4) Introduction of Nagaoka CCU Project for effective recycling of CO2 to produce methane

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About INPEX

On October 1, 2008, INPEX Holdings Inc. marked a new beginning by changing its name to INPEX CORPORATION, following completion of the business integration between INPEX CORPORATION and Teikoku Oil Co., Ltd.

INPEX is the largest oil and gas E&P company in Japan. INPEX are currently engaged in more than 64 projects spread across more than 20 countries worldwide.

INPEX's 1 of special class share (18.94%) are held by the Minister of Economy, Trade and Industry (METI).

Please refer to our HP in detail!! https://www.inpex.co.jp/english/

Vision 2040 (established in May 2018) in INPEX

Sustainable Growth of Oil and Natural Gas E&P Activities

A top 10

international oil company

Development of Global Gas Value Chain Business

A key player

in natural gas development and supply in Asia & Oceania

Reinforcement of Renewable Energy Initiatives

10%

of project portfolio

INPEX's Strengths

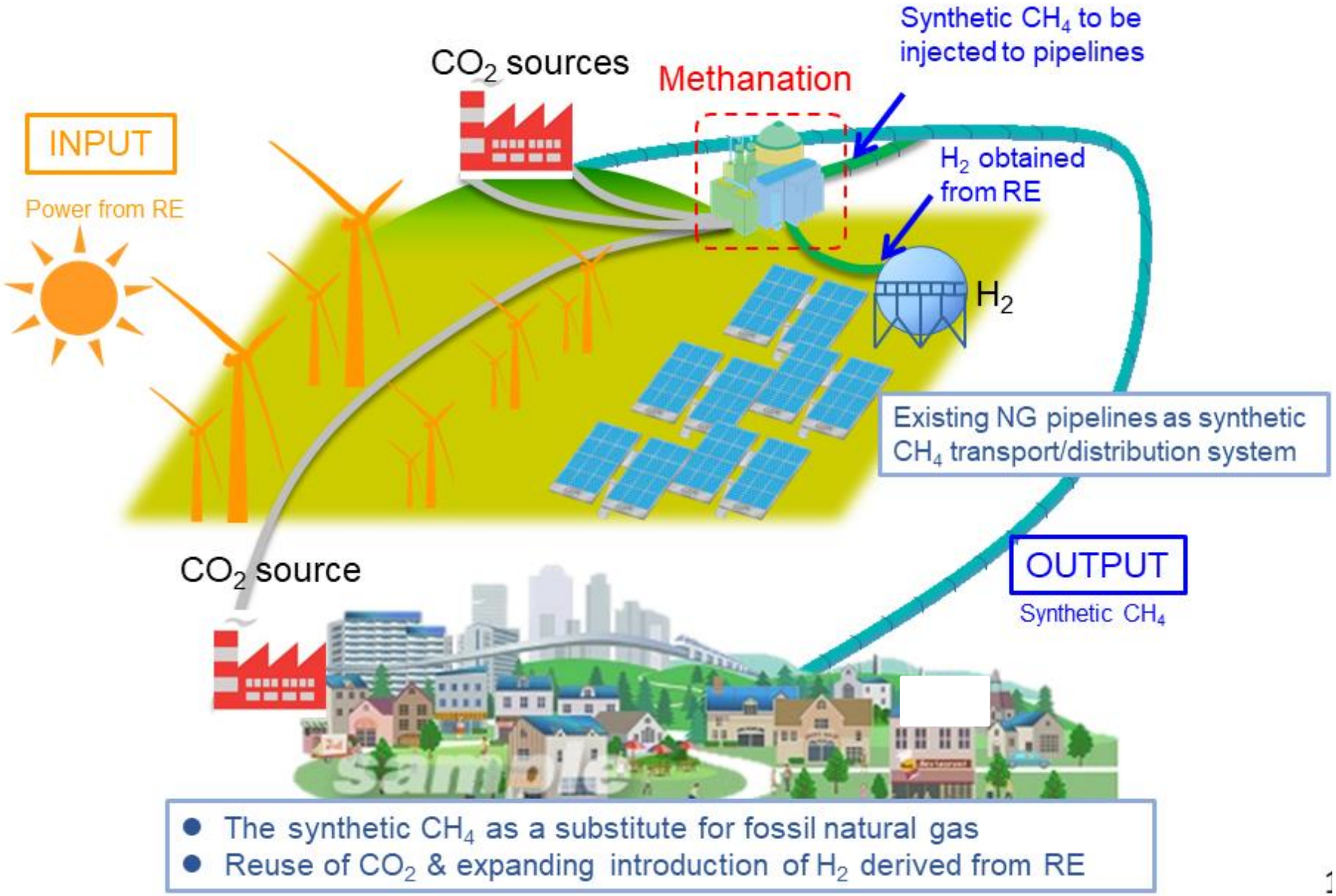
Strong portfolio, partnerships with oil-producing countries, project execution capabilities, diverse human resources, financial soundness, support from the Japanese government

