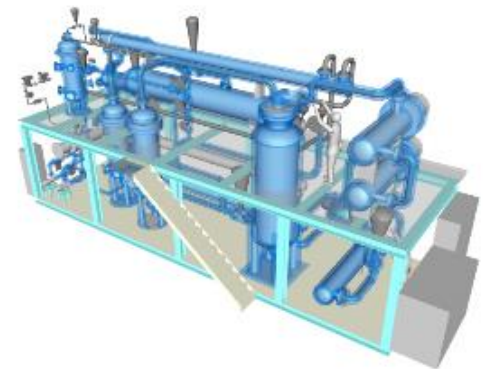


# Distributed Green Ammonia Production

by Low Temperature and Low Pressure Synthesis Technology

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Tsubame BHB Co., Ltd.  
June 2023



# Tsubame BHB: Startup Company from the Tokyo Institute of Technology (Tokyo Tech)

- Established in April 2017.
- Financial Series C1 completed in 2022.

## Establishment Background



**Hosono Laboratory**  
(Tokyo Institute of Tech)

Innovative ammonia synthesis catalyst technology

*Nature Chem.* **2012**, 4, 934-940



**Tsubame BHB**

**Company Establishment**



AJINOMOTO

**Ajinomoto Co., Inc.**  
(food and biotechnology)



**Universal Materials Incubator Co., LTD.**  
(Venture Capital)

## Company Overview

Name	Tsubame BHB Co., Ltd.
Main Address	4 <sup>th</sup> Floor, Konwa Building, Tsukiji 1-12-22, Chuo-ku, Tokyo
R&D Center	4259 Nagatsuta-cho, Midori-ku, Yokohama City, Kanagawa Suzukakedai Campus, Tokyo Institute of Technology, J-3 Building, Room 1417
Kawasaki Branch	1-1 Suzuki-cho, Kawasaki-ku, Kawasaki City, Kanagawa Ajinomoto Co., Inc., Kawasaki Pilot Plant
Established	April 2017
Business Activities	R&D, production, sales and maintenance of Ammonia synthesis catalyst and On-site ammonia supply systems
Employees	60 (Incl. temporary employees)

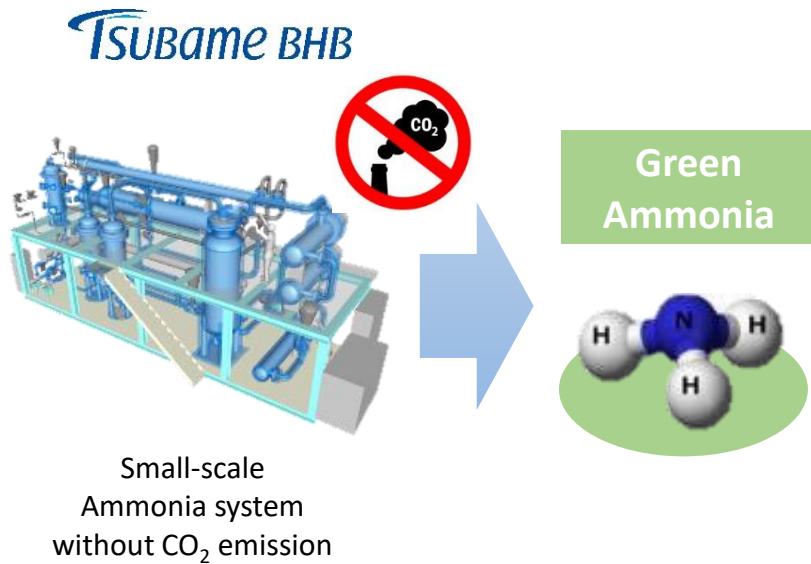
## Main Stockholders



# Tsubame BHB provides a solution to de-carbonize the agricultural industry through modular system

1. Replace conventional ammonia production with CO<sub>2</sub> emission to CO<sub>2</sub>-free production

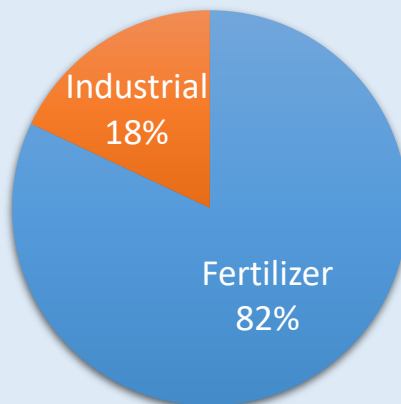
2. Reduce cost and stabilize ammonia supply-chain through distributed ammonia production



# Tsubame provides a carbon-free solution for \$90B market of Nitrogen Fertilizer

Existing Market: Total 180 million ton

Ammonia Application:



Ammonia



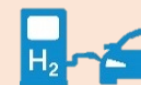
Emerging Market: **potentially new 100 Mton market in 2035**

### Clean Fuel

- Maritime Fuel
- fuel of coal power plant



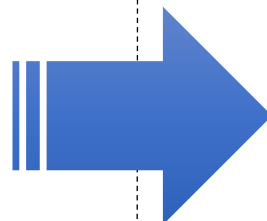
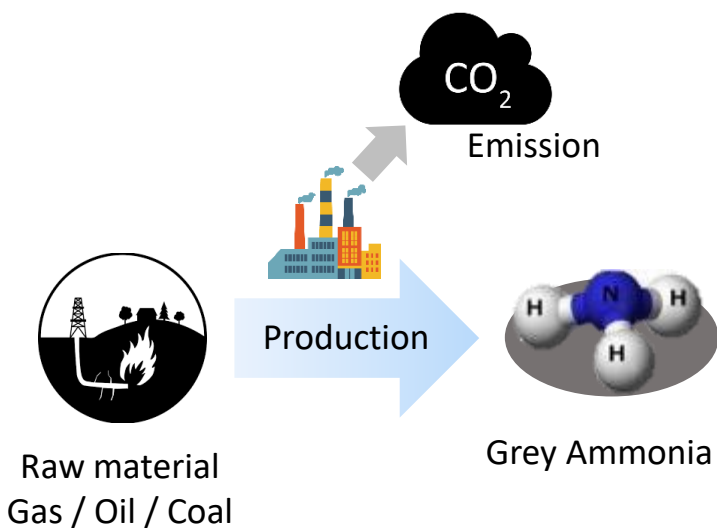
### Hydrogen Carrier



