Introduction of Liquid Organic Hydrogen Carrier and the Global Hydrogen Supply Chain Project

12th September 2018

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SPERA HYDROGEN

SPERA derives from the Latin word for “hope”. We at Chiyoda Corporation chose the name to represent our desire that hydrogen technology will give people around the world the hope they need to build a better future.

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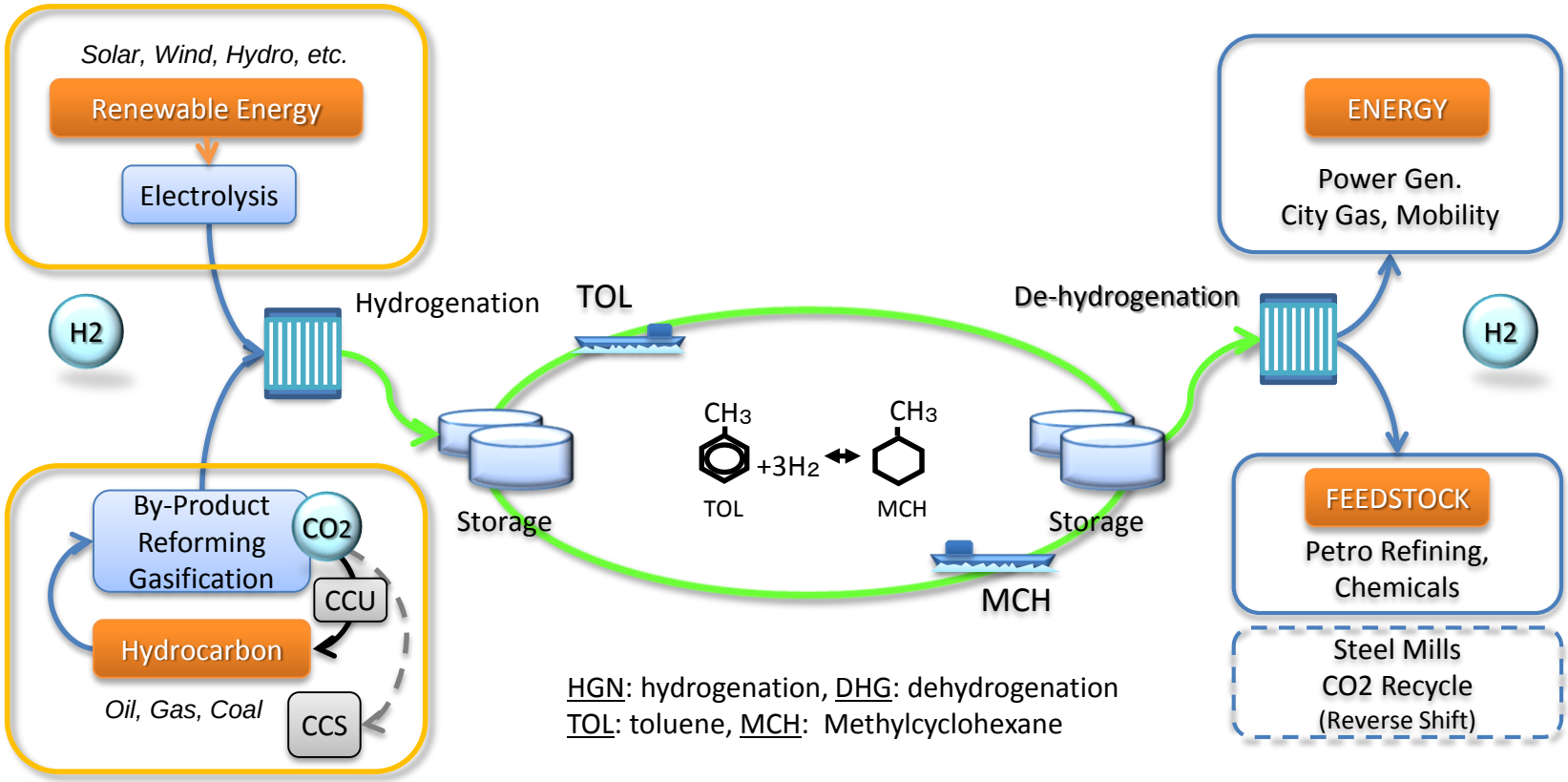
I. Chiyoda's Hydrogen Technology & Projects

Hydrogen Storage & Transportation Technology

- Chiyoda has established an efficient and large scale hydrogen storage and transportation system.
- Methylcyclohexane (MCH), Liquid Organic Hydrogen Carrier (LOHC), stays in liquid state under ambient temperature and pressure anywhere.



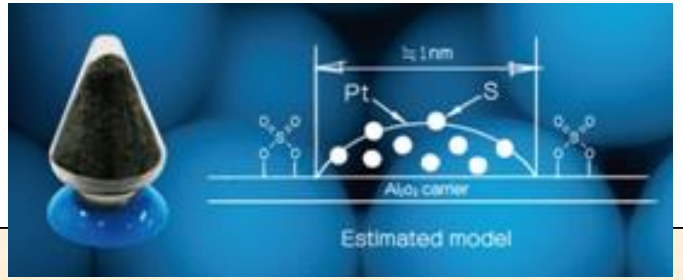
Key Technology is New Catalyst of Dehydrogenation.

