



TOSHIBA

Hydrogen Energy Supply Systems Utilizing Renewable Energy

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01

Toshiba's Technologies of Hydrogen

Toshiba's Hydrogen business domain

Production

Storage

Utilization

Hydrogen EMS Hydrogen Energy Management System

Power-to-gas

H₂Power Storage

Fuel Cell



Hokkaido H₂ supply chain project



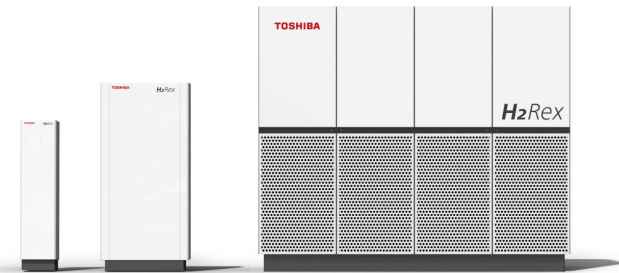
Hydrogen station



Fukushima H₂ energy research field



Regional H₂ energy supply sys.



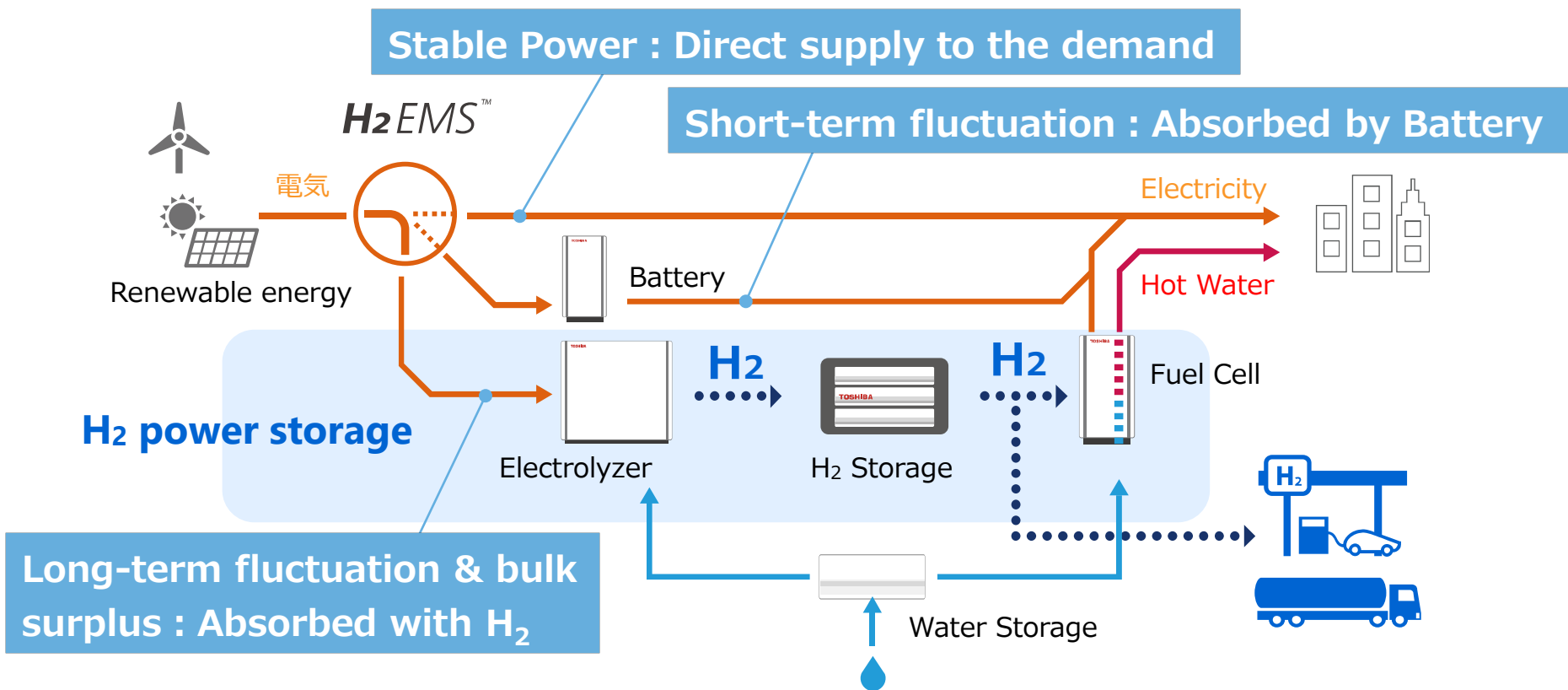
Pure Hydrogen Fuel cell

02

Toshiba's Hydrogen EMS **(※)EMS : Energy Management System**

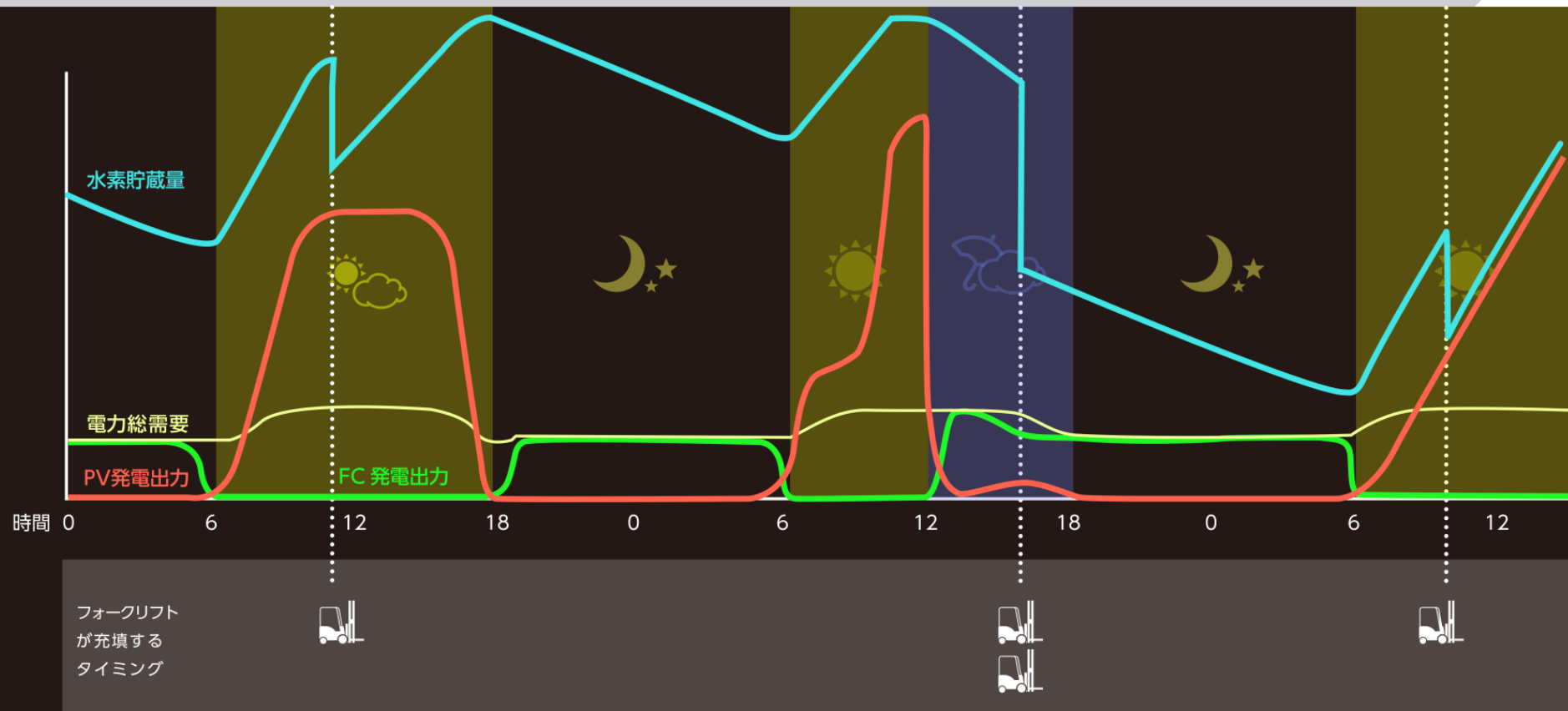
Effective Utilization of RE by Power Leveling

Hybrid system of battery and hydrogen power storage



Realizes an energy system that can absorb short to long-term RE fluctuations with a combination of storage batteries and H₂ power storage

H₂EMS™ to support hydrogen application



Hydrogen EMS to execute demand prediction and effective hydrogen production

The slide features a white background with a large blue triangle in the top right corner and a yellow triangle in the bottom left corner. The number '03' is positioned in the upper left, and the title 'Toshiba's Solutions for Hydrogen' is centered in the middle. The page number '7' is in the bottom right.