# Ammonia production is emitting >1% of global CO<sub>2</sub> emission

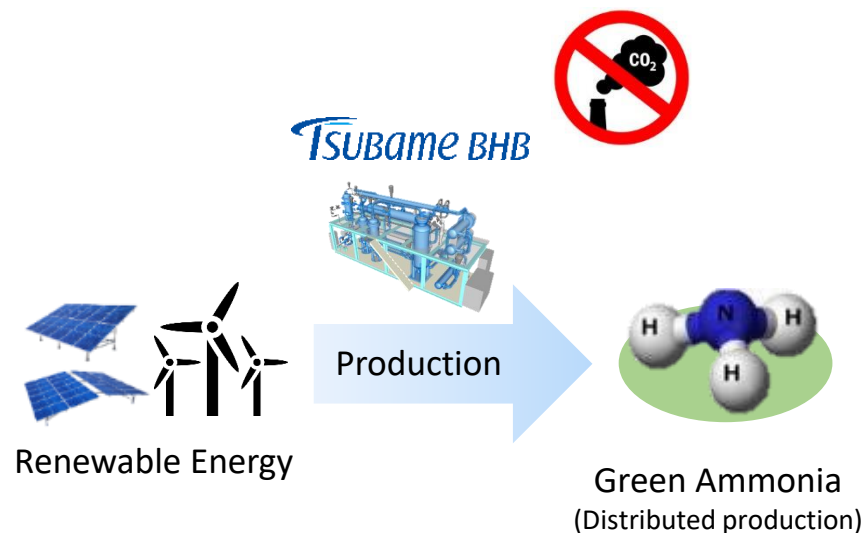
Current  
Ammonia Production

>1% of CO<sub>2</sub> in global emission



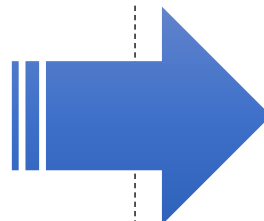
Green Ammonia Production  
By Tsubame technology

No CO<sub>2</sub> Emission

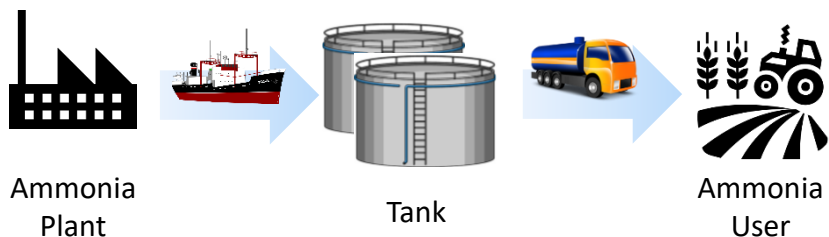


# Supply-chain cost and Risk of supply chain interruption

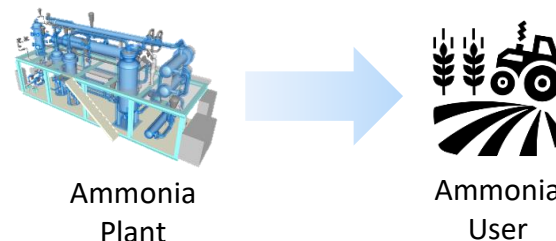
**Centralized** production  
with supply chain



**Onsite** Ammonia Production



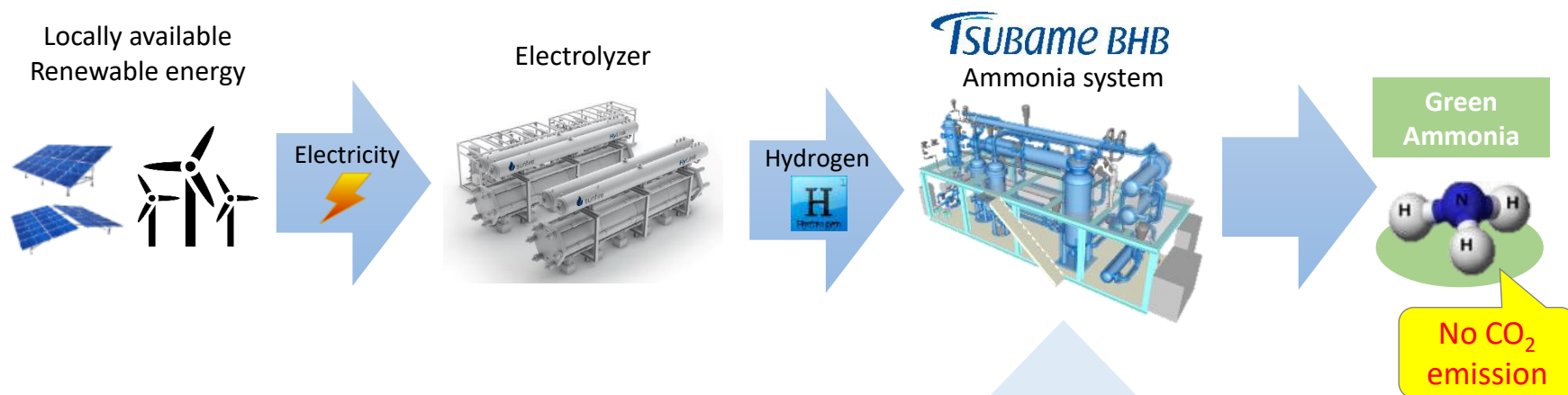
- ✗ Additional transportation and storage cost
- ✗ Additional risk of delivery interruption



- Supply chain cost saving
- Stable ammonia supply

# Green Ammonia Production by Small-scale production system

Semi-automated ammonia production system requires less operating labor, which enables user-friendly ammonia production.



Line-up of ammonia production system

Type	Module			Plant
Name	TM-500	TM-3000	TM-5000	
Capacity	500 ton/yr	3,000 ton/yr	5,000 ton/yr	10,000 – 50,000 ton/yr
Size	17 yd x 23 yd	22 yd x 33 yd	27 yd x 37 yd	TBC
CO2 avoidance (*2)	800 ton-CO <sub>2</sub> /year	5000 ton-CO <sub>2</sub> /year	8000 ton-CO <sub>2</sub> /year	16k – 80k ton-CO <sub>2</sub> /year