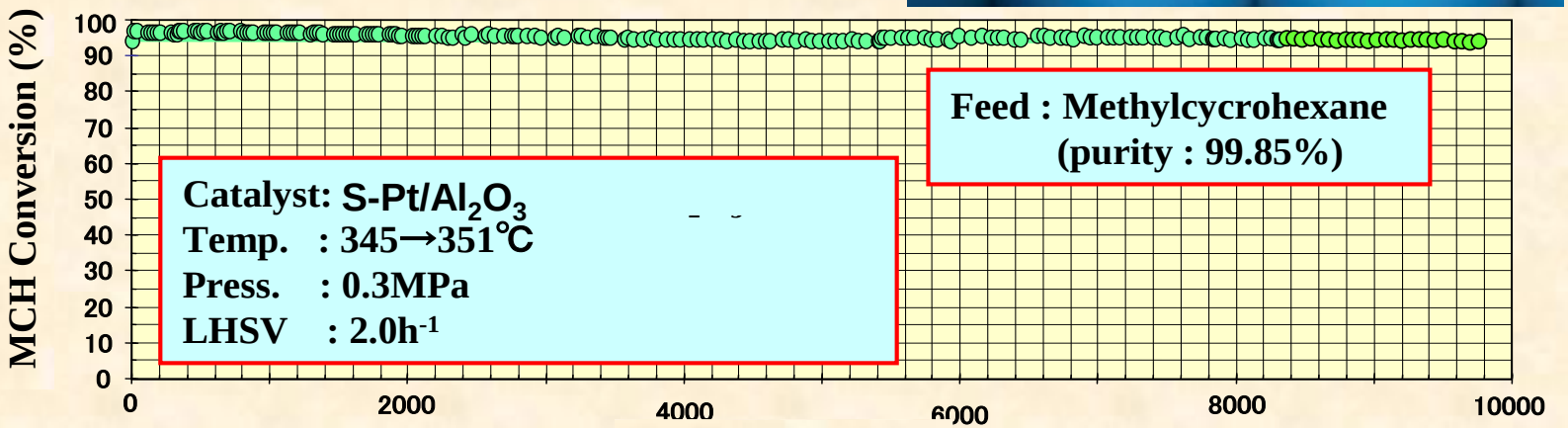
LOHC Technology

Long term storage & long distance transport	Chemically stable Very minor loss by long term storage & long distance transport
Easy to handle	Liquid under ambient temperature & pressure
Use of existing oil infrastructure	Conventional Oil & Chemicals Infrastructure can be Used for storage & transportation.
Reduced risk of H2 storage & transport	Hydrogen gas is converted to chemical liquid.
Combination of Proven technologies	Combination of conventional equipment except for new catalyst for dehydrogenation.

LOHC Technology - lab test

- Catalyst developed by Chiyoda
- Life longer than 1 year was confirmed by lab test – longer life possible





Catalyst performance

MCH Conversion : >95% Toluene Selectivity : >99.9% H_2 Yield : >95%

H_2 generation rate : > 1,000 Nm^3-H_2/h/m^3-cat. (1,000 Ncc-H_2/h/cc-cat.)

Catalyst life : > 8,000 (1year)

