Japan’s activity on hydrogen energy

10 September, 2019

Eiji Ohira

New Energy and Industrial Technology Development Organization (NEDO)
Policy: “Basic Hydrogen Strategy”

<table>
<thead>
<tr>
<th>Year</th>
<th>Current</th>
<th>2020</th>
<th>2025</th>
<th>2030</th>
<th>2050</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supply</td>
<td>Domestic H₂</td>
<td>(RD&amp;D)</td>
<td>International H₂ Supply Chains</td>
<td>CO₂-free H₂</td>
<td>Domestic Power-to-gas</td>
</tr>
<tr>
<td>Volume (t/y)</td>
<td>200</td>
<td>4k</td>
<td>300k</td>
<td>5~10m</td>
<td></td>
</tr>
<tr>
<td>Cost ($/kg)</td>
<td>~10</td>
<td>3</td>
<td>2</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Demand</th>
<th>Generation</th>
<th>Mobility</th>
</tr>
</thead>
<tbody>
<tr>
<td>Large Power Plant</td>
<td>(RD&amp;D)</td>
<td>1GW</td>
</tr>
<tr>
<td>FC CHP*</td>
<td>274k</td>
<td>1.4m</td>
</tr>
<tr>
<td>*Primary energy: natural gas.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>HRS</td>
<td>103</td>
<td>160</td>
</tr>
<tr>
<td>FCV</td>
<td>3.0k</td>
<td>40k</td>
</tr>
<tr>
<td>FC Bus</td>
<td>18</td>
<td>100</td>
</tr>
<tr>
<td>FC FL</td>
<td>160</td>
<td>500</td>
</tr>
<tr>
<td>Industry Use</td>
<td>(RD&amp;D)</td>
<td></td>
</tr>
</tbody>
</table>

Source: Ministry of Economy, Trade and Industry
## Strategic Roadmap for Hydrogen & Fuel Cells

<table>
<thead>
<tr>
<th>Use</th>
<th>Mobility</th>
<th>Power</th>
<th>FC</th>
<th>Supply</th>
<th>Green H2</th>
</tr>
</thead>
<tbody>
<tr>
<td>FCV 200k by 2025</td>
<td>HRS 320 by 2025</td>
<td>Commercialize by 2030</td>
<td>Early realization of grid parity</td>
<td>Hydrogen Cost</td>
<td>System cost of water electrolysis</td>
</tr>
<tr>
<td>800k by 2030</td>
<td>900 by 2030</td>
<td></td>
<td></td>
<td>¥30/Nm³ by 2030</td>
<td>¥50,000/kW in future</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>¥20/Nm³ in future</td>
<td></td>
</tr>
</tbody>
</table>

### Goals in the Basic Hydrogen Strategy

<table>
<thead>
<tr>
<th>Set of targets to achieve</th>
<th>Approach to achieving target</th>
</tr>
</thead>
<tbody>
<tr>
<td>Price difference between FCV and HV (¥3m → ¥0.7m)</td>
<td>Regulatory reform and developing technology</td>
</tr>
<tr>
<td>Cost of main FC system</td>
<td></td>
</tr>
<tr>
<td>FC ¥20/kWh → ¥5k/kWh</td>
<td>Consideration for creating nation-wide network of HRS</td>
</tr>
<tr>
<td>Hydrogen Storage ¥0.7m → ¥0.3m</td>
<td>Extending hours of operation</td>
</tr>
<tr>
<td>Construction and operating costs</td>
<td></td>
</tr>
<tr>
<td>Construction cost ¥350m → ¥200m</td>
<td></td>
</tr>
<tr>
<td>Operating cost ¥34m → ¥15m</td>
<td></td>
</tr>
<tr>
<td>Costs of components for HRS</td>
<td></td>
</tr>
<tr>
<td>Compressor ¥90m → ¥50m</td>
<td></td>
</tr>
<tr>
<td>Accumulator ¥50m → ¥10m</td>
<td></td>
</tr>
<tr>
<td>Vehicle cost of FC bus (¥105m → ¥52.5m)</td>
<td>Increasing HRS for FC bus</td>
</tr>
</tbody>
</table>

### Source: Ministry of Economy, Trade and Industry

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Action Plan (mobility) on the RM