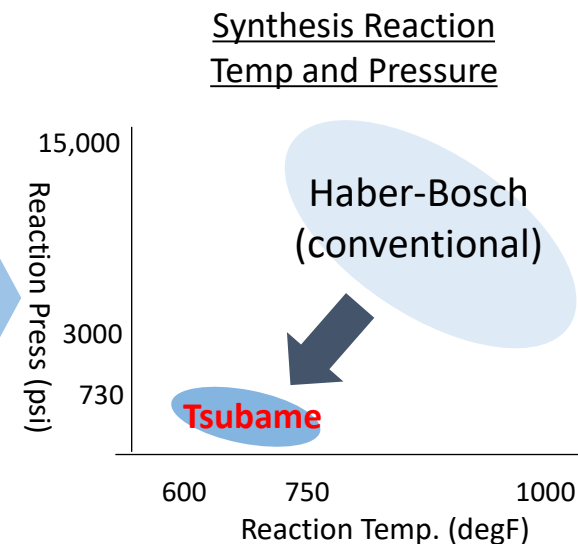
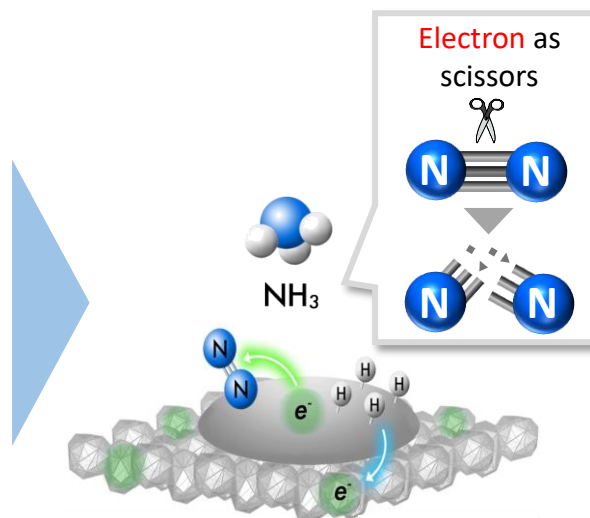
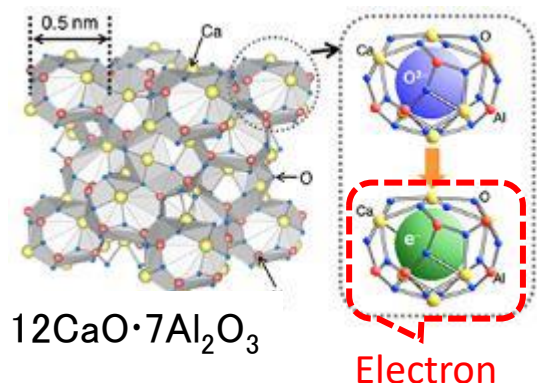
(\*1: CAPEX is for reference purpose only)

(\*2: comparison with natural gas based ammonia production)

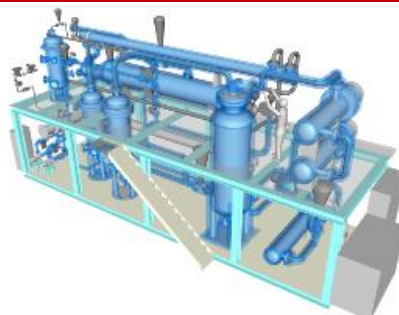
# Tsubame's Electride Catalyst enables Low Temp. and Pressure Ammonia Synthesis

Our electride catalyst, developed by Tokyo Institute of Technology, creates an advantage on small-scale ammonia production compared to conventional Haber-Bosch process