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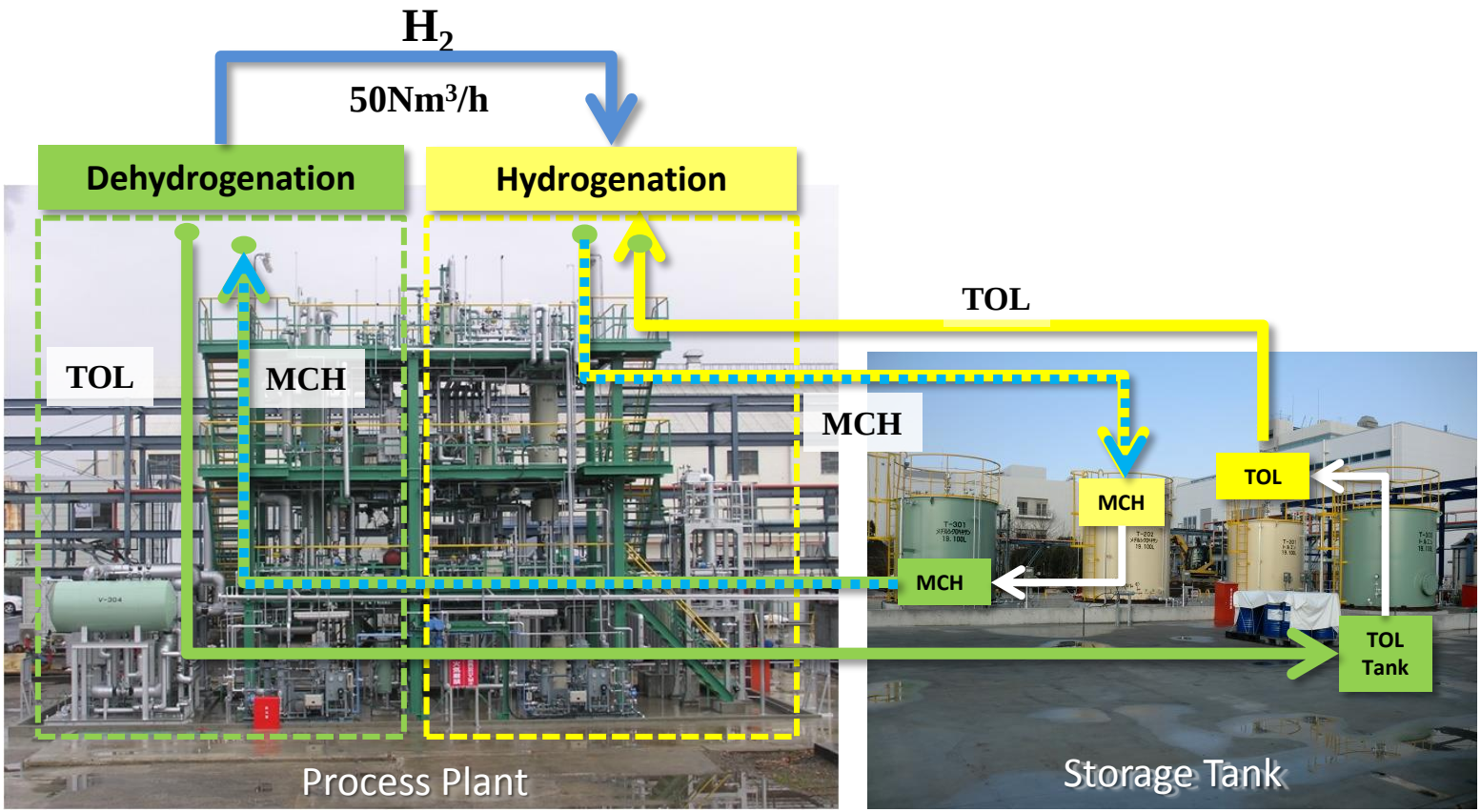
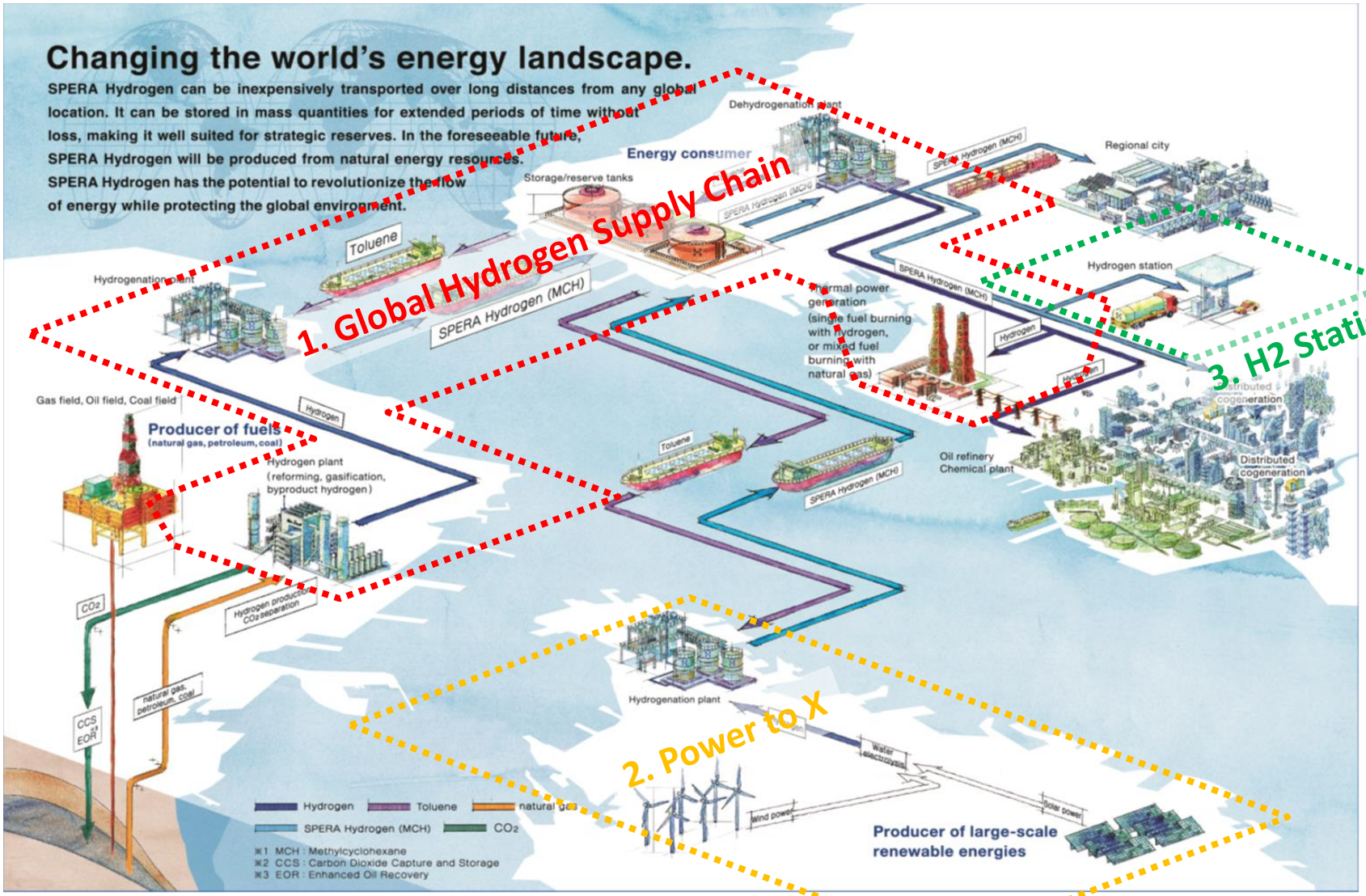
LOHC Technology - demo plant

