Hydrogen Infrastructure in Japan

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New Energy and Industrial Technology Development Organization (NEDO)

2014 AMR
June 19, 2014
Washington Marriott Wardman Park Hotel, Washington, USA
1. Strategic Energy Plan
2. Cooperation between Industry, Academia and Government
3. FCV and HRS Deployment
4. FCV/Hydrogen Infrastructure Projects in Japan
5. Promotion of H$_2$ Refueling Station (HRS) Installation
6. NEDO’s Program for Hydrogen Infrastructure
1. Strategic Energy Plan (updated by Cabinet on 11th April 2014)

~ H₂/FC Field ~

(1) Promotion of Stationary Fuel Cells (FC)
- Residential FC (Ene-Farm): Target 1.4 mil unit by 2020, 5.3 mil unit by 2030
  - Installation subsidy toward self-sustained market (by FY2016),
  continuous support for R&D/standardization for cost reduction
- Stationary FC in commercial/industry application
  - Support for RD&D toward early commercialization (mainly for SOFC)

(2) Creation of preferable market conditions for FCV commercialization
- Build 100 HRSs by FY2015 and streamline regulations/R&D for cost reduction

(3) Promote new technologies such as H₂ gas-based power generation and wider H₂ applications
- Promotion of new H₂ technologies such as H₂ gas-based power generation can contribute to increase mass introduction of H₂ in the market, reducing the H₂ cost

(4) R&D for large-scale H₂ production/storage/delivery technologies for stable supply
- R&D effort on H₂ production/storage/delivery technologies that can contribute to large-scale storage/long-distance delivery with low-cost/large volume hydrogen supply

(5) Develop H₂/FC Roadmap toward "H₂/FC society"
- Develop a roadmap toward H₂/FC society and establish a committee to follow the progress
2. Cooperation between Industry, Academia and Government ~ toward ‘H₂/FC society’ ~

METI

Committee for Strategy of Hydrogen & Fuel Cell
Secretariat : METI

Planning to release

H₂/FC Roadmap
toward“H₂/FC society”

- The committee is organized by
government,
-private companies,
-academia and
-other stakeholders

- METI is gathering opinions from this committee, then reflect on planning of ‘H₂/FC Roadmap toward“H₂/FC society”’
2. Cooperation between Industry, Academia and Government ~toward ‘Regulatory reform ’~

- Cabinet Office is strongly promoting Regulatory reform for the world's fastest dissemination of FCEV & HRS.

![Diagram showing cooperation between Cabinet Office, Regulatory reform committee, Committee members (Trading companies, Industrial Manufactures, Academia, Financier, Media, ITC service, Lawyer), and Minister, Minister, METI with regulatory reform requests.

Regulatory reform requests for the world's fastest dissemination of FCEV & HRS:
- FCEV’s Hydrogen vessel
- Filling pressure for FCEV
- According with GTR
- Standards for Liquid Hydrogen utilization in HRS
- Materials for HRS
- Location and place limits for HRS

Committee members:
- Trading companies
- Industrial Manufactures
- Academia
- Financier
- Media, ITC service
- Lawyer

Ministers from Cabinet Office, METI, and other unspecified ministers are involved in the regulatory reform process.
3. FCV and HRS Deployment
~ Commercialization Scenario by FCCJ*~

* Fuel Cell Commercialization Conference of Japan

Commercialization Scenario for FCVs and H₂ Stations

<table>
<thead>
<tr>
<th>Phase 1</th>
<th>Phase 2</th>
<th>Phase 3</th>
<th>Phase 4</th>
</tr>
</thead>
</table>

- Phase 1: 2010
- Phase 2: 2015
- Phase 3: 2025
- Phase 4: 2026

- **2010**: Solve technical issues and promote review regulations (Verifying & reviewing development progress as needed).
- **2015**: Verify utility of FCVs and H₂ stations from socio-economic viewpoint.
- **2025**: Increase numbers of FCV and H₂ stations based on profitable business.
- **2026**: Contribute to diversity of energy sources and reduction of CO₂ emissions.