Reduce carbon footprint

Continuously and sustainably increase corporate value

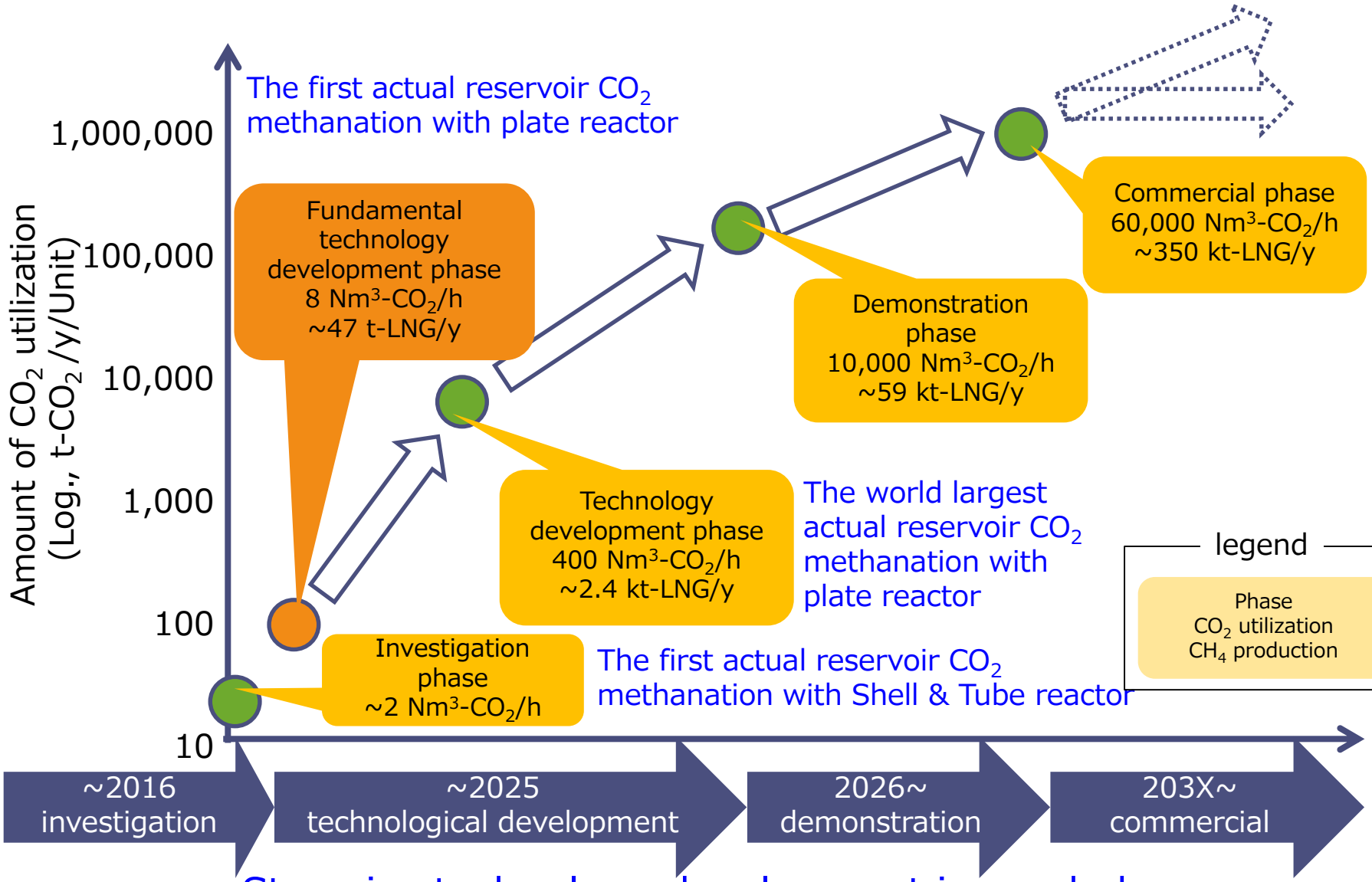
INPEX has already started the projects of renewable energy such as geothermal power, PV and WT in Japan and overseas.