## Unique Electride catalysts



## Advantage on Small Scale production

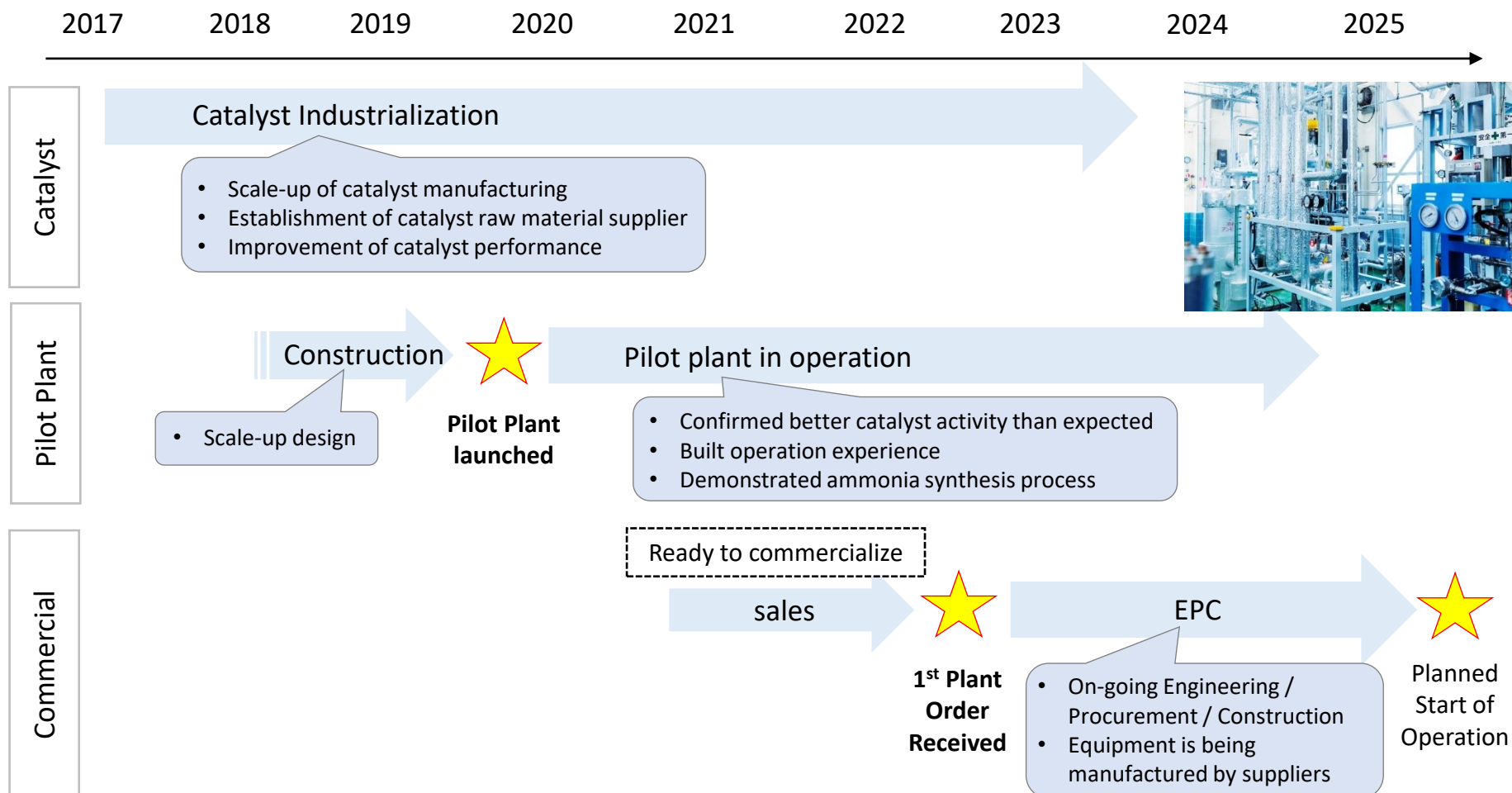




# Ready for deployment of commercial plant

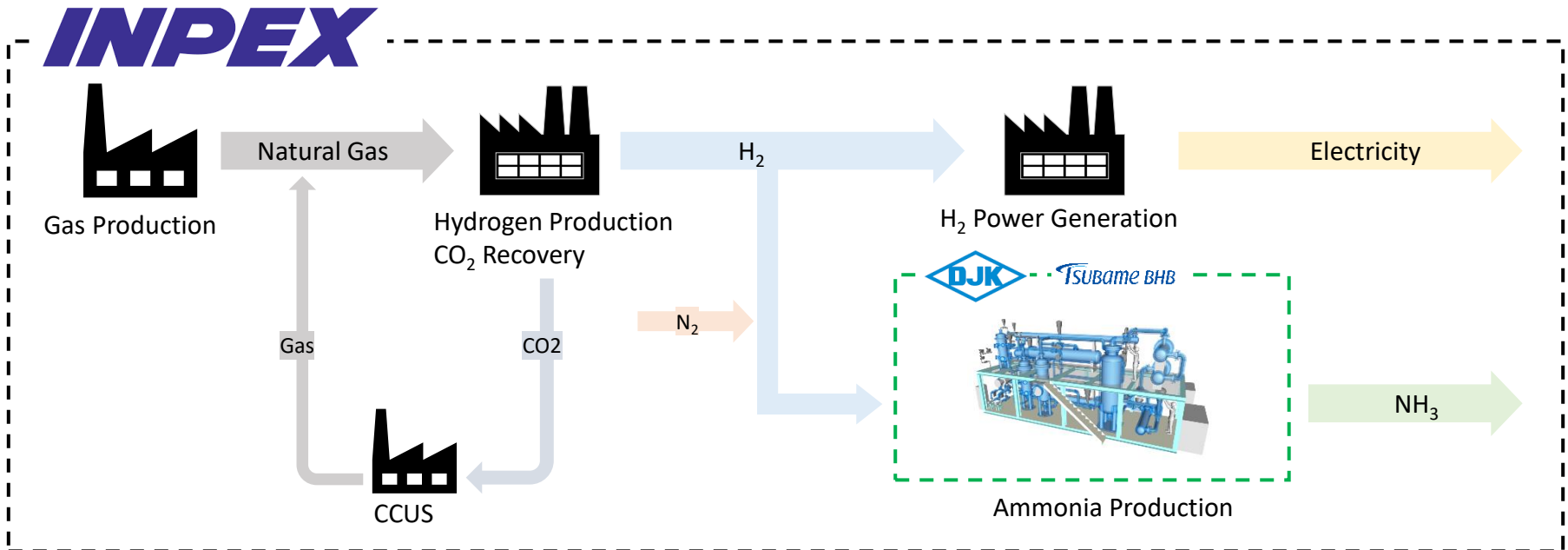
Engineering and Procurement of 1<sup>st</sup> commercial plant is on-going.  
We are ready to deploy our system for customers.

## Achievement / Milestone



# 1<sup>st</sup> Commercial Plant

PJ Owner: INPEX Co.  