03

Toshiba's Solutions for Hydrogen

New business created by hydrogen economy

Distributed energy business

Regional revitalization by local energy enterprises



Energy service

Power supply
Fuel supply for FCV/EV
Hot water
BCP

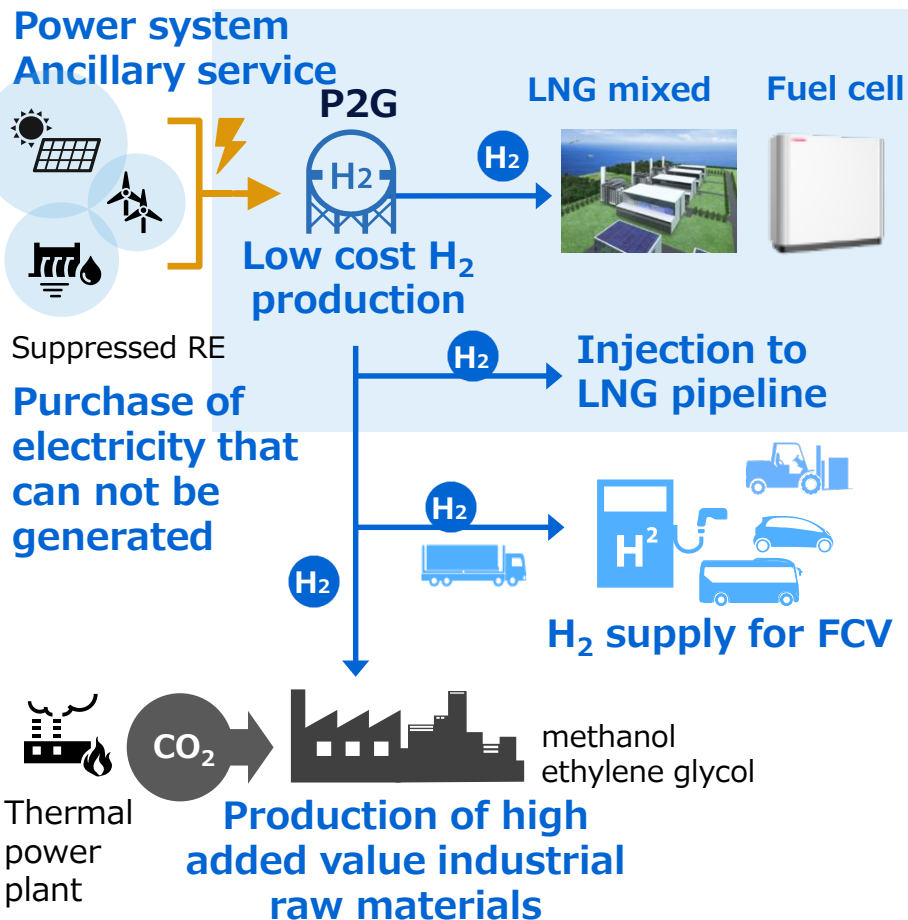


Social service

Activation support
Logistics
Telecoms
Watching over

P2G H₂ supply chain business

A new supply chain that maximizes the potential of RE and hydrogen



H2OneTM Standard model

Running at Kawasaki Marien which also has evacuation center function

Supply one week's power to 300 displaced people



Installation scene at Kawasaki Marien

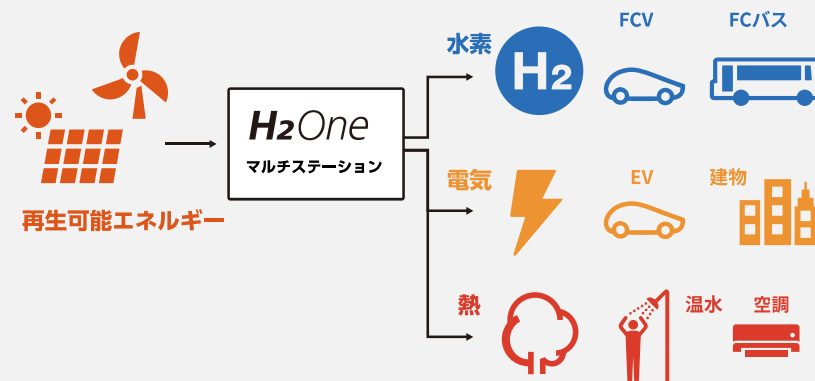


Footprint: approx. tennis court 1 field including PV

※Photo by Kawasaki Marien

Packaged hydrogen supply system

- Addition of hydrogen fuel supply function for FCV to H₂One™
- H₂ Local production and local consumption system also contributes to regional revitalization / popularization enlightenment.
- Independent system can apply emergency energy supply



Normal

Fuel supply to FCV, FC bus, EV (70 MPa)
Power and heat supply to the building

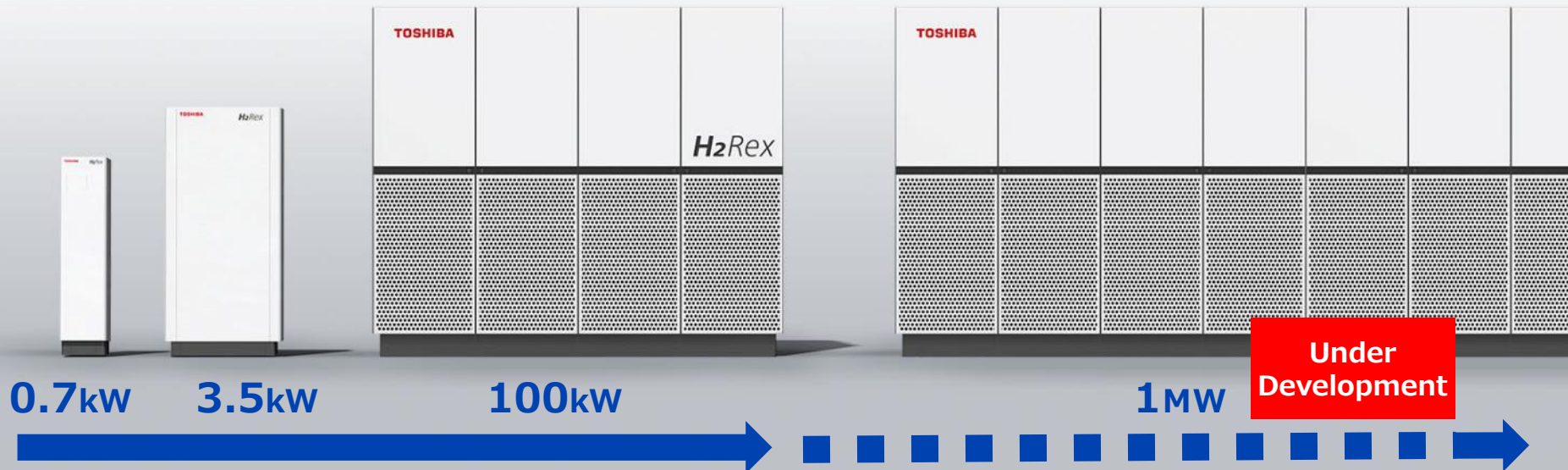
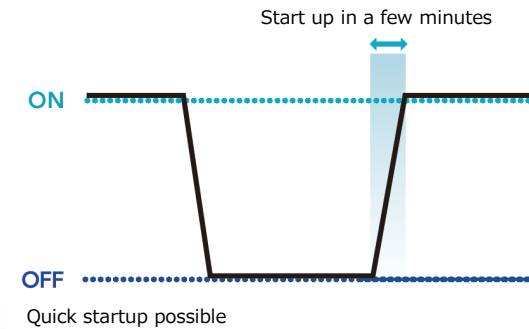
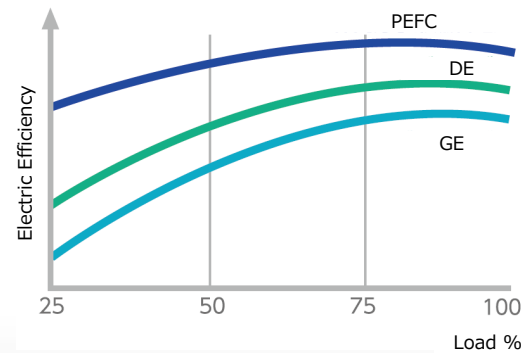
Emergency

Possible for emergency operation of FCV · FC bus · EV with autonomous system to produce hydrogen even in case of power outage.
Supplies electricity and hot water for evacuation sites for three days to 300 people using stored hydrogen using BCP function

H2Rex™ Hydrogen Fuel Cell system

Commercialization of pure hydrogen fuel cell system with high efficiency

- PEFC
- Electric Efficiency 50~55%
- Total Efficiency 95%
- Start up in a few minutes