- After lab tests, another 10,000hr of demo plant operation was successfully completed.
- Expected performance was confirmed.

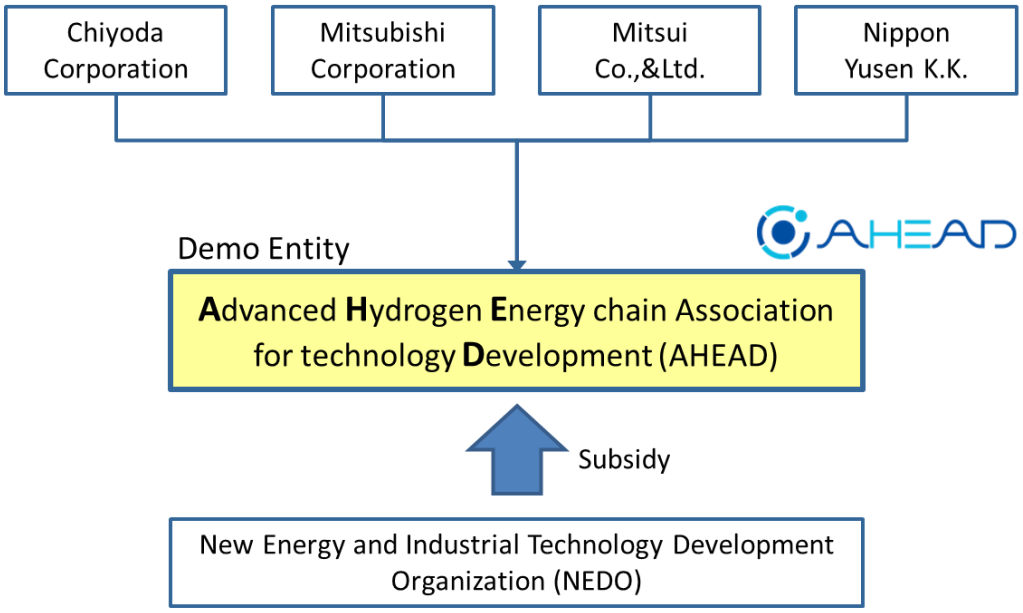


Hydrogen Demonstration Projects



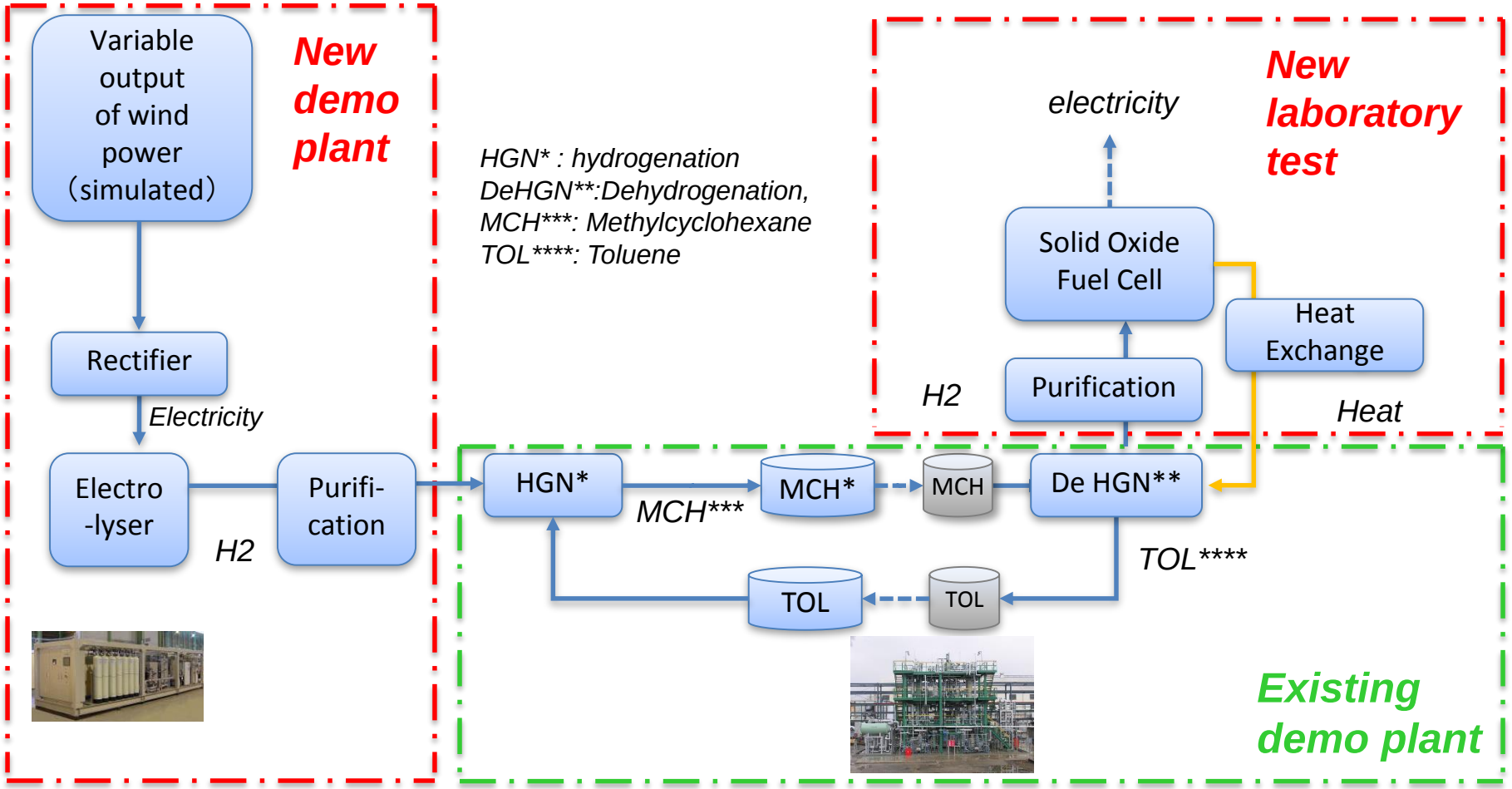
1. Global Hydrogen Supply Chain Demonstration