Conceptual illustration of the INPEX's project



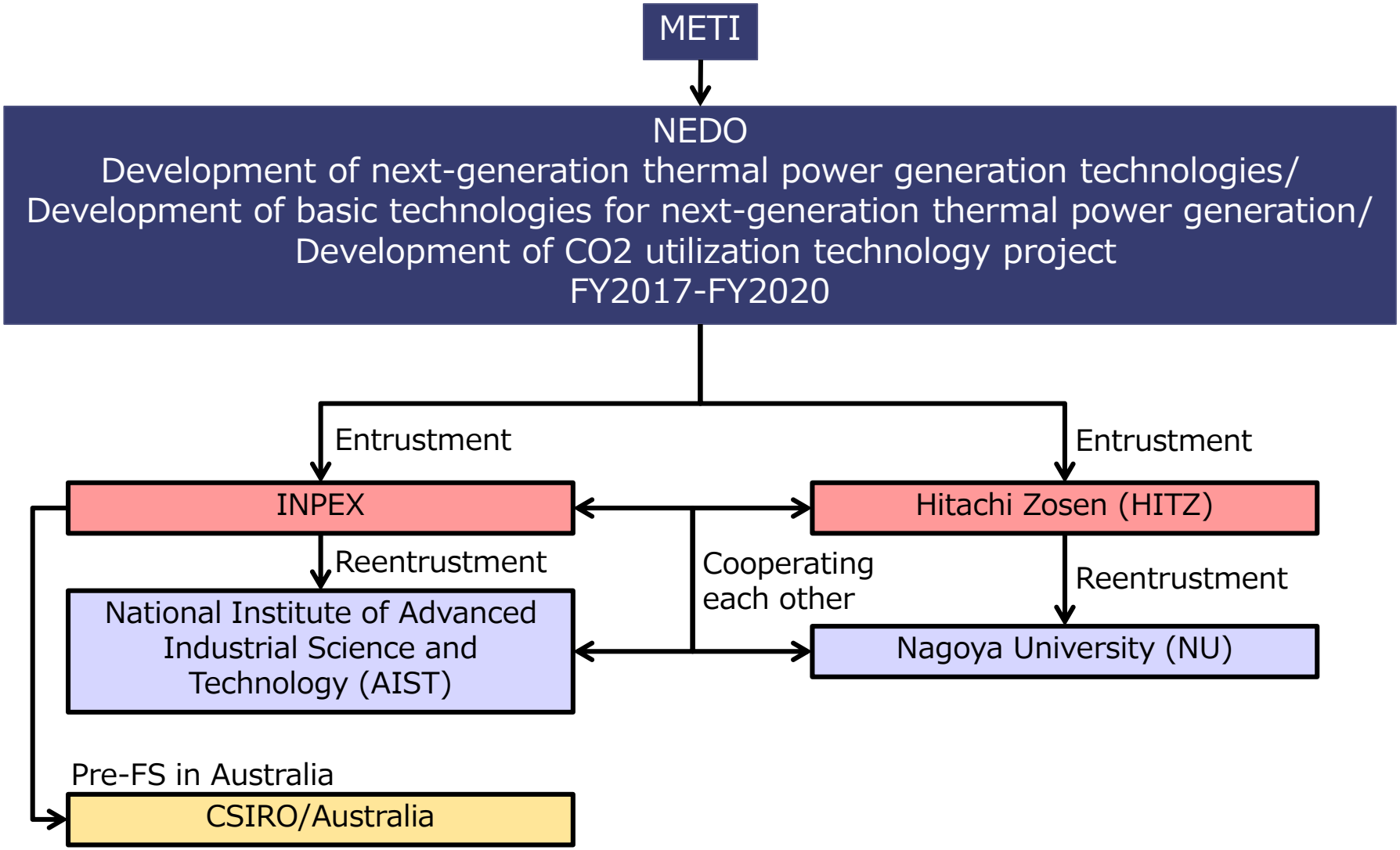
- The synthetic CH_4 as a substitute for fossil natural gas
- Reuse of CO_2 & expanding introduction of H_2 derived from RE