 PJ: Kashiwazaki Clean Hydrogen/Ammonia Project  
 Plant Location: Niigata, Japan  
 Contractor: Daiichi Jitsugyo (DJK)  
 EPC Period: Dec. 2022 ~ Aug. 2025, plan to start operation from Aug 2025  
 Capacity: 500 TPA (TM-500)





# Clean Ammonia Demonstration Project in Niigata, Japan: Subsurface Perspective



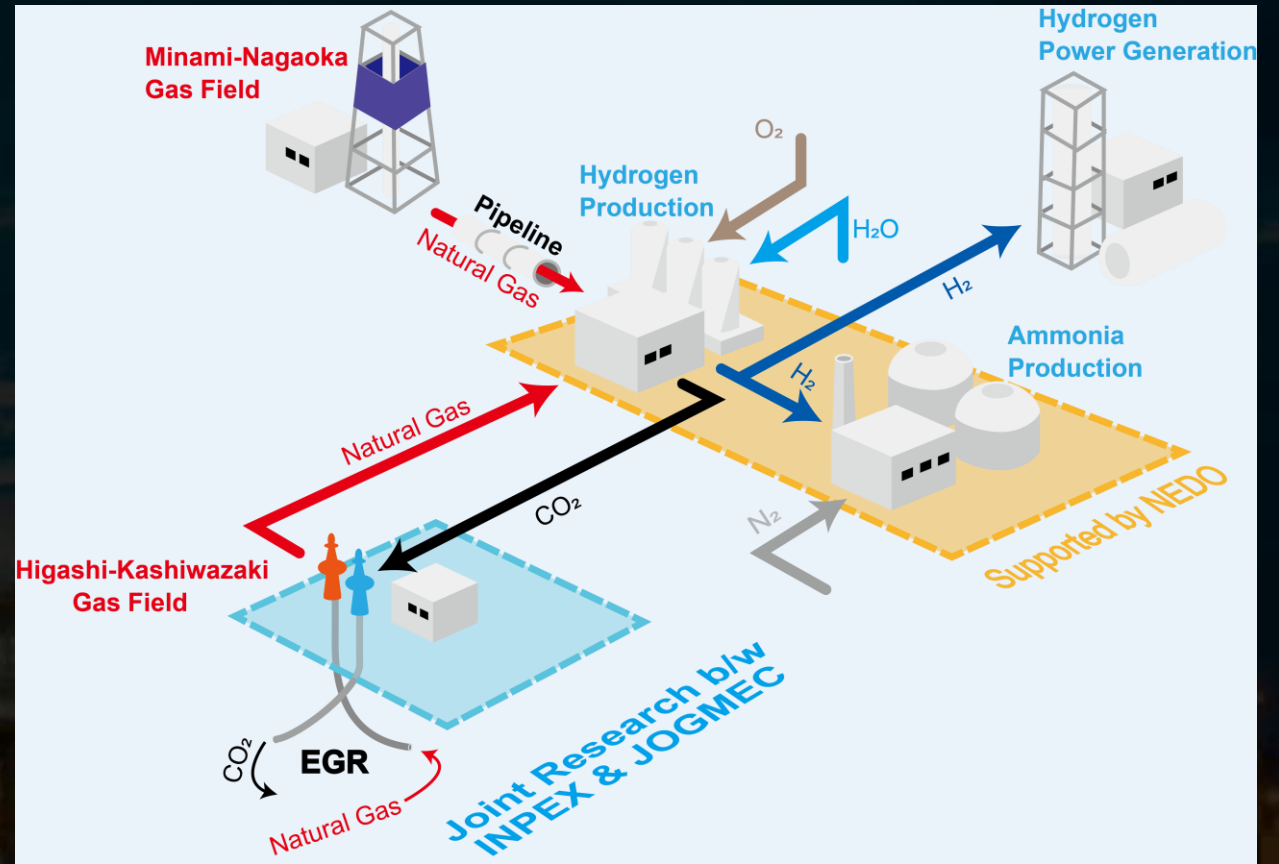
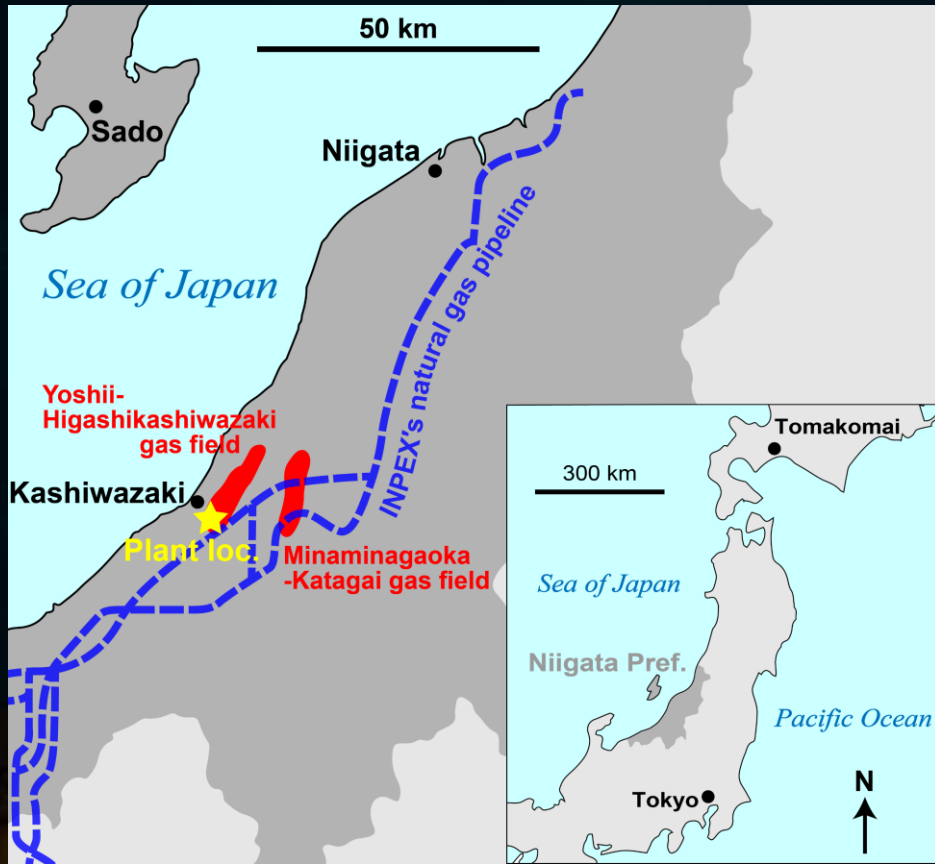
JOGMEC