Chiyoda and its partners established the **Advanced Hydrogen Energy Chain Association for Technology Development (AHEAD)**, and started the world's first global hydrogen supply chain demonstration project toward 2020.



2. Power to X Technology

Demonstration project to produce hydrogen by variable renewable energy, funded by the New Energy and Industrial Technology Development Organization (NEDO)



Location : Chiyoda Koyasu Office & Research Park (Yokohama - city)

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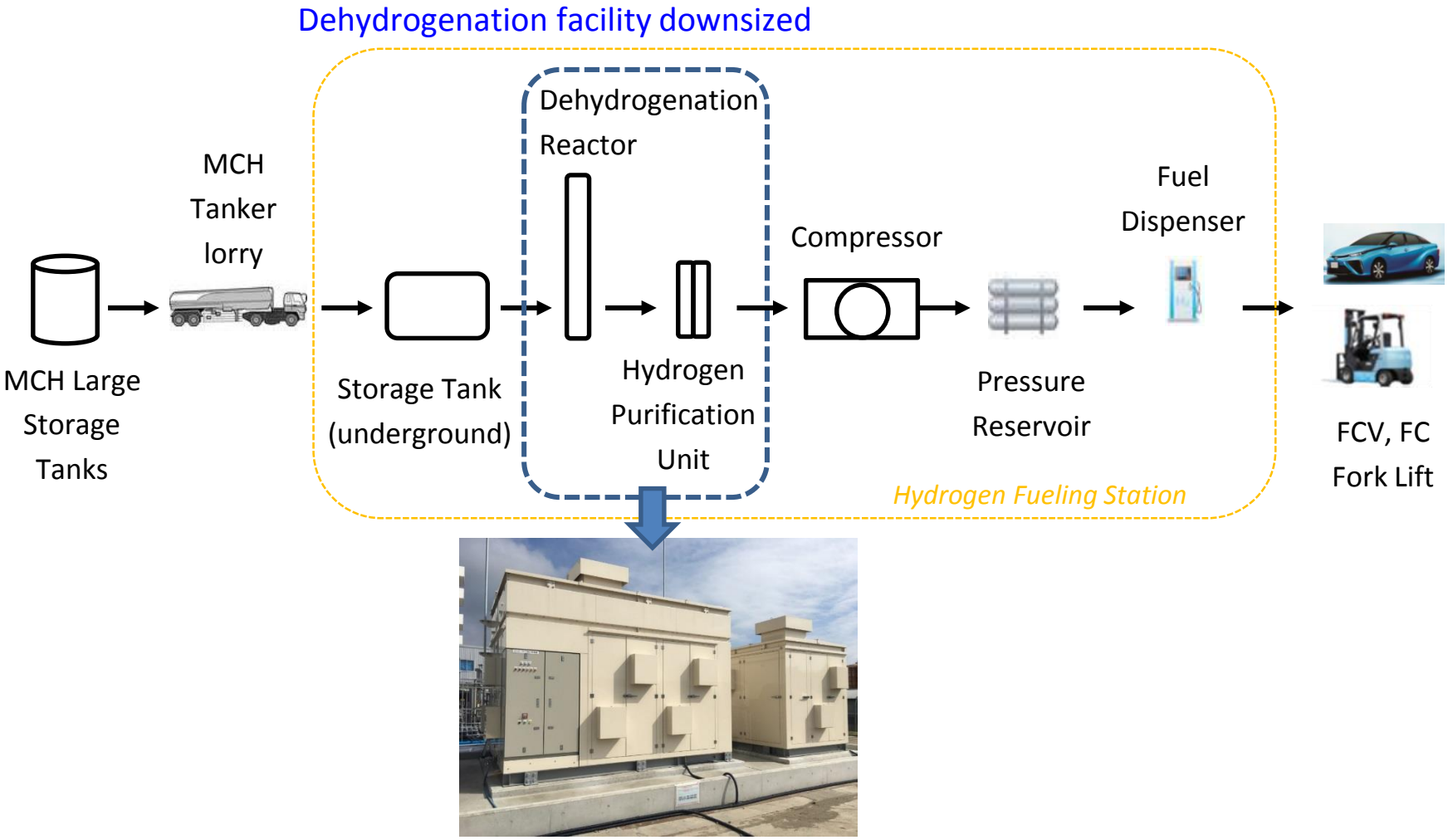
3. Hydrogen Fueling Station Technology