Roadmap of NEDO/INPEX methanation project



Stepwise technology development is needed to complement cost reductions due to scale-up

Organization of this project



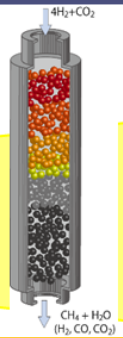
Research teams of various organizations are conducting R&D in close cooperation for 4 objectives.

Interaction of these research team & 4 objectives

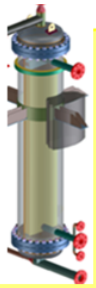
INPEX

1. Scaleup of the reactor/system

INPEX Hitz



July
(FY2019)



Demonstration plant
at NAGAOKA, Niigata

4. Overall analysis

Scale-up for commercialization

Labo-scale exam.

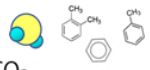
Pilot scale exam.

0.1 $Nm^3 \cdot h^{-1}$

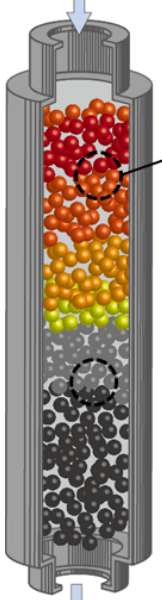
1-8 $Nm^3 \cdot h^{-1}$

2. Mechanism
3. Simulation

S, VOC etc.



$4H_2+CO_2$



$CH_4 + H_2O$
(H_2, CO, CO_2)

AIST

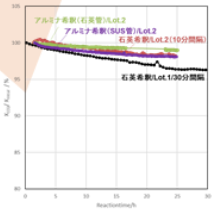
Investigations on:
- Thermal degradation in hot spot region
- Chemical degradation caused by trace elements (e.g. Sulfur, BTX,)
- Optimization to homogenize temperature distribution

名古屋大学
NAGOYA UNIVERSITY

Develop chemical reaction model for methanation over the highly active Hitz catalyst

Experiences from demonstration plant

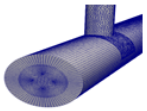
Suggestions from Fundamental study



Clarifications: effects of temperature, contaminations on catalytic activity

Systematic experiments in laboratory-scale facility

Interaction

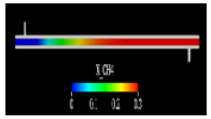


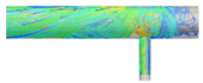
Exploration of optimum operation condition for high conversion, selectivity, thermal efficiency

Develop an original in-house numerical code for simulating chemically reacting flow and heat transfer in the methanation reactor

