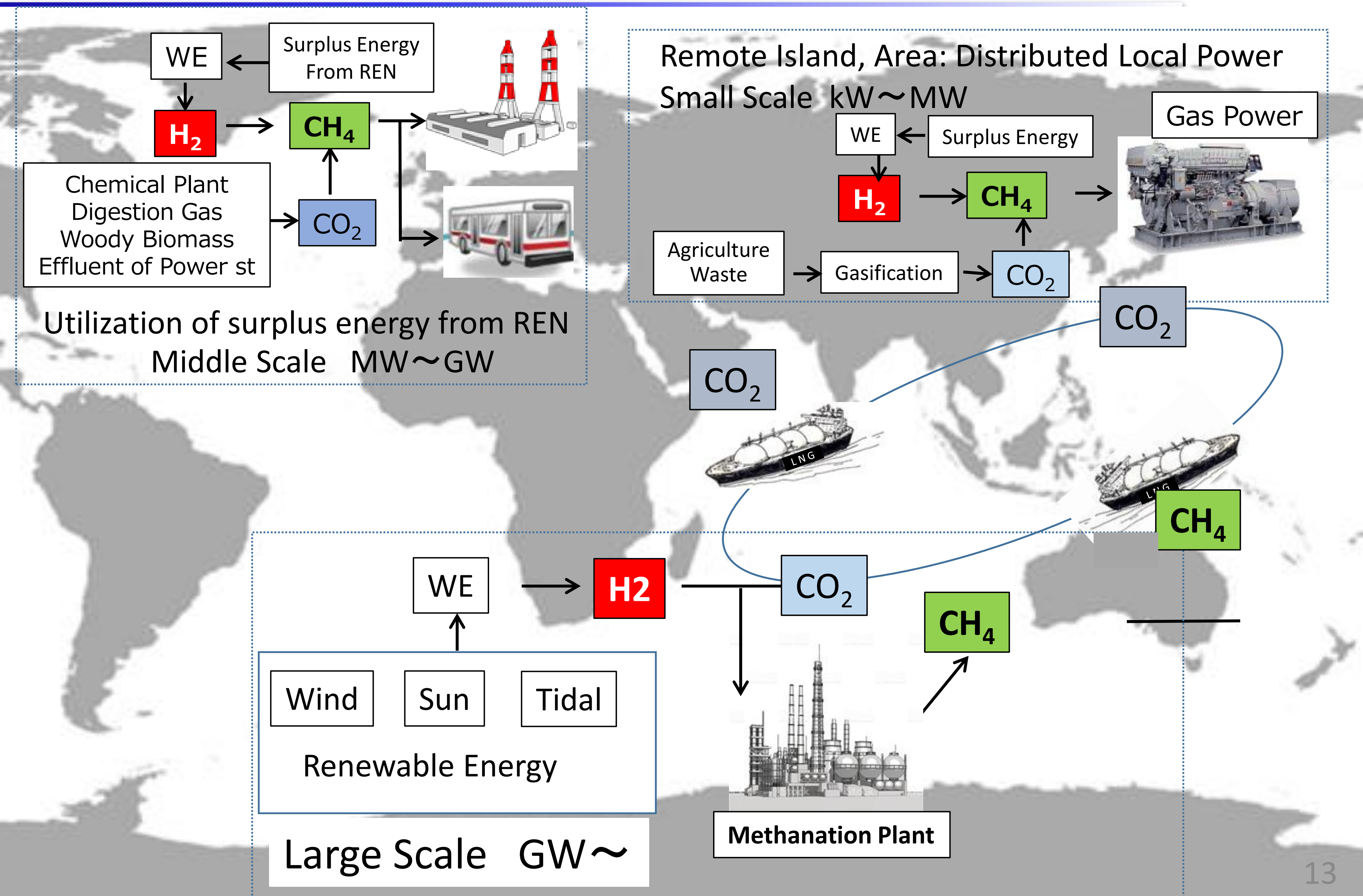


Thank you for your attention!

Technology for People, the Earth and the Future

地球と人のための技術をこれからも

日立造船はつないでいきます。かけがえのない自然と私たちの未来を。

Hitz Hitachi Zosen 日立造船株式会社 http://www.hitachizosen.co.jp/

A part of our work is supported by below projects of New Energy and Industrial Technology Development Organization (NEDO), Japan.