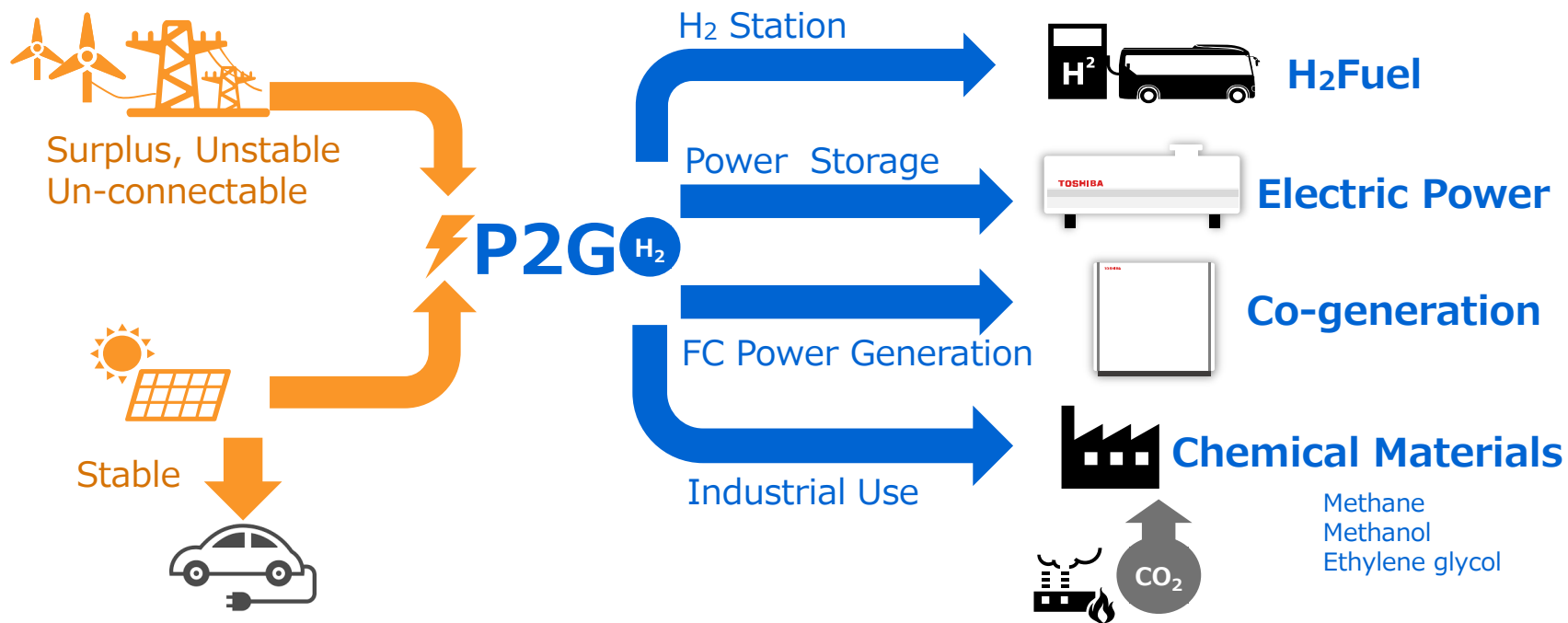


04

Power-to-gas
(Fukushima Hydrogen Energy Research Field
"FH2R")