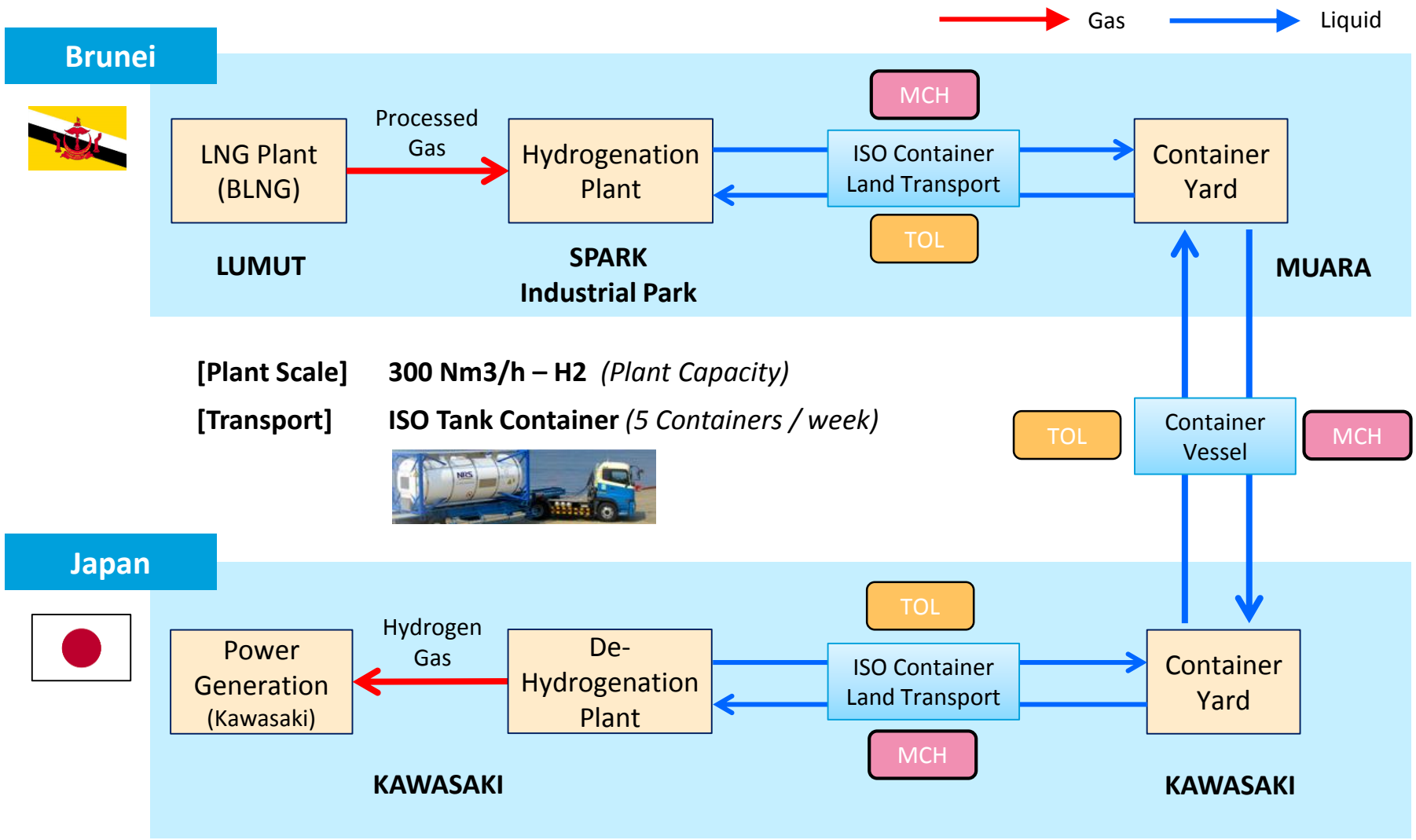
Develop compact-type dehydrogenation facility (downsizing and automatic operation) in order to fit for FCV fuel stations, funded by NEDO.