Global CO2 recycling

Global CO_2 Recycling
Advocate
Emeritus Prof.
Koji Hashimoto
Tohoku Univ

Sabatier Reaction

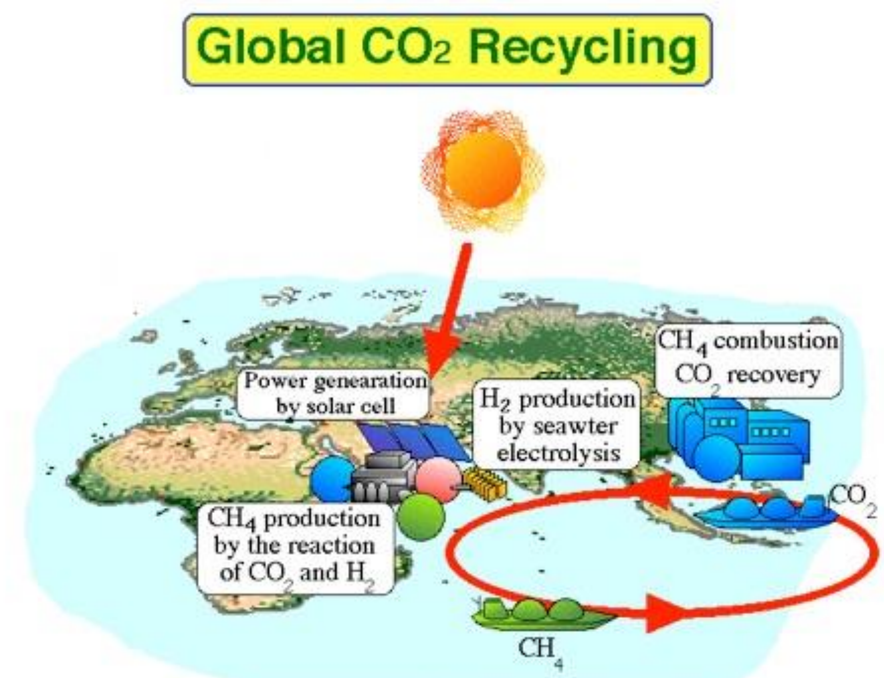
Catalyst

$$4H_2 + CO_2 \xrightarrow{\text{Catalyst}} CH_4 + 2H_2O$$

CO_2 Recycling

Renewable energy →H_2 energy + CO_2 → Methane→LNG fired power→CCR

CCR: Carbon Capture and Reuse



Professor Hashimoto proposed Global CO_2 Recycling System **26 years ago**, we and his group have so far developed new materials such as **new electrodes** for Alkali water electrolysis and Methenation **catalysts** so as to realize his idea.

12.5 Nm^3-CH_4/h Methanation (NEDO Project)

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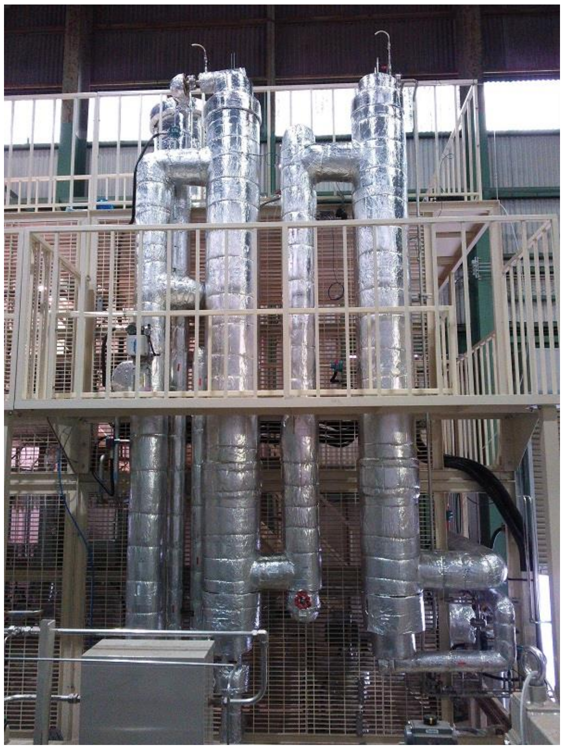
CH_4 Production 12.5Nm^3/h (max)
(Amount of H_2 input : 50Nm^3/h(Max.)



Performance Data

Items		Value
Operation Condition	GHSV / h^{-1}	4,807
	Pressure / MPaA	0.5
	Temperature / ^oC	230
CO_2 Conversion Rate / %		99.2
Output Gas composition / vol%(dry)	CH_4	98.0
	CO_2	0.3
	H_2	1.3
Heat Recovery Ratio / %		73.2