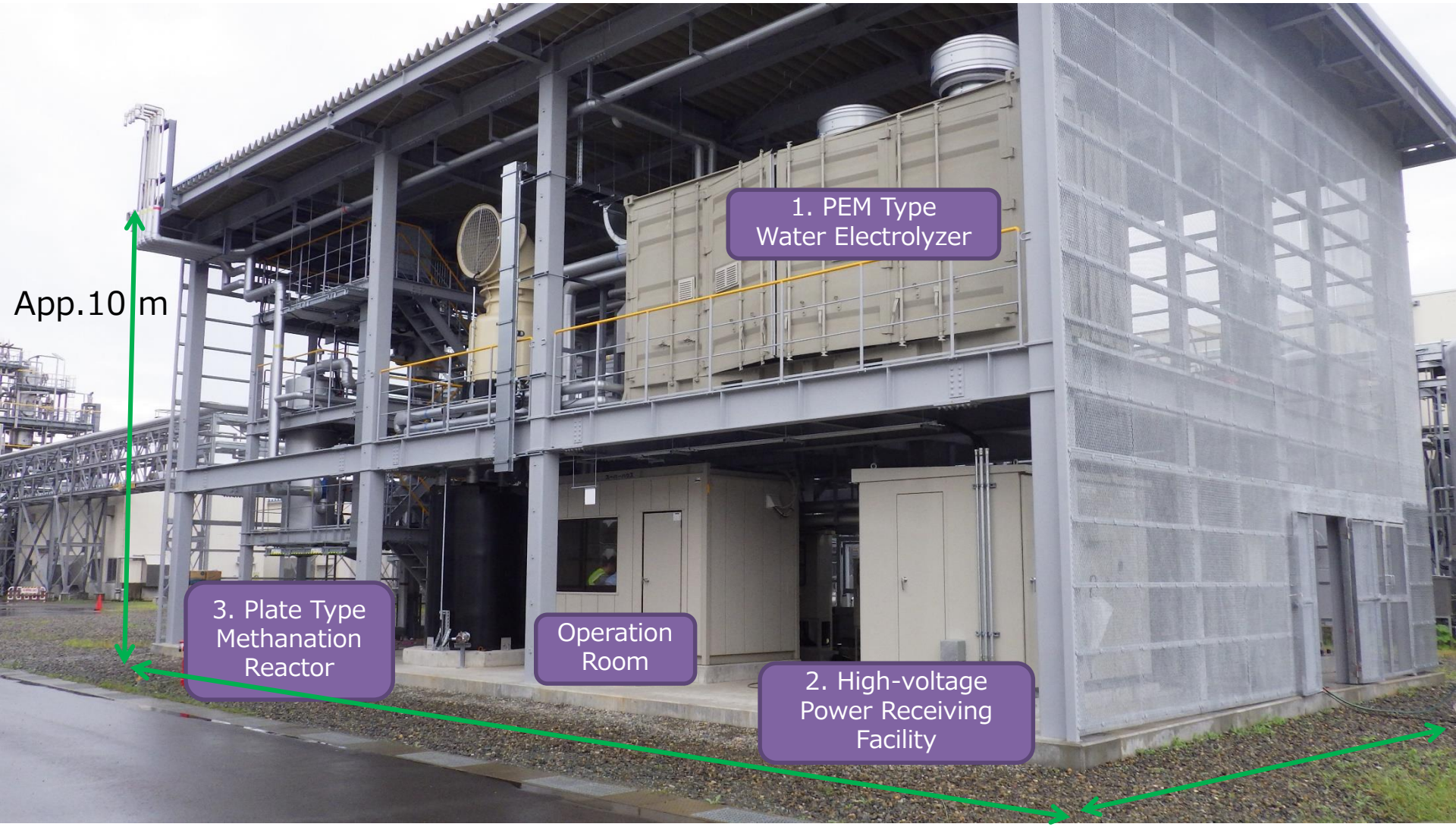
Predict reaction and flow characteristics in the reactor with numerical simulation

Simulation driven the best reactor design and acceleration of process development