Location : Chiyoda Koyasu Office and Research Park (Yokohama - city)

II. Global H2 Supply Chain Project

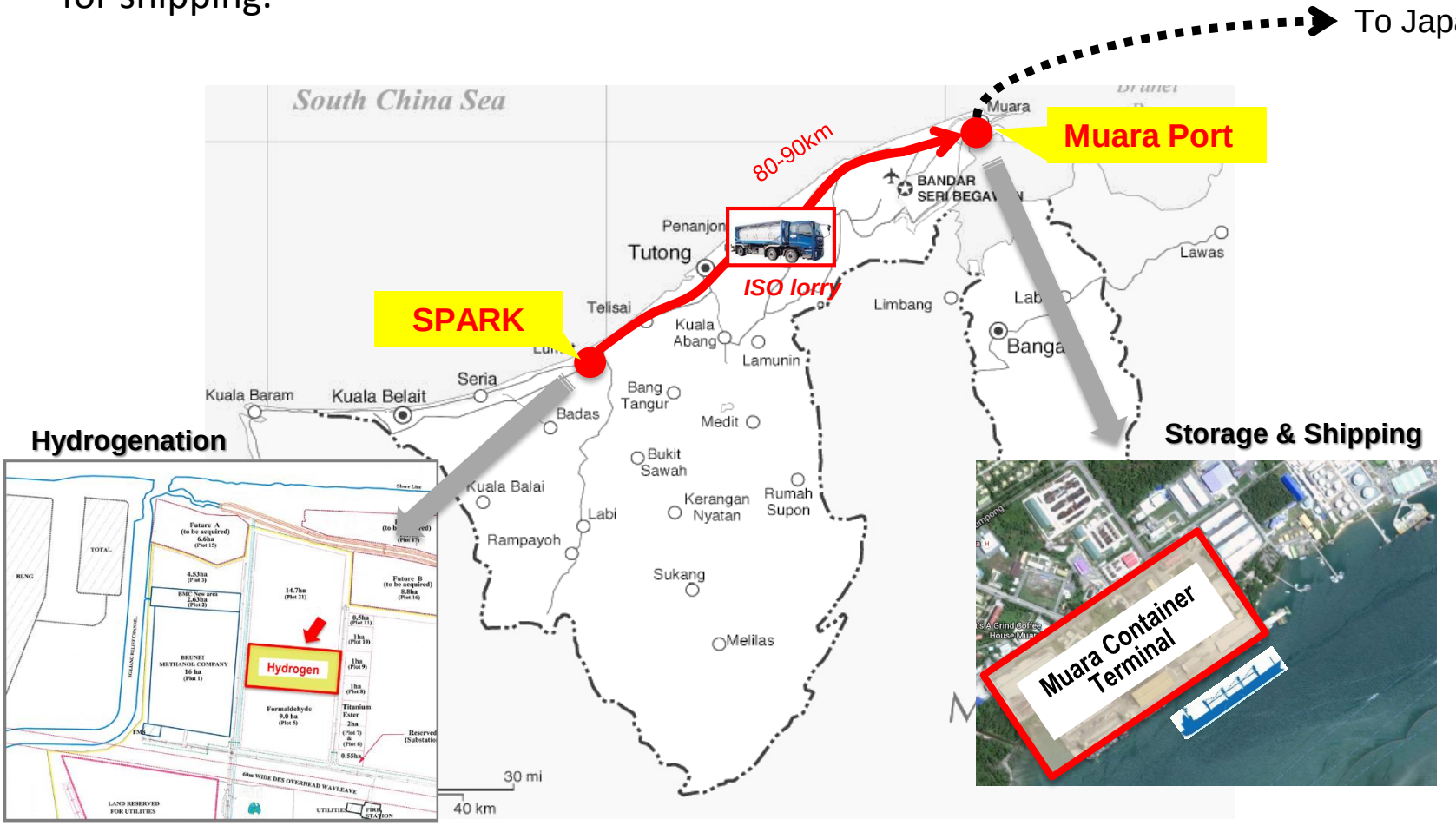
PROJECT OVERVIEW



MCH : Methyl cyclohexane, TOL : Toluene

1) GEOGRAPHICAL LOCATION

- Hydrogen production / hydrogenation plant will be located at SPARK, and hydrogen will be transported on land using ISO tank containers (in form of MCH) to Muara Port for shipping.



2) HYDROGENATION PLANT (IMAGE)

Hydrogenation plant will consist of Hydrogenation unit, H2 production unit, utility & offsite facilities, administration/control building and ISO tanks area.

3) GROUND BREAKING CEREMONY

- Ground breaking ceremony was hold on April 21, 2018, and the guest of honor was Deputy Minister of Ministry of Energy and Industry, together with 150 other guests.

4) CONSTRUCTION WORK (as of July 2018)

- Construction started in April 2018, and foundation/building work is ongoing.

1) GEOGRAPHYICAL LOCATION

The site of dehydrogenation will be located at Keihin Industrial Zone in Kawasaki, and ISO tank containers from Brunei Darussalam will arrive at Kawasaki Port.