FH2R FUKUSHIMA
HYDROGEN
ENERGY
RESEARCH
FIELD

Power to Gas; Counterplan for increasing renewable energy to grid

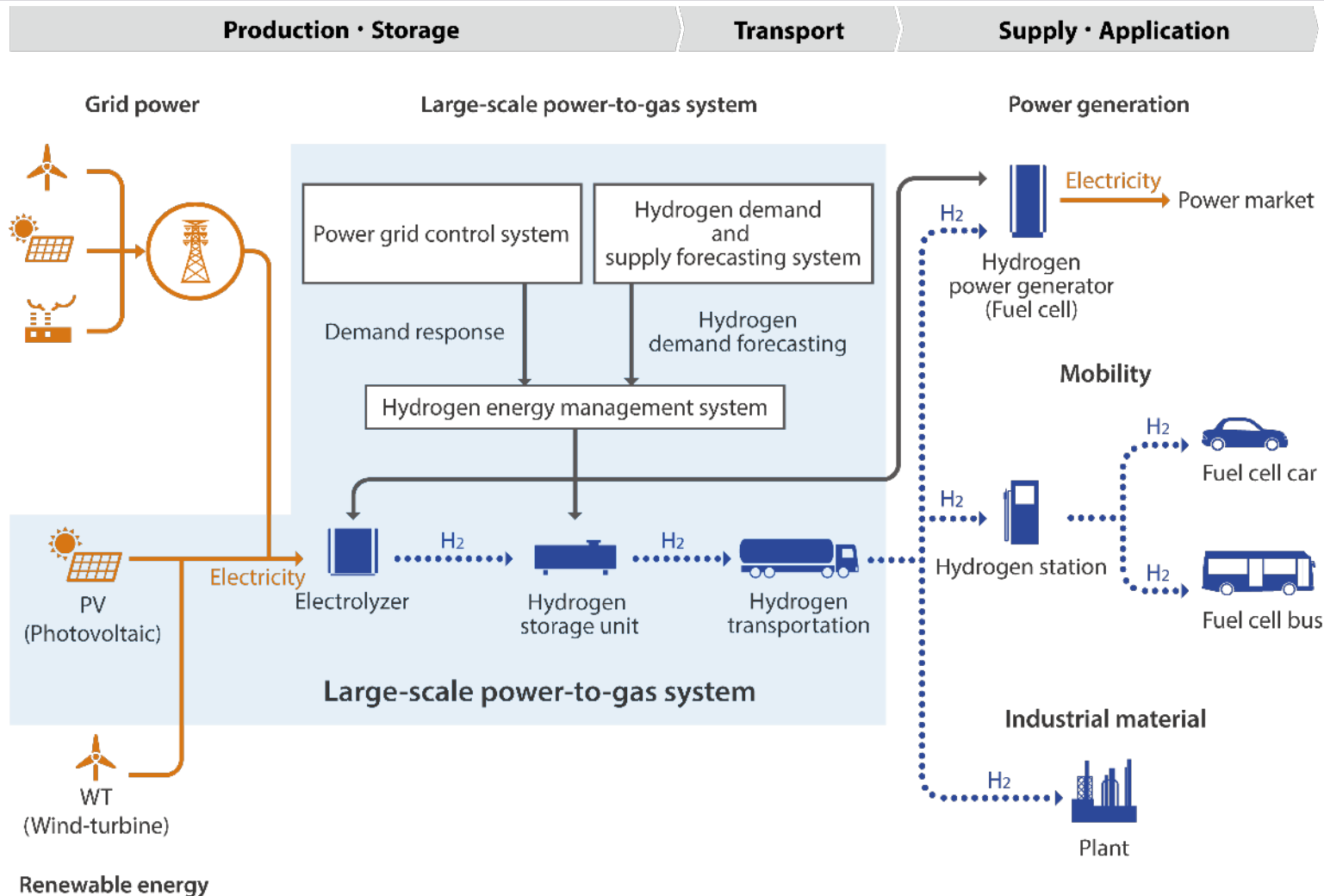


Advantages of P2G

Coordinate grid power / Develop restrain RE /
Produce inexpensive H₂ / Improve domestic energy
production rate / Possibility of base loading of LNG

- P2G demonstration has advanced and its commercialization soon in EU.
- The Ministry of the Environment and the Agency for Natural Resources and Energy / NEDO promote P2G demonstration PJs in Japan.

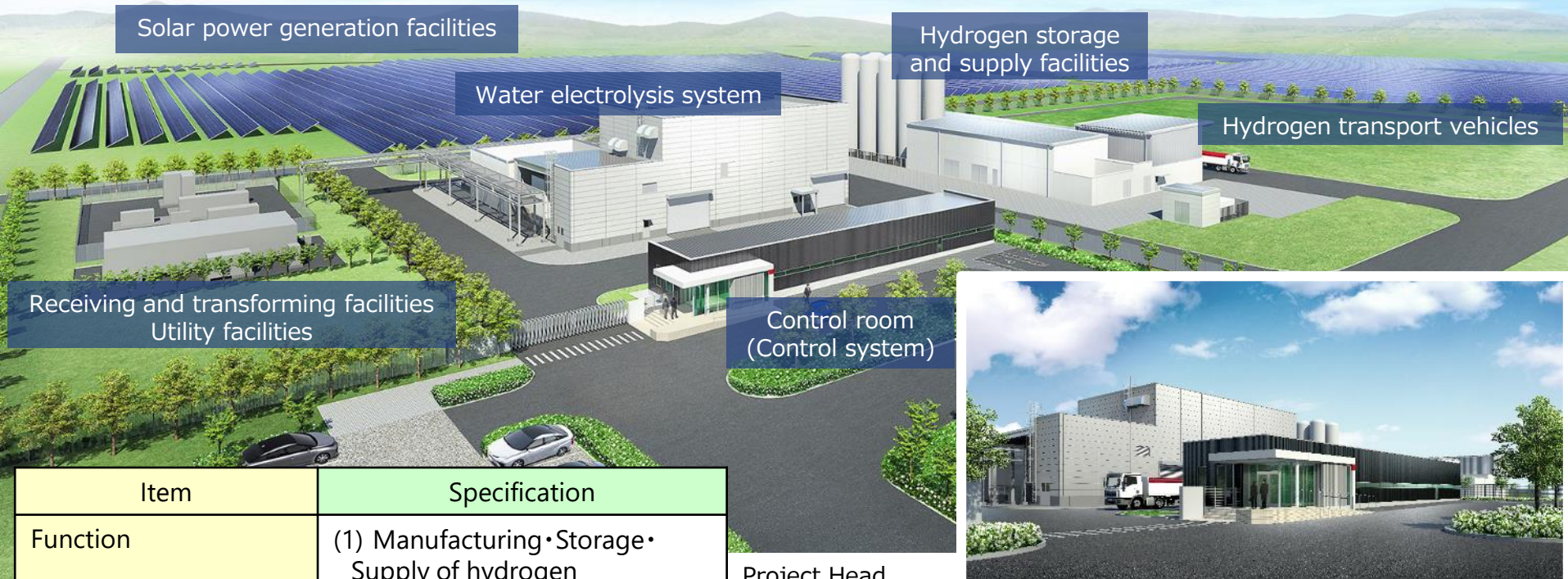
Fukushima Hydrogen Energy Research Field (System Overview)



Demonstration Items :

- Develop a hydrogen utilization business model that optimizes the exploitation of hydrogen as both a commercial commodity and an energy source for balancing the supply and demand of the electricity grid
- Realize a new control system that optimizes hydrogen production and supply with demand forecasting for hydrogen

Fukushima Hydrogen Energy Research Field (Rendering Image)



Item	Specification
Function	(1) Manufacturing・Storage・Supply of hydrogen (2) Balancing the supply and demand of the electricity grid
Annual manufacturing capability of hydrogen (Rated output)	900t-H ₂ /year
Input power of electrolyzer	(Max.) 10MW (Rated) 6MW (Range) 1.5MW ~ 10MW

Project Head

New Energy and Industrial Technology Development Organization (NEDO)