Yasushi SHIMANO

Japan **O**rganization for **M**etals and **E**nergy Sec**u**rity

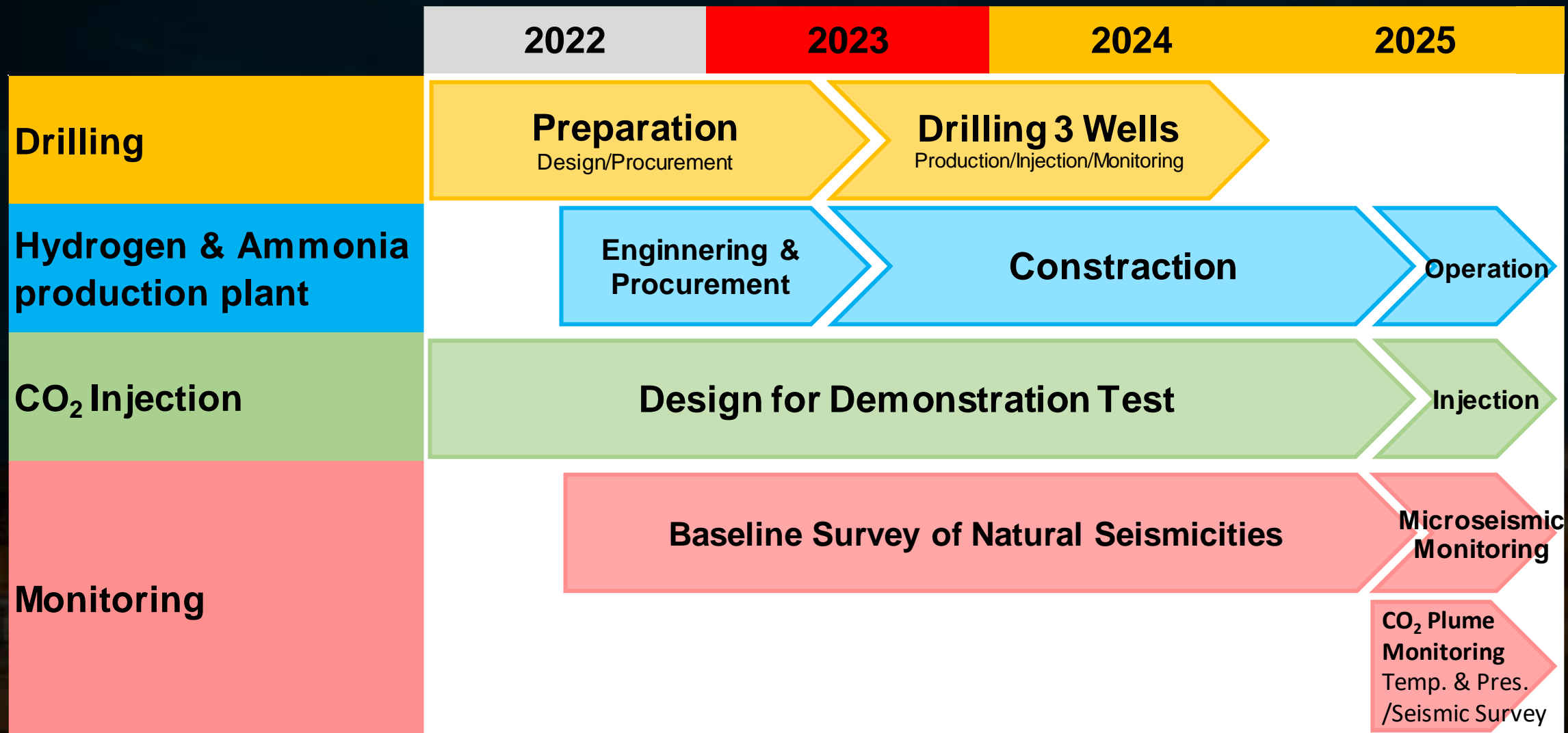


# Project Overview



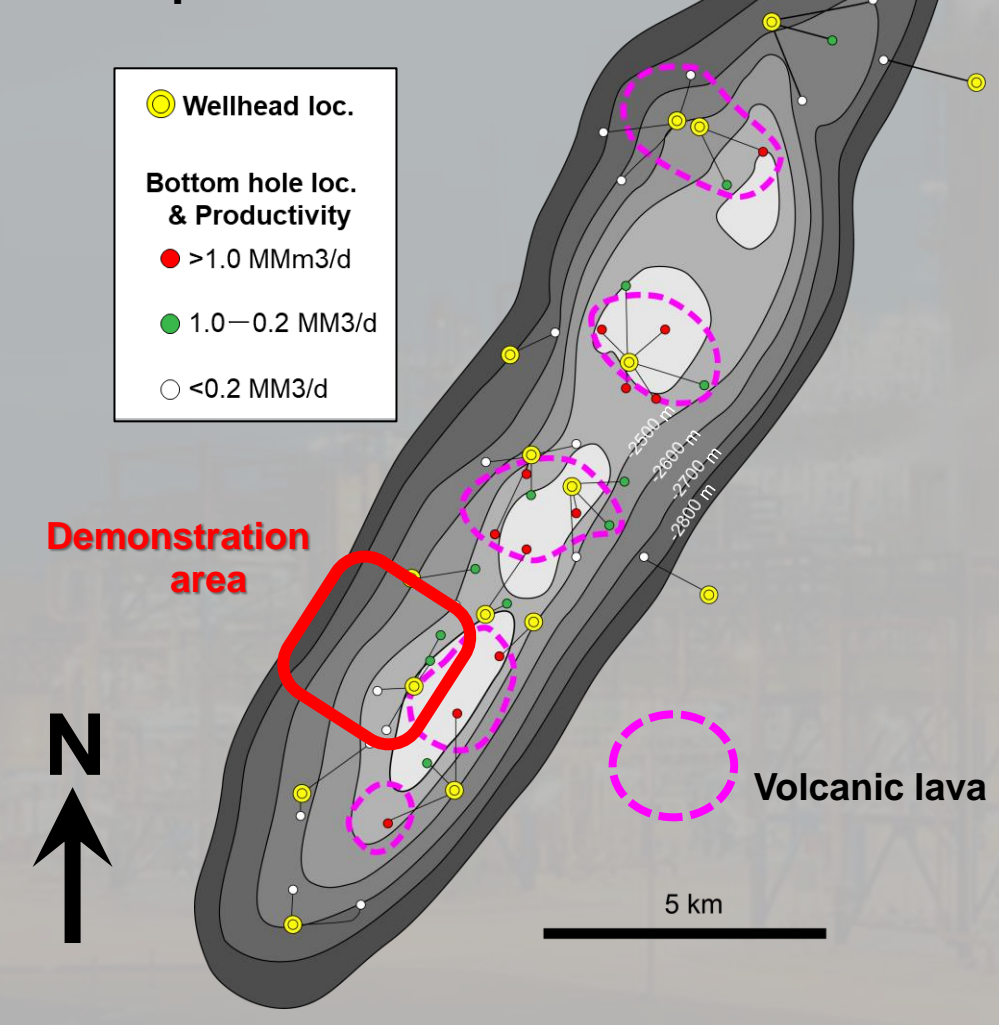
- INPEX, as an operator, plans to produce hydrogen and ammonia using natural gas produced from the Minami-Nagaoka gas field with the support of NEDO.
- INPEX and JOGMEC are conducting a joint research to inject associated  $CO_2$  of hydrogen production into the depleted reservoir of the Higashi-Kashiwazaki gas field.

# Project Schedule

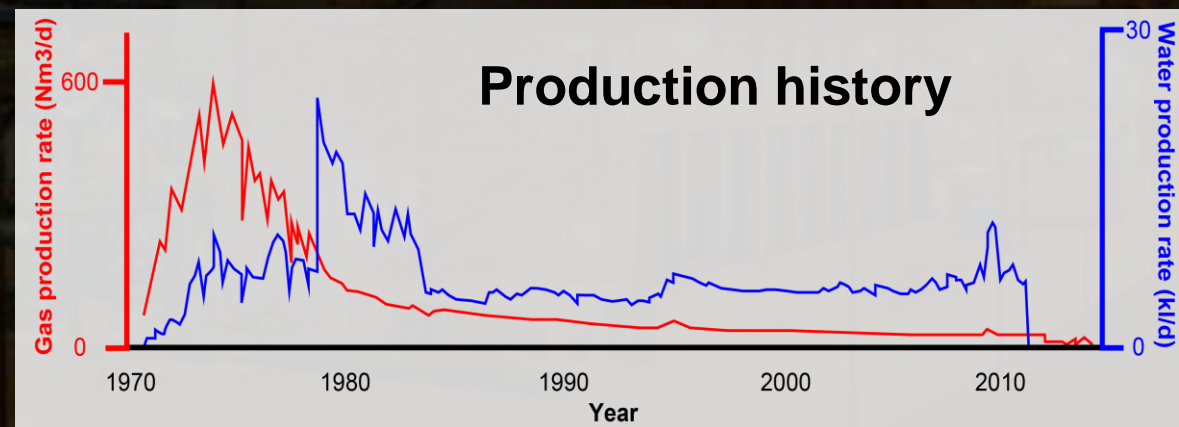
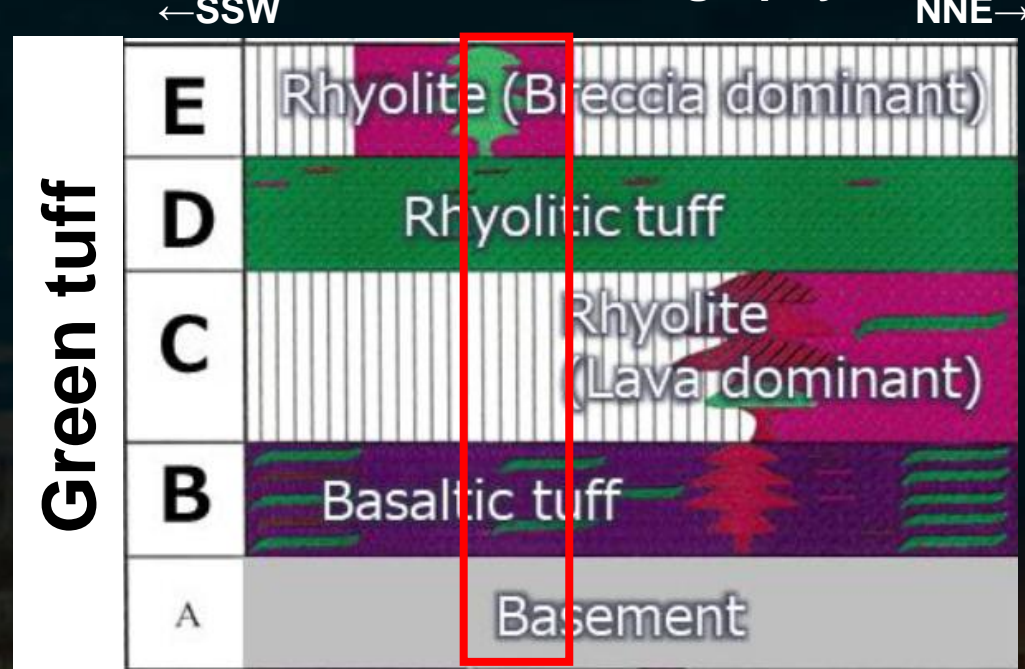