**Target to achieve**

**FCV**
- 200k by FY2025, 800k by FY2030
- Achieving a cost reduction of FCV to the level of HV around 2025 (Price difference ¥3m → ¥0.7m)
- Reducing cost of main elemental technologies around 2025
  - Fuel cell system around ¥20k/kW → ¥5k/kW
  - Hydrogen storage system around ¥0.7m → ¥0.3m
- Expansion of vehicle types for volume zones in FY2025

**HRS**
- 320 by FY2025, some 900 by FY2030
- Making HRS independent by the second half of the 2020s
- Reduction of cost for construction and operation by FY2025
  - (Construction cost ¥50m → ¥20m, operation cost ¥34m/year → ¥15m/year)
- Setting of cost target for each component
  - Compressor ¥90m → ¥50m
  - High pressure vessels ¥50m → ¥10m

**Bus**
- 1,200 FC buses by 2030
- Expansion of regions where FC buses run
- Reducing FC bus price by half (¥105m → ¥52.5m)
- Independent FC bus by FY2030

**Forklift**
- 10k FC forklifts by 2030
- Expansion to an overseas markets

**Approach to achieving target**

- Sharing technical information and problems in a cooperation area among stakeholders
- Developing technology for reducing the amount of platinum used.
- Developing technology for reducing the amount of carbon fiber in hydrogen storage systems
- Thoroughly integrate promotion of regulatory reform and technological development (Realization of self-service HRS, use of inexpensive steel material etc.)
- Consideration for nationwide networking of HRS
- Extending opening hours
- Increasing of the number of HRS with gasoline station/convenience store
- Developing technology for enhancing the fuel efficiency and durability of such vehicles
- Expansion of types other than city buses
- Promotion of deployment of HRS for FC buses
- Versatile deployment of fuel cell units
- Promotion of maintenance of simple and easy to operate filling equipment

*In addition, promote development of guidelines and technology development for expansion of hydrogen use in the field of FC trucks, ships and train.

Source: Ministry of Economy, Trade and Industry
Current status of Fuel Cell application

15 Fuel Cell Bus (Toyota SORA)
Regular operation in Tokyo

3,200 FCVs was registered

103 HRSs was opened

140 FCFL

FC delivery track

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RD&D: Scaling-up

10MW Electrolysis PtG Demo
Related Activities: Maritime application

“Raicyo (Ptarmigan) N”
Tokyo University of Marine Science and Technology
Gross tonnage: 9.1 tons
The length of the ship: 12.60 meters
Maximum speed at full load: 11 knots
Fuel cell: PEFC 7 kW (3.5 kW x 2)
Battery: Lithium ion 145 kWh (13.2 kWh x 11 pack)
Propulsion motor: 90 kW (45 kW x 2)

Source: Tokyo University of Marine Science and Technology

“PHEB-3” Osaka City University
Gross tonnage: 2.6 tons
The length of the ship: 9.6 meters
Rated speed: 8 knots
Battery: 24kWh (96V)、2.4kWh (24V)、1.2kWh (12V)
Propulsion motor: 12 kW (6 kW x 2)

Source: Osaka City University
Related Activities: Transportation

Hydrogen Storage:
- 1,250m³ x 1 / 75t-H₂
- vacuum insulated double-walled structure
- Boil off rate: 0.1 vol %

Source: CO₂-free Hydrogen Energy Supply-chain Technology Research Association (HySTRA)
Related Activities: Transportation

Source: CO2-free Hydrogen Energy Supply-chain Technology Research Association (HySTRA)
Related Activities: @port

Total operation hours: 699 hours
- with hydrogen: 444 hours
  - Hydrogen only: 49 hours
  - H2/NG: 395 hours
- NG only: 255 hours

H2 Consumption: 179,000 Nm3 (16t)
Total Power Generation: 822 MWh
Total Steam Distribution: 547 t
Estimated CO2 reduction: 109 t

Source: KHI, Obayashi
Related Activities: @port

Concept of FC towing tractor

<table>
<thead>
<tr>
<th>Item</th>
<th>Spec</th>
</tr>
</thead>
<tbody>
<tr>
<td>Output Rated</td>
<td>8kW</td>
</tr>
<tr>
<td>Peak</td>
<td>32kW</td>
</tr>
<tr>
<td>H₂ Refueling</td>
<td>35MPa, 1kg (3min)</td>
</tr>
<tr>
<td>Working time</td>
<td>8hours</td>
</tr>
<tr>
<td>Price: JPY 13,400,000- (US$ 127K)</td>
<td></td>
</tr>
</tbody>
</table>

Source: Toyota Industries Corporation
Thank you!