**Vehicle Number**

- Approx. 2 million FCVs*

**H₂ Station Number**

- Approx. 1,000 H₂ stations*

**Year**

- Target commercialization start of FCV to general public (Year 2015)
- Costs for H₂ station construction and hydrogen reach targets, making the station business viable. (FCV 2,000 units/station)
- Period in which preceded H₂ station building is necessary
- Increase of FCV numbers through introduction of more vehicle models

**Note**: Vertical axis indicates the relative scale between vehicle number & station number.

* Precondition: Benefit for FCV users (price/convenience etc.) are secured, and FCVs are widely and smoothly deployed.

3. FCV and HRS Deployment
~ History of Japanese FCEV development ~

NISSAN to launch 1st commercial model

TOYOTA / HONDA to launch 1st commercial model

FCHV-adv

FCX Clarity

HONDA

TOYOTA

X-TREIL FCV

TOYOTA

HONDA

NISSAN
3. FCEV and HRS Deployment

### Automakers' Worldwide Cooperation

<table>
<thead>
<tr>
<th>Toyota = BMW</th>
<th>Nissan = Daimler = Ford</th>
<th>Honda = GM</th>
</tr>
</thead>
<tbody>
<tr>
<td>(announced on Jan 24, 2013) - Agreed on joint development of a fundamental fuel-cell vehicle system aiming for next-generation in 2020. - Launch of FCVs in 2015</td>
<td>(announced on Jan 28, 2013) - Agreed on joint development of common fuel cell electric vehicle system. - Launch of mass-production FCEVs in 2017</td>
<td>(announced on July 2, 2013) - Agreed on joint development of fuel cell system and hydrogen storage technologies, aiming for next-generation in 2020. - Launch of FCVs in 2015</td>
</tr>
</tbody>
</table>

- Joint announcement by 13 companies including automakers and energy companies (Jan 13, 2011)
  1. Introduction of FCEV in 2015,
  2. Installation of 100 hydrogen refueling stations in four major metropolitan areas
- "Japan Revitalization Strategy" (June 14, 2013)
  1. Installation of 100 hydrogen refueling stations in four major metropolitan areas
  2. The world's fastest dissemination of FCVs
3. FCEV and HRS Deployment
~ Industry cooperation toward ‘H₂/FC society’ ~

[Industry]

Stationary FC (ENE-FARM)
- ENE-FARM Partners
  Industrial cooperation for ENE-FARM diffusion

HRS infrastructure & FCV
- FCCJ
  Leading for commercialization and diffusion of Fuel Cell
- HySUT
  Research association for demonstration of Hydrogen Supply (HRS) / Utilization (FCV) Technology

Industrial association for Promoting Fuel Cell diffusion
- FCA

Industrial association for R&D of the automotive industry and technology
- JARI

Industry association for development of Petroleum Energy utilization
- JPEC

Industry association for automobile manufacturing
- JAMA

Industrial association for promotion of technical development
- ENAA
3. FCEV and HRS Deployment
~ Industrial Cooperation for RD&D ~

**About HySUT**

*The Research Association of Hydrogen Supply / Utilization Technology*

- **Goal and Objective -**
  - HySUT’s goal is commercialization of hydrogen supply business and FCVs by private companies.
  - HySUT’s objective is to solve the issues of technology, consumer awareness, social acceptance and to assist business establishment through our demonstration program.

<table>
<thead>
<tr>
<th>Date of establishment</th>
<th>July 31st, 2009</th>
</tr>
</thead>
<tbody>
<tr>
<td>Members</td>
<td>19 Companies and Organizations</td>
</tr>
<tr>
<td></td>
<td>4 Petroleum / 4 City gas / 6 Industrial gas, Devices, Engineering &amp; Materials</td>
</tr>
<tr>
<td></td>
<td>3 Automotive / 2 Related organizations</td>
</tr>
<tr>
<td>Term</td>
<td>2009 to FY2015</td>
</tr>
</tbody>
</table>
3. FCEV and HRS Deployment
~ HySUT member companies ~

