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   (EMS : Energy Management System)

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   (Fukushima Hydrogen Energy Research Field “FH2R”)
Toshiba’s Technologies of Hydrogen
Toshiba’s Hydrogen business domain

Production

- Power-to-gas
  - Hokkaido H₂ supply chain project

Storage

- H₂Power Storage
  - Hydrogen station
  - Regional H₂ energy supply sys.

Utilization

- Fuel Cell
  - Pure Hydrogen Fuel cell

Hydrogen EMS (Hydrogen Energy Management System)
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
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

**Power system**
- Ancillary service
- Low cost H₂ production

**Ancillary service**
- Purchase of electricity that can not be generated
- Injection to LNG pipeline
- H₂ supply for FCV

**Suppressed RE**
- Fuel cell
- Production of high added value industrial raw materials
- Methanol
- Ethylene glycol

**CO₂**
- Production of high added value industrial raw materials
- Thermal power plant
- Watching over
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
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”)
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.

Power to Gas; Counterplan for increasing renewable energy to grid
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)

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

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-H2/year
Input power of electrolyzer | (Max.) 10MW
(Rated) 6MW
(Range) 1.5MW ~ 10MW
Fukushima Hydrogen Energy Research Field
(Demonstration Location)

Namie ~ Sendai: 100km
Namie ~ Fukushima: 70km
Namie ~ Tokyo: 250km

Solar power generation facilities
(180,000 m²)

R&D and main production plant
(40,000 m²)

※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)

※Created by Toshiba Energy Systems & Solutions Corporation based on 「the Namie-machi tanashio industrial complex」
(Organization for Small & Medium Enterprises and Regional Innovation)
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
   - Annual production of hydrogen: 1200Nm³ per hour × 24 hours
   - Ordinary home electrical consumption: 150 households
   - Fuel tank capacity of FCV (Fuel Cell Vehicle): 560 cars

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”.

<table>
<thead>
<tr>
<th>Electricity Grid</th>
<th>Hydrogen Power-to-gas System</th>
</tr>
</thead>
<tbody>
<tr>
<td>Demand &lt; Supply</td>
<td>Increase hydrogen production (Increase demand)</td>
</tr>
<tr>
<td>Demand &gt; Supply</td>
<td>Reduce hydrogen production (Reduce demand)</td>
</tr>
</tbody>
</table>
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)
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
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
Thank you for your attention