# Storage Reservoir Descriptions

Depth structure map of top reservoir



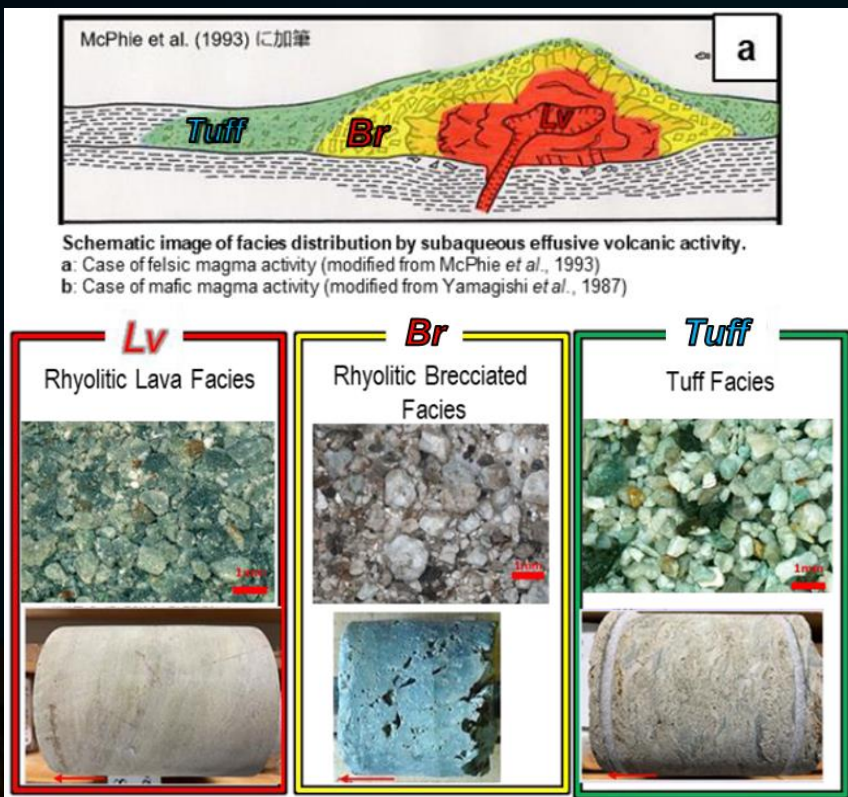
Reservoir stratigraphy



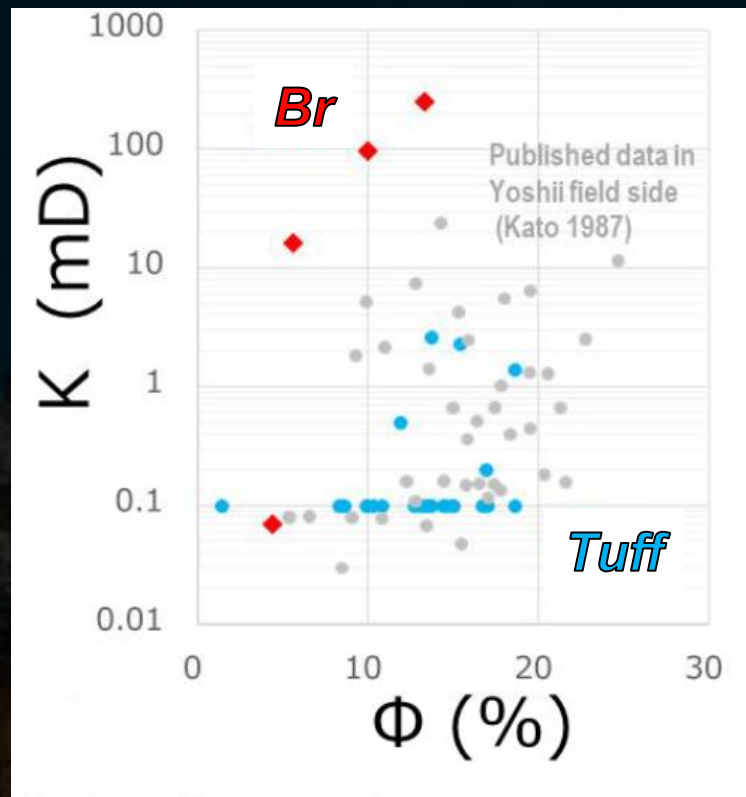


# Technical Focus (1): Reservoir Characterization

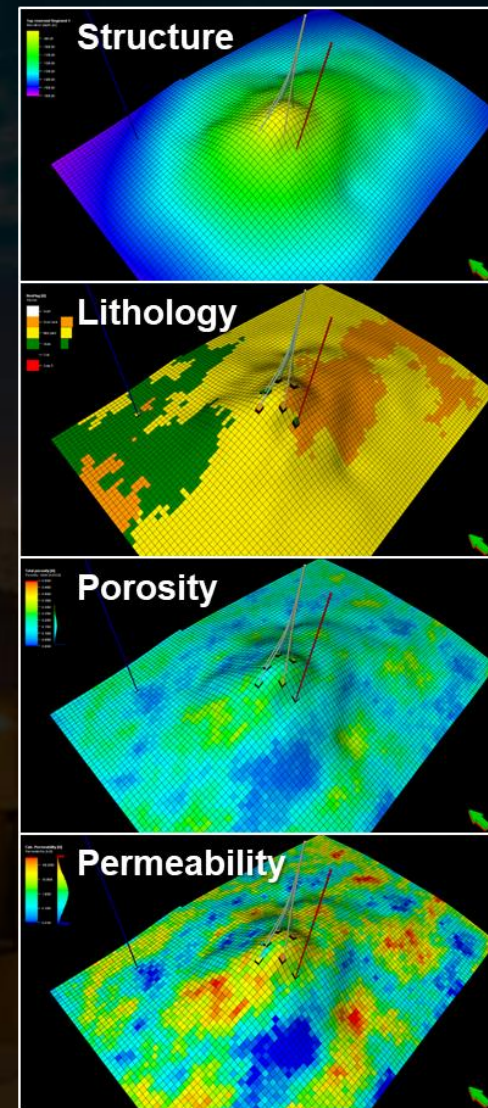
## Geological concept & Observation



## Laboratory analysis



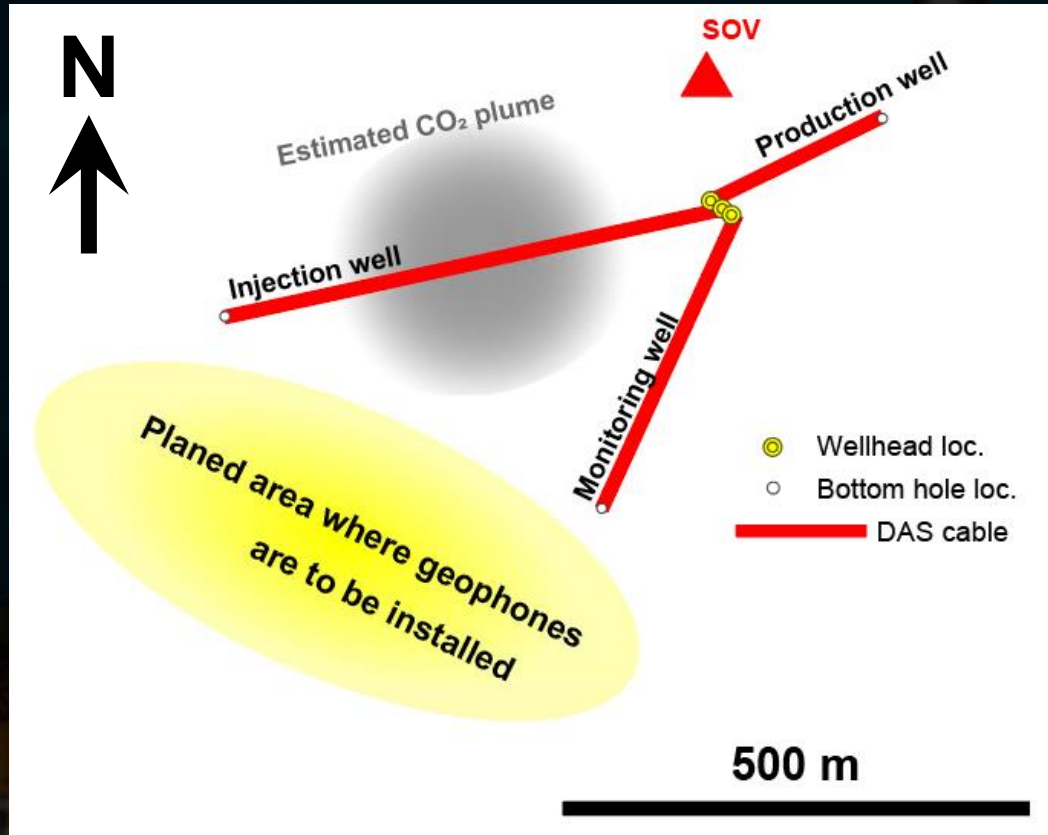
## Geological model



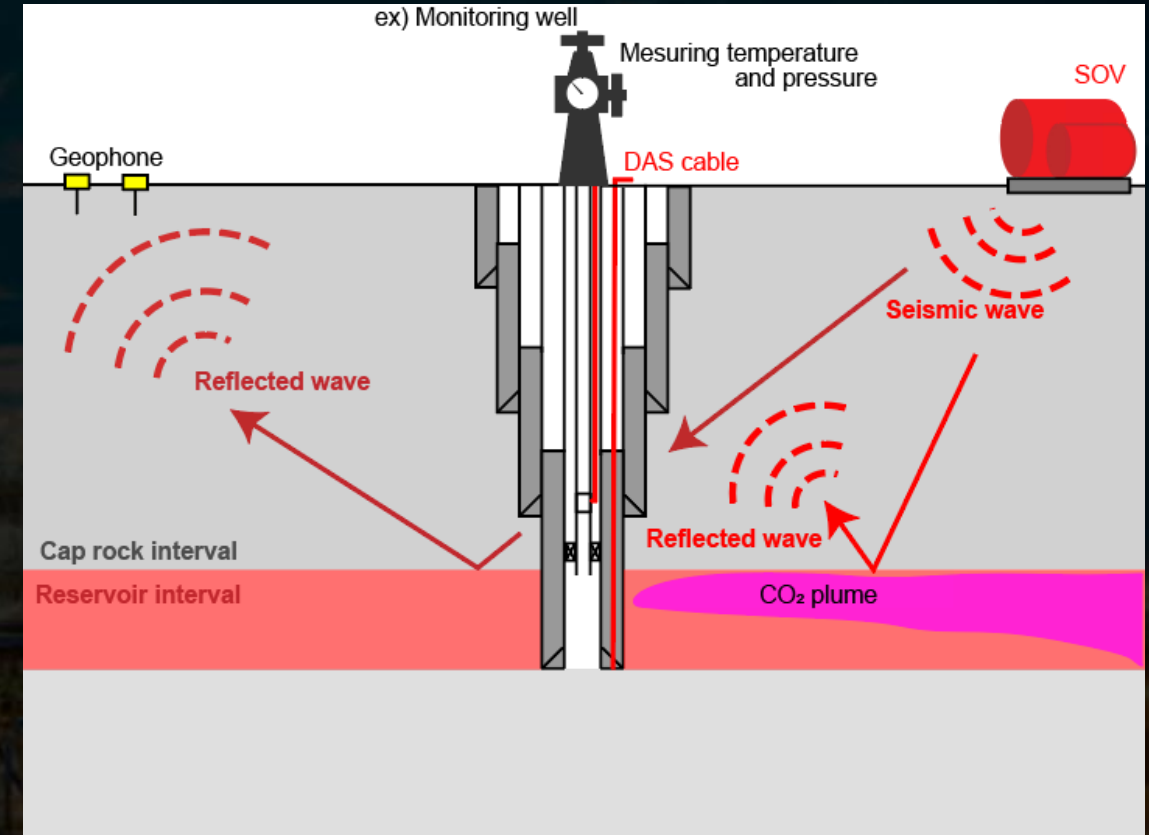
- The green tuff reservoir was characterized based on geological observations and laboratory analysis data.
- Available data were integrated to build a geological model.

# Technical Focus (2): Monitoring of CO<sub>2</sub> Plume Migration

## Layout of the monitoring systems



## Monitoring plans for CO<sub>2</sub> plume migration



- Gas production is still ongoing in the adjacent blocks.
- CO<sub>2</sub> plume behavior in the reservoir will be attempted to monitor using seismic survey methods.



# Conclusions

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- INPEX and JOGMEC are implementing a CCS/CCUS project at the Higashi-Kashiwazaki gas field that will contribute to clean hydrogen and ammonia production in Niigata, Japan.
- 3 wells will be drilled in 2023—2024, and hydrogen/ammonia production and CO<sub>2</sub> injection operations are planned to start from 2025.
- The reservoir, a volcanic rock formation called “Green Tuff”, has been characterized based on existing data, and a geological model has been built integrating available data.
- It is planned to monitor CO<sub>2</sub> plume migration using seismic survey methods in addition to reservoir temperature and pressure measurements at the wells.