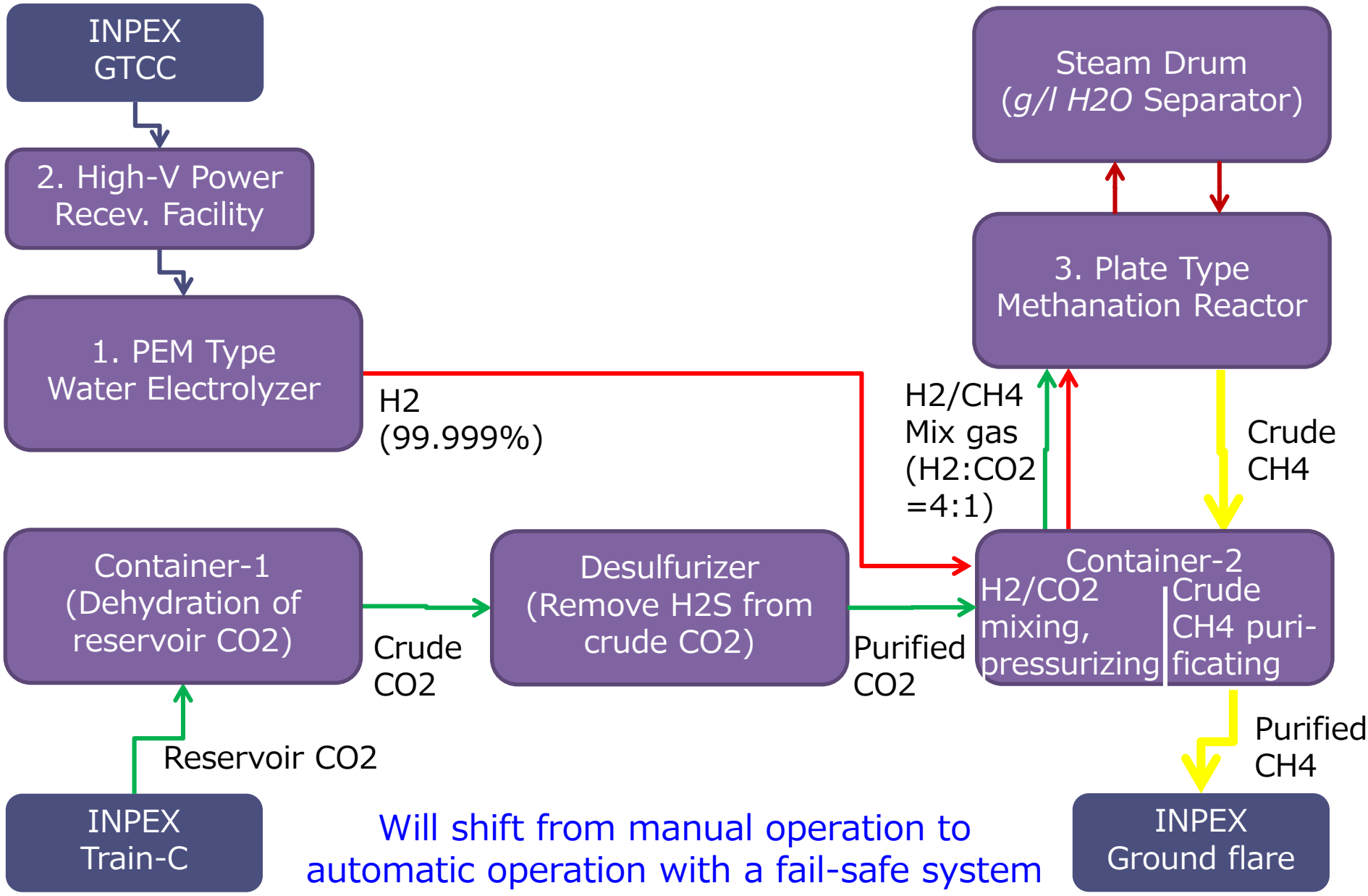


8 Nm3-CO2/h methanation plant@Nagaoka



NEDO/INPEX/Hitz started bench-scale testing at the Koshijihara Plant in the Nagaoka Gas Field of Niigata Prefecture, where INPEX produces natural gas.