<table>
<thead>
<tr>
<th>Members</th>
<th>19 Companies and Organizations</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>JX Nippon Oil &amp; Energy Corporation, Idemitsu Kosan Co., Ltd., Cosmo Oil Co., Ltd., Showa Shell Sekiyu K.K.</td>
</tr>
<tr>
<td>4</td>
<td>Tokyo Gas Co., Ltd., Osaka Gas Co., Ltd., Toho Gas Co., Ltd., Saibu Gas Co., Ltd</td>
</tr>
<tr>
<td>3</td>
<td>Toyota Motor Corporation, Nissan Motor Co., Ltd., Honda R&amp;D CO., Ltd.</td>
</tr>
<tr>
<td>2</td>
<td>Engineering Advancement Association of Japan (ENAA), Japan Petroleum Energy Center (JPEC)</td>
</tr>
</tbody>
</table>
4. FCEV/Hydrogen Infrastructure Projects in Japan

<table>
<thead>
<tr>
<th>Year</th>
<th>Project/Activity</th>
<th>Agency/Institution</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1993</td>
<td>WE-NET</td>
<td>METI</td>
<td>Common fundamental development project of hydrogen society building by NEDO</td>
</tr>
<tr>
<td>~2001</td>
<td>JHFC1</td>
<td>METI</td>
<td>Fundamental development of technologies for safe use of hydrogen infrastructure by NEDO</td>
</tr>
<tr>
<td>2004</td>
<td>JHFC2</td>
<td>METI</td>
<td>Development of technologies for hydrogen production, delivery and storage systems by NEDO</td>
</tr>
<tr>
<td>2007</td>
<td>JHFC3</td>
<td>NEDO</td>
<td>Hydrogen highway project by METI</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>WE-NET (1) Technical &amp; Social Demonstration</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>WE-NET (2) Regional Demonstration</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Establishment of HySUT highway project</td>
</tr>
<tr>
<td>2008</td>
<td></td>
<td></td>
<td>Research and development of technologies for hydrogen utilization by NEDO</td>
</tr>
<tr>
<td>2009</td>
<td></td>
<td></td>
<td>Research on hydrogen storage material by NEDO</td>
</tr>
<tr>
<td>2010</td>
<td></td>
<td></td>
<td>Advanced fundamental research on hydrogen storage materials by NEDO</td>
</tr>
<tr>
<td>2011</td>
<td></td>
<td></td>
<td>Fundamental research on advanced hydrogen science by NEDO</td>
</tr>
<tr>
<td>2012</td>
<td></td>
<td></td>
<td>Basic fundamental research on hydrogen science by NEDO</td>
</tr>
<tr>
<td>2013</td>
<td></td>
<td></td>
<td>Common fundamental development project of hydrogen society building by NEDO</td>
</tr>
<tr>
<td>2014</td>
<td></td>
<td></td>
<td>Development of technologies for hydrogen production, delivery and storage systems by NEDO</td>
</tr>
<tr>
<td>2015</td>
<td></td>
<td></td>
<td>Fundamental development of technologies for safe use of hydrogen infrastructure by NEDO</td>
</tr>
</tbody>
</table>

**Acronyms:**
- **METI:** Ministry of Economy, Trade and Industry
- **NEDO:** New Energy and Industrial Technology Development Organization
- **WE-NET:** International Clean Energy Network using Hydrogen Convention (World Energy-NETwork)
- **JHFC:** Japan Hydrogen & Fuel Cell Demonstration Project

**Diagram Notes:**
- JHFC1 by METI
- JHFC2 by METI
- JHFC3 by NEDO
- WE-NET by METI
- Establishment of HySUT
- Research and development of technologies for hydrogen utilization by NEDO
4. FCEV/Hydrogen Infrastructure Projects in Japan ~ FCVs & FC Buses Served for JHFC3 ~