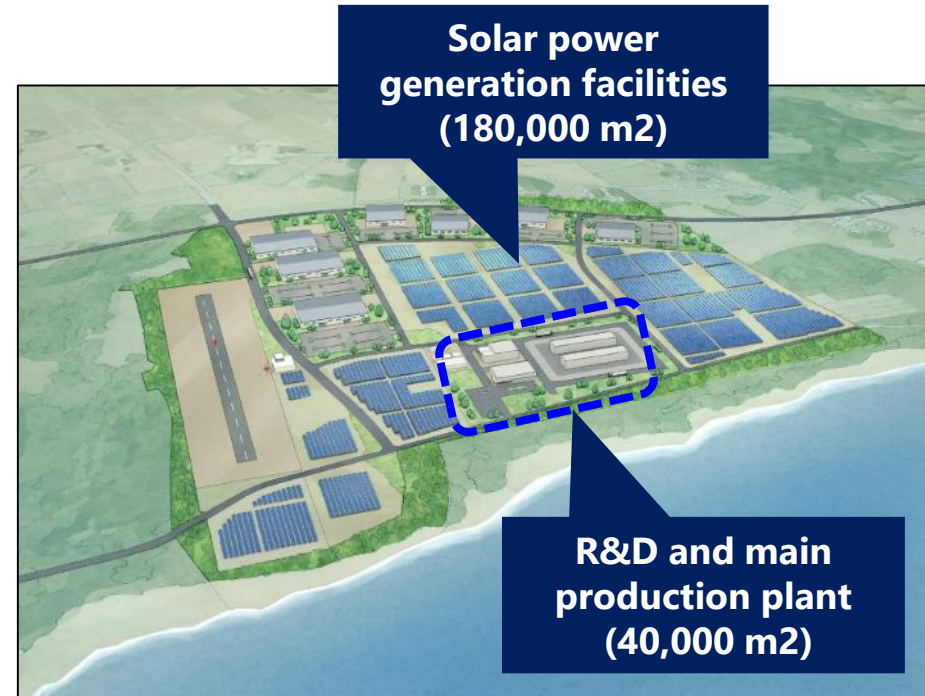
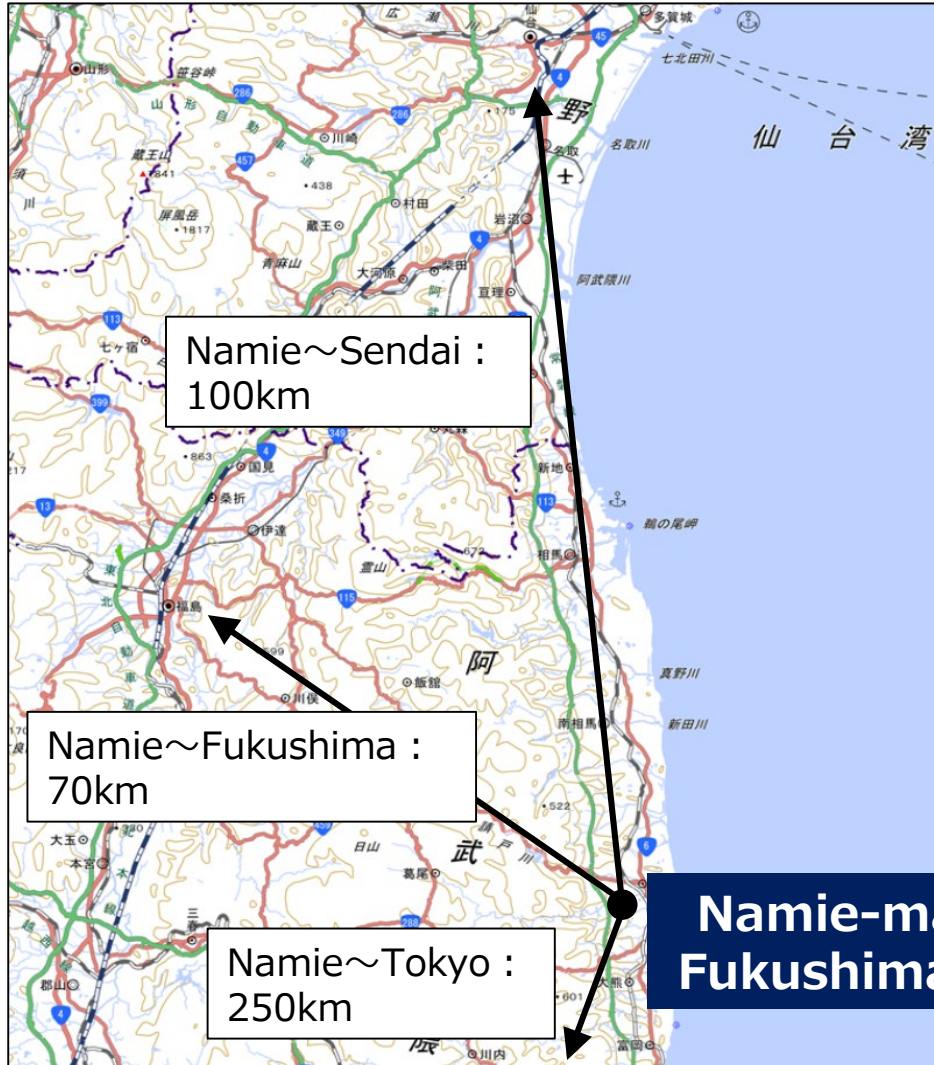
Related Organizations

Agency of Natural Resources and Energy, Ministry of Economy, Trade and Industry (METI), Reconstruction Agency, Cabinet Office, Fukushima Prefecture, The Town of Namie Project

Members

Toshiba Energy Systems & Solutions Corporation, Tohoku Electric Power Co., Inc., Iwatani Corporation

Fukushima Hydrogen Energy Research Field (Demonstration Location)



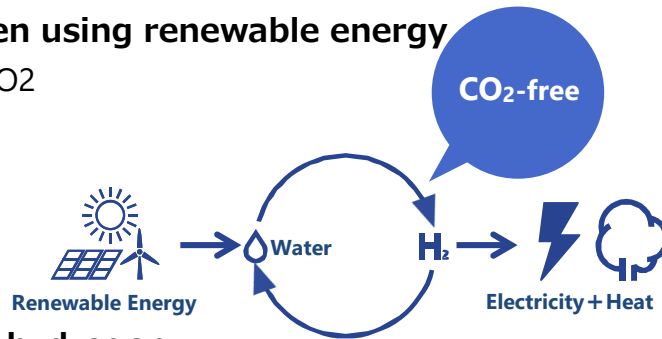
※Created by Toshiba Energy Systems & Solutions Corporation based on 「the Namie-machi tanashio industrial complex」 (Organization for Small & Medium Enterprises and Regional Innovation)