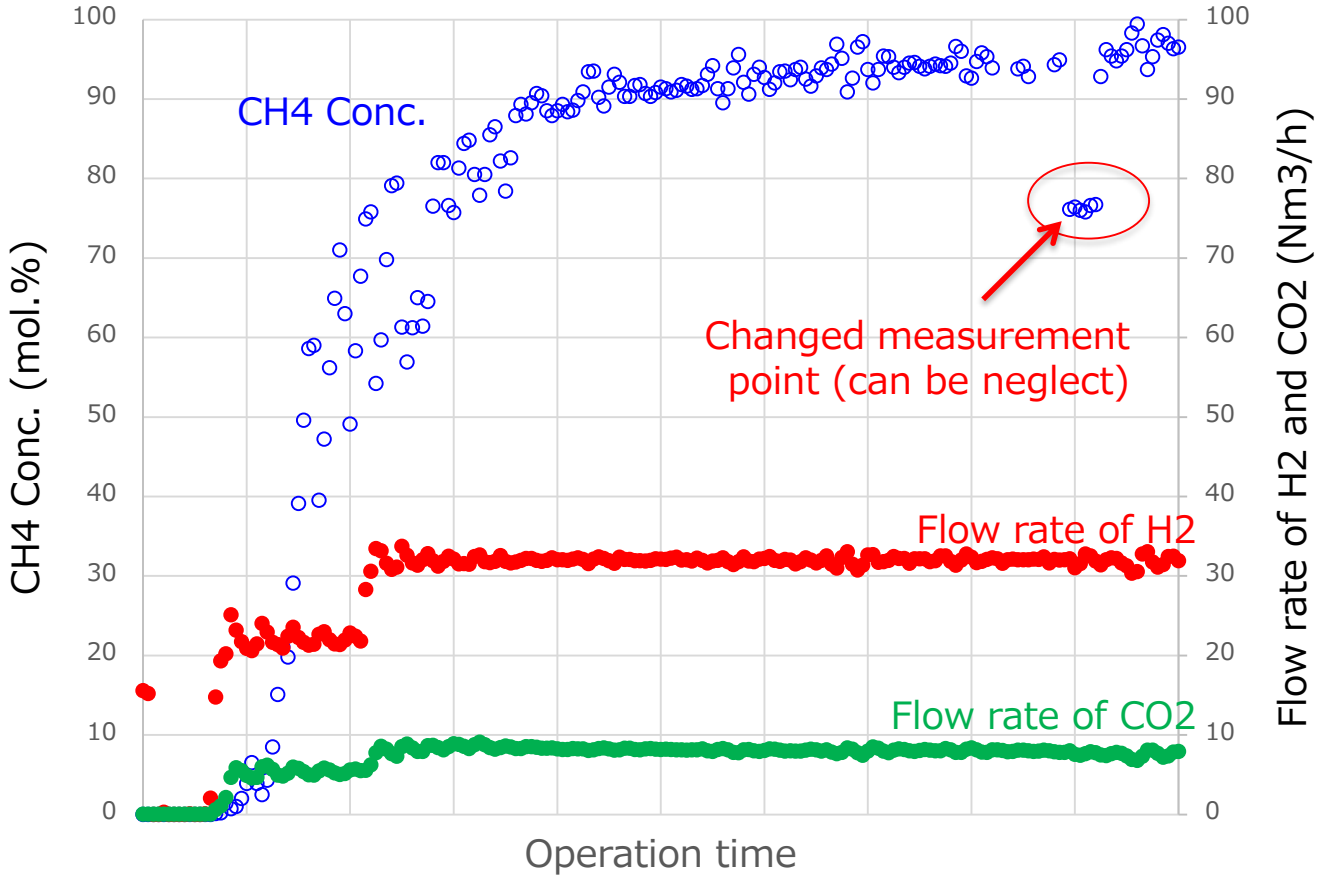
System flow of the test plant



Results of the methanation by actual reservoir CO2

- Operation load: 100% (8 Nm3-CO2/h)
- Temp. of thermal jacket: 238°C
- Pressure of the reaction: 0.7 MPaG

Reach the target as >96 mol.%-CH4



After various tests operation in which temperature, pressure and operation load etc. are changed, it is planned to shift to full loaded continuous operation.

Summary

- CO_2 methanation technology can reduce CO_2 while utilizing existing natural gas infrastructure (page 3-4).
- Commercial scale plant of 60,000 Nm3/h at over 203X will reduce 1 million tons of CO_2 annually (page 5)
- The economics of methanation mainly depend on the electricity (or Hydrogen) price of renewable energy.
- Under certain conditions, the electricity price is below 3 JPY/kWh, the IRR is roughly estimated to be 9.5%.
- Thank you for your attention!