- **FCHV-adv (Toyota)**
- **X-TRAIL FCV (Nissan)**
- **FCX CLARITY (Honda)**

**Fleet Demonstration**

Other FCVs leased from automakers

- **ANA CHUBU AIRPORT CO., LTD.**
- **Manzaki Transport Co., Ltd.**
- **FCX CLARITY (Honda) ANA Welcome-home Taxi Service**
- **Airport Transport Service Co., Ltd.**
- **FCHV-BUS (Toyota, Hino) Airport Limousine**
- **FCHV-BUS (Toyota, Hino) Ramp Bus**
- **FCHV-BUS (Toyota, Hino) Shuttle Bus**
- **FCHV-BUS (Toyota, Hino)**
- **New Kansai International Airport Co., Ltd.**
4. FCEV/Hydrogen Infrastructure Projects in Japan ~HRSs in JHFC3 (FY2013)~

- Technical & Social Demonstration by HySUT and HySUT’s members
- Regional Demonstration by local governments etc.
4. FCEV/Hydrogen Infrastructure Projects in Japan ~HRS with commercial scale fueling ability~

<table>
<thead>
<tr>
<th>City</th>
<th>Name</th>
<th>Type</th>
<th>Hydrogen Resource</th>
<th>Characteristic</th>
<th>Photo</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ebina</td>
<td>Ebinachuo</td>
<td>Off-site</td>
<td>Compressed H₂ gas</td>
<td>• Establishment in commercial GS.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>• Hydrogen trailer utility</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nagoya</td>
<td>Kaminokura</td>
<td>On-site</td>
<td>LPG</td>
<td>• Establishment in commercial GS.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Toyota</td>
<td>Toyota ecoful town</td>
<td>On-site</td>
<td>City gas</td>
<td>• Packaging equipments (Iwatani/Linde)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>• Large amount fueling for FC bus</td>
<td></td>
</tr>
</tbody>
</table>
5. Promotion of HRS Installation
~HRSs in Japan~

<table>
<thead>
<tr>
<th></th>
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<th></th>
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<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>METI’s new subsidy scheme for installation of commercial HRSs</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>FY2013 $46 mil</td>
<td>FY2014 $72 mil</td>
<td>FY2015 ?</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>NEDO’s New Project “Hydrogen utilization technology development”</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>FY2013 $20 mil</td>
<td>FY2014 $32 mil</td>
<td>FY2015 ?</td>
<td></td>
</tr>
</tbody>
</table>

JHFC2
- Technical and Social Demonstration (JHFC3)
- Numbers of HRS served in JHFC: 17 (FY2010), 16 (FY2011, FY2012), 17 (FY2013)

JHFC3
- Numbers of HRS served in JHFC: 15 (FY2016)
- HySUT: 12
- Regional Gov.: 3

- METI’s new subsidy scheme for installation of commercial HRSs
- FY2013: $46 mil
- FY2014: $72 mil
- FY2015: ?

- NEDO’s New Project “Hydrogen utilization technology development”
- FY2013: $20 mil
- FY2014: $32 mil
- FY2015: ?
5. Promotion of HRS Installation

- Prior to market introduction of FCEVs (2015), 100 HRSs will be installed in 4-major-populated-areas (Tokyo, Aichi, Osaka, Fukuoka)
- METI subsidizes about 50% of HRS installation cost (2014FY 7.2 billion JPY)

Status of HRSs (as of June 19th)
- Budget secured:
  - 31 stations
  - 1 Large H₂ Production Facility

The third round for the application to hydrogen station installation in 2014 is now under process.
5. Promotion of HRS Installation
~ Summary of the approved HRSs by type~

<table>
<thead>
<tr>
<th>Fueling ability</th>
<th>100-300 Nm³/h (FY2013/FY2014)</th>
<th>300&lt; Nm³/h (FY2013/FY2014)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>CHG</td>
<td>LH</td>
</tr>
<tr>
<td>on-site</td>
<td>0/1</td>
<td></td>
</tr>
<tr>
<td>off-site</td>
<td>0/0</td>
<td>0/0</td>
</tr>
</tbody>
</table>

CHG: compressed hydrogen gas
LH: liquid hydrogen
3. Promotion of HRS Installation
Subsidy Scheme for HRS (2014FY)