※Created by Toshiba Energy Systems & Solutions Corporation based on 「GSI Maps」 (Geospatial Information Authority of Japan) (<http://maps.gsi.go.jp/#10/37.865650/141.221008/&base=std&ls=std&disp=1&vs=c1j0l0u0t0z0r0f0>)

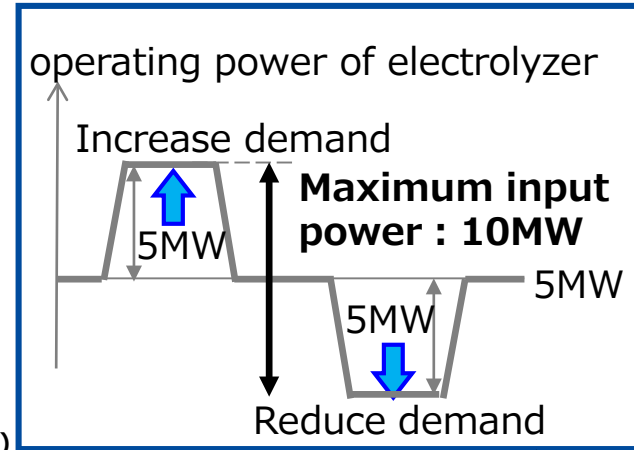
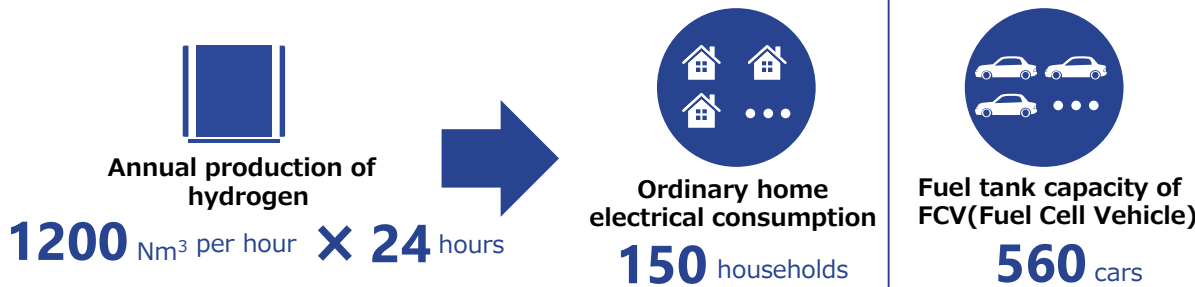
Fukushima Hydrogen Energy Research Field (Features of Project)

1 Produce CO₂-free hydrogen using renewable energy

By using CO₂-free hydrogen, CO₂ emissions can be reduced



2 Produce large amounts of hydrogen



3 Realize expansion of use of renewable energy

“Hydrogen energy management system” performs optimum operation for each unit using information from “Power grid control system balances the supply and demand of electricity grid and generates demand response information” and “Hydrogen demand and supply forecasting system predicts hydrogen demand in the market and generates hydrogen demand forecasting information”.

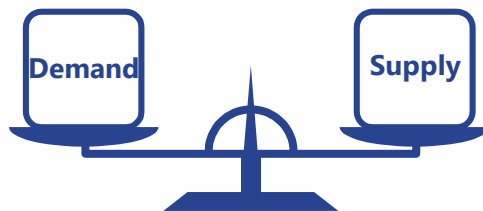


Image of balancing the supply and demand of electricity grid

Electricity Grid	Hydrogen Power-to-gas System
Demand < Supply	Increase hydrogen production (Increase demand)
Demand > Supply	Reduce hydrogen production (Reduce demand)

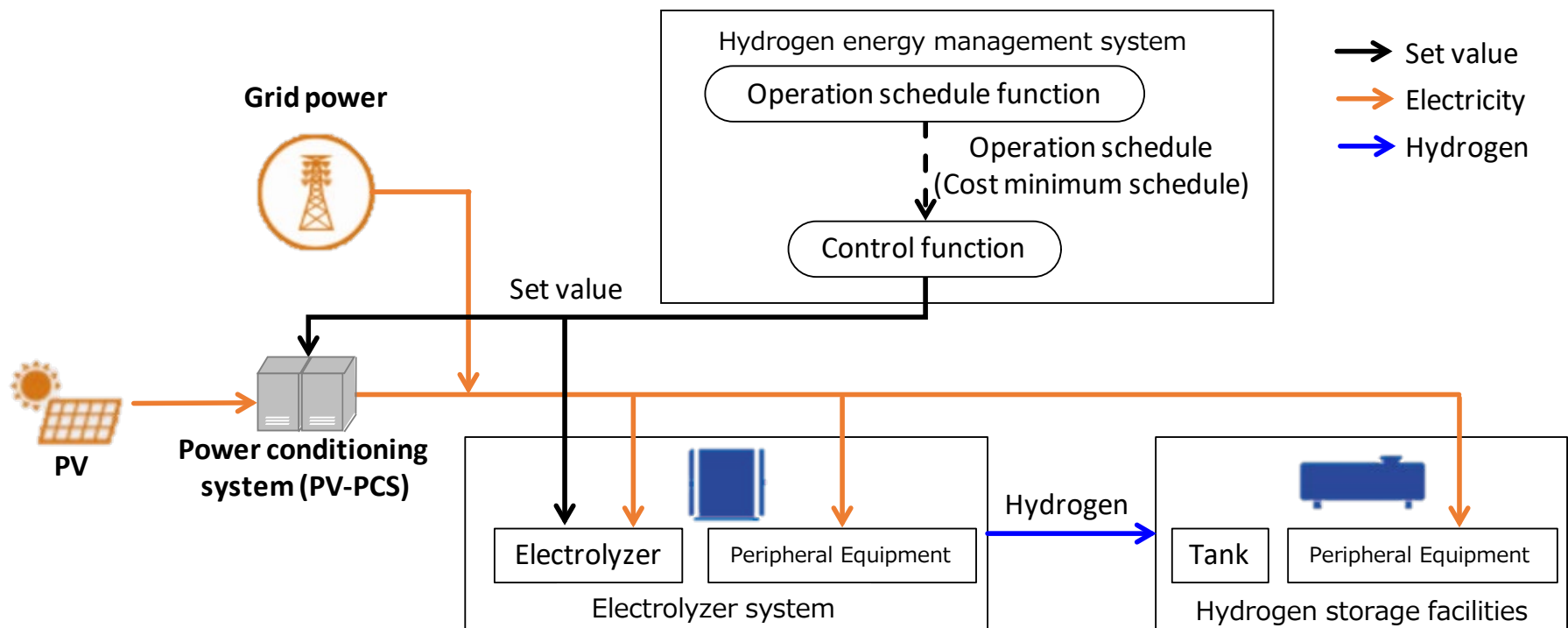
Fukushima Hydrogen Energy Research Field (Hydrogen energy management system)