2) H2 SUPPLY INFRASTRUCTURE

Dehydrogenation Plant will be located inside TOA OIL's Keihin Refinery, and extracted hydrogen gas will be transported to existing power generation by pipeline.

[Keihin Waterfront District]

TOA OIL (Zone - F)

- Dehydrogenation plant
- MCH /TOL storage tank
- Loading/unloading facility

EXISTING POWER PLANT

- Output 79,300kW
- Fuel Refinery gas
- Type Gas Turbine

[Cooperation with TOA OIL]

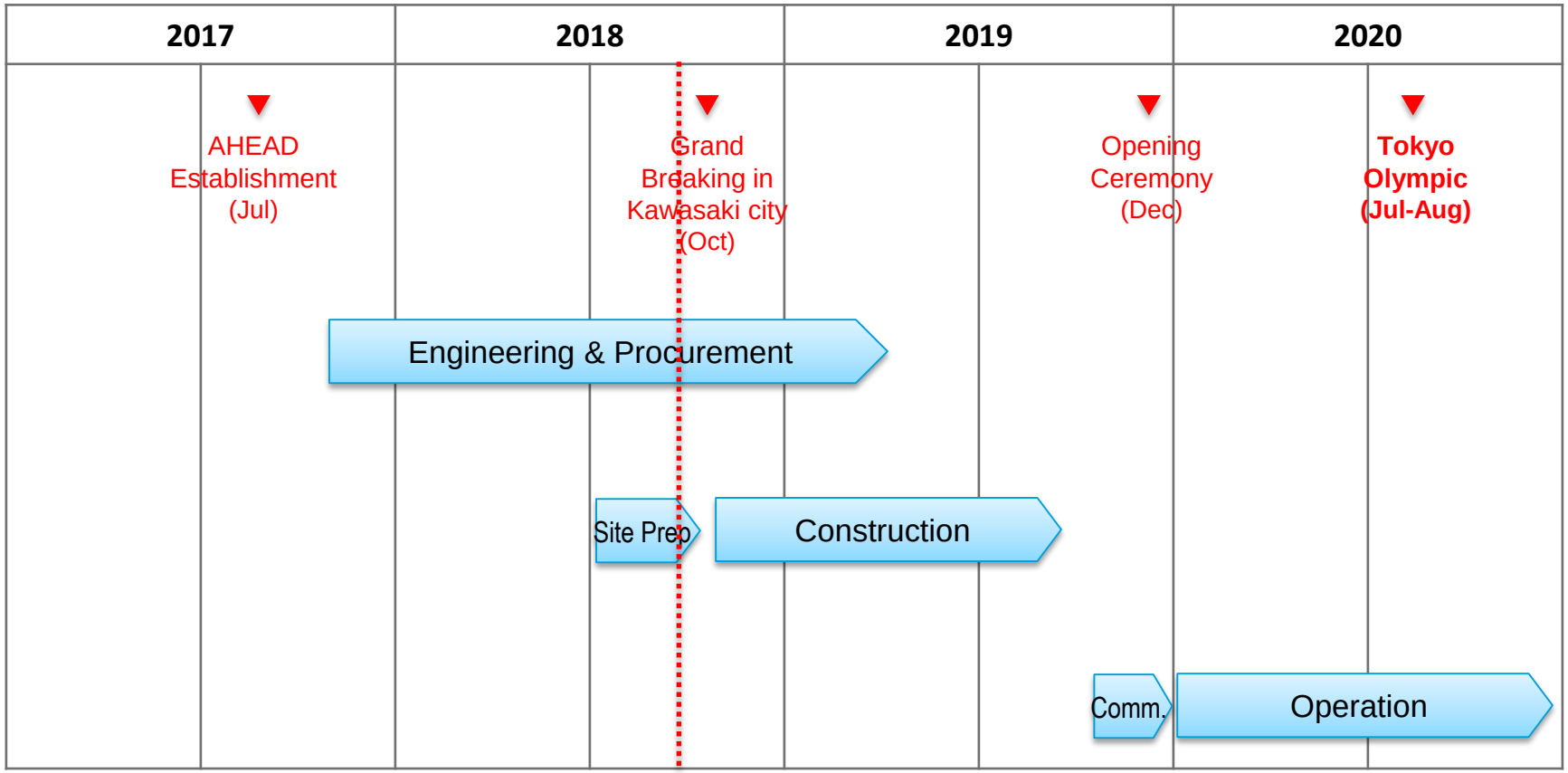
- Land in TOA OIL's refinery
- Utility supply to Dehydrogenation plant
- Operation of Dehydrogenation plant

3) DEHYDROGENATION PLANT (IMAGE)

- Dehydrogenation plant will consists of Process unit, MCH/TOL storage tanks, administration/control building and loading/unloading facility.

4）PROJECT SCHEDULE

Construction will begin from October 2018, and Hydrogen Supply Chain will operate between Brunei and Japan in 2020.



Thank you !

ADVANCED **H**YDROGEN **E**NERGY CHAIN **A**SSOCIATION
FOR TECHNOLOTY **D**EVELOPMENT