<table>
<thead>
<tr>
<th>Fueling ability (average) [Nm³ / hr]</th>
<th>Types of HRS</th>
<th>Grant rate</th>
<th>Upper subsidy limit (million JPY)</th>
</tr>
</thead>
<tbody>
<tr>
<td>more than 300</td>
<td>On-site ( partial / full packaging )</td>
<td>Fixed</td>
<td>280</td>
</tr>
<tr>
<td></td>
<td>On-site ( Except above )</td>
<td>50%</td>
<td>280</td>
</tr>
<tr>
<td></td>
<td>Off-site ( partial / full packaging )</td>
<td>Fixed</td>
<td>220</td>
</tr>
<tr>
<td></td>
<td>Off-site ( Except above )</td>
<td>50%</td>
<td>220</td>
</tr>
<tr>
<td></td>
<td>Movable</td>
<td>Fixed</td>
<td>250</td>
</tr>
<tr>
<td>100 to 300</td>
<td>On-site ( partial / full packaging )</td>
<td>Fixed</td>
<td>180</td>
</tr>
<tr>
<td></td>
<td>On-site ( Except above )</td>
<td>50%</td>
<td>180</td>
</tr>
<tr>
<td></td>
<td>Off-site ( partial / full packaging )</td>
<td>Fixed</td>
<td>150</td>
</tr>
<tr>
<td></td>
<td>Off-site ( Except above )</td>
<td>50%</td>
<td>150</td>
</tr>
<tr>
<td></td>
<td>Movable</td>
<td>Fixed</td>
<td>180</td>
</tr>
<tr>
<td></td>
<td>One Hydrogen production equipment for Hydrogen Shipping facility (10 equipment maximum at one site)</td>
<td>50%</td>
<td>60</td>
</tr>
<tr>
<td></td>
<td>Liquid hydrogen receiving and feeding equipment for HRS</td>
<td>50%</td>
<td>40</td>
</tr>
</tbody>
</table>
Item 1: Streamlining Regulations

“Regulation Reform Plan” (Cabinet approved in June 2013)
- 24 items were identified as priority
  (e.g. location, distance, materials, etc.)

Item 2: R&D on low cost equipment for HRS

  e.g. Compressor, Pre-cooler, Reformer, etc.

Item 3: Code and Standard

  e.g. quality, metering, filling, inspection, etc.
6. NEDO’s Program
~ Streamlining Regulations for HRS ~

Regulations on operations
Regulations on location
Regulations on materials
Transport regulations
Clearance/distance regulations
Other traffic regulations

NEDO's Program
- Streamlining Regulations for HRS
- Regulations on materials
- Regulations on location
- Regulations on operations
- Transport regulations
- Clearance/distance regulations
- Other traffic regulations
6. NEDO’s Program
~ R&D on low cost equipment for HRS ~

-The present cost of supply equipment is 500 to 600 million yen, which is a major problem.
-The goal is to lower the cost of H₂ refueling stations.
-Cost reduction can be achieved by deregulation, mass production and simplification of system components.
6. NEDO’s Program
~ Research for Codes and Standards ~

Kyushu Univ. as COE of Hydrogen
6. NEDO’s Program
~Budgets for H₂ & FC in 2014 ~

Total Budget: JPY 9.3 billion (USD 93 mil.)
6. NEDO’s Program
~ HRS Reliability Project ~

Software
- Improving Usability
  - Simple user operation

Hardware
- Equipment / System
  - Avoid of Human Error
- Seamless pipe
- Improvement in durability
- Characteristics of temperature / pressure
- New material design

Improving Usability

Reliability

Safety / Reassurance

2015
- Education Tool for Operator
- Operation manual
- Case study for self fueling

2025
- Operator’s capacity building
- Parts reduction
- Frequent Inspection
- Advanced monitoring system
- Automatic filling

Disaster-prevention facility
- Outreach activities
- Organize academia on hydrogen safety

Resiliency

Public Acceptance

Communication

Operation DB
- Safety Handbook (JHFC3)
- Training scheme for 1st responder
- Disaster-prevention facility

Materials
Thank you for your attention!