■ Operation schedule function

Plans the operation schedule, and notifies the control function of each unit.

■ Control function

Controls Electrolyzer and Power-Conditioning-System for Solar Power based on the operation schedule in real time.

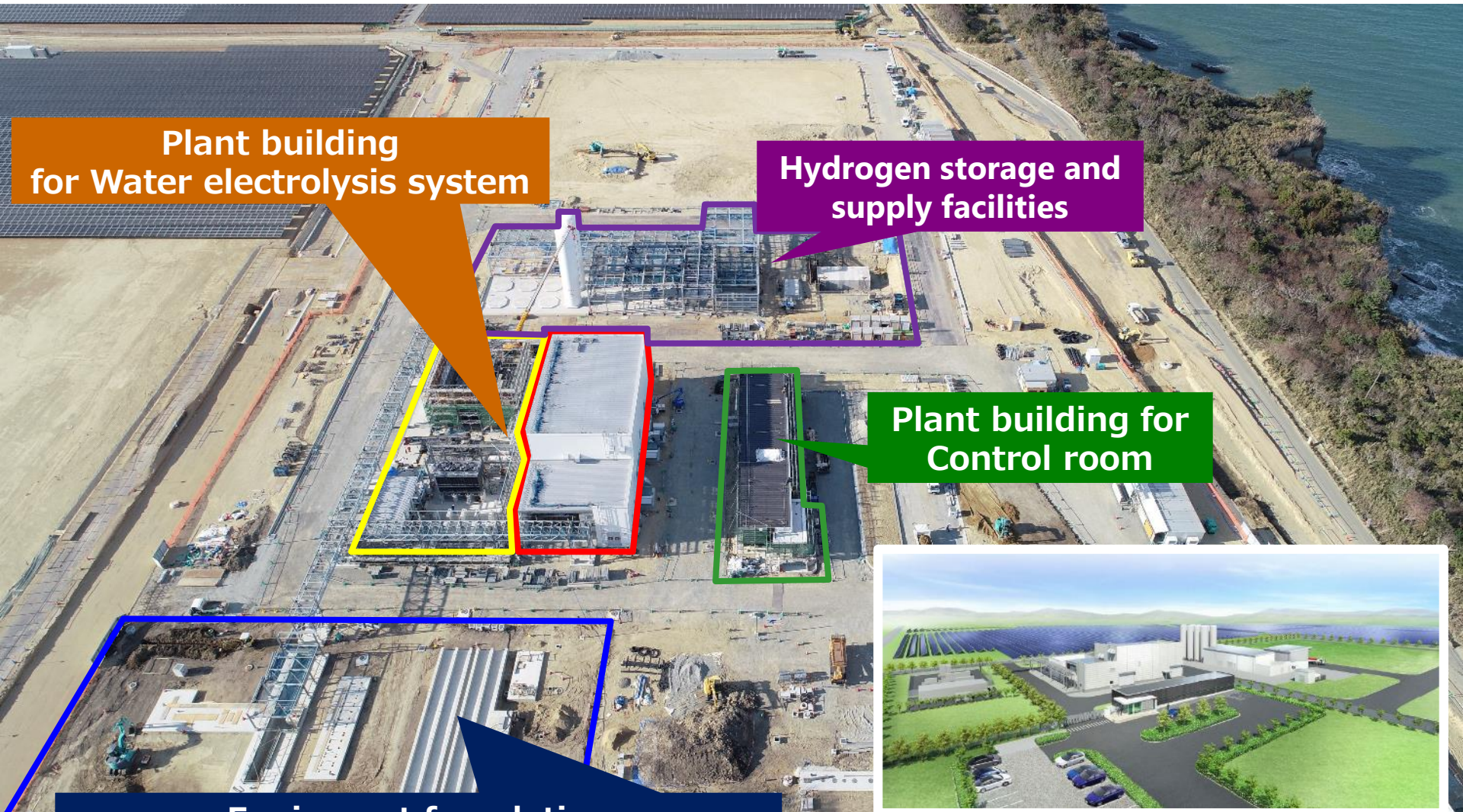


Fukushima Hydrogen Energy Research Field (Photo of construction)



2/19/2019

Fukushima Hydrogen Energy Research Field (Photo of construction)



**Plant building
for Water electrolysis system**

**Hydrogen storage and
supply facilities**

**Plant building for
Control room**

**Equipment foundation
for Receiving and transforming facilities
And Utility facilities**



4/9/2019

Fukushima Hydrogen Energy Research Field (Schedule)

■ August 2019

Supply of electricity using the dedicated power transmission line will be started

■ October 2019

The overall system test and commissioning will be started

■ July 2020

This plant will be completed and demonstration operation will be started

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Thank you for your attention