JHFC Project Activities
in FY 2009
(Supported by NEDO)

Presented for IPHE Forum
September 21-22, Shanghai

Jinichi Tomuro
(ENAA, Japan)
1. The situation surrounding FCVs
   • Energy trends in Japan
   • The trends on FCV hydrogen infrastructure in Japan and abroad
   • Merits and positioning of FCVs
   • Trends in other next generation vehicles
   • Positioning of JHFC with NEDO related projects

2. The progress of JHFC in 2009
   • JHFC activities: up to now, objectives from this point, enhancement of the structure
   • Results achieved with FCV driving performance, hydrogen refueling, fuel economy etc.
   • The research results of primary technology verifications

3. Summary and intended measures for 2010
   • Summary of 2009
   • Clarification of technical issues to be verified for commencement of FCV hydrogen infrastructure expansion
   • Intended measures for 2010
Energy Trends in Japan

At the Summit of the heads of state and government on climate change held at the United Nations headquarters in September 2009, Prime Minister Hatoyama announced that Japan intends to reduce its CO₂ emissions by 25% below 1990 levels by 2020.

Basic Act on Energy Policy


Energy requirement forecast for 2030 (2005)

Discuss the view of energy supply-demand structure for 2030, and study mid-long term energy strategy.

New national energy strategy (2006)

Mid to long term (-2030) national energy strategy focusing on energy security

Improvement Target:
- energy saving 30%
- oil dependence (whole) 40%
- oil dependence (transport) 80%
- nuclear power ratio 30-40%

Next generation vehicle fuel initiative (2007)

“Next generation battery”
“Hydrogen•Fuel cell”
“Clean diesel”
“Biofuel”
“ITS”

50 beautiful stars (2007) (Cool Earth 50)

Proposed to reduce CO₂ to 50% by 2050

Technical strategy milestones

Select the technologies highly demanded for national and private sectors.

Long term energy need expectation (2008)

For achieving the target of “New national energy strategy”, clarify Japan’s vision of energy demand-supply structure assuming that cutting edge energy technologies are progressed and implemented “utmost”.

UN conference on climate change (2009)

Summit in Toyako / Hokkaido (2008)

G8 agreed to share the target of reducing global production to 50% at least, by 2005, with UNFCCC contracting states.

Declared to reduce 25% of CO₂ by 2020 compared to 1990
Trends in abroad about FCV / Hydrogen Infrastructure

The efforts to introduce FCV / Hydrogen are distinctively more active in the EU / USA member countries and states than their respective governments.

<table>
<thead>
<tr>
<th>Europe</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>• The automobile manufacturers announced LoU, and particularly the</td>
<td>• In the EU within FP7, the FCH-JU (= FCH-JTI) commences with the</td>
</tr>
<tr>
<td>infrastructure manufacturers on the receiving end announced MoU, and</td>
<td>development of NextHyLight (the successor to HyLight) or H2 Move</td>
</tr>
<tr>
<td>the test scenario regarding the introduction of hydrogen stations was</td>
<td>Scandinavia (demonstration in Oslo) etc. and development is</td>
</tr>
<tr>
<td>developed with the H₂ Mobility consortium.</td>
<td>progressing.</td>
</tr>
<tr>
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<td>progressing.</td>
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</table>

<table>
<thead>
<tr>
<th>U.S.A.</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>• Although the DOE Secretary Chu greatly reduced the hydrogen budget,</td>
<td>• CaFCP and the government of New York state are outlining a plan</td>
</tr>
<tr>
<td>congress resisted and succeeded in obtaining the same budget level as</td>
<td>for the introduction and development of FCV stations commencing</td>
</tr>
<tr>
<td>the previous year. However, there remains a concern regarding</td>
<td>in 2015.</td>
</tr>
<tr>
<td>governmental support.</td>
<td></td>
</tr>
<tr>
<td>• CaFCP and the government of New York state are outlining a plan for</td>
<td></td>
</tr>
<tr>
<td>the introduction and development of FCV stations commencing in 2015.</td>
<td></td>
</tr>
<tr>
<td>• In the Canadian provinces of BC etc. the emphasis is on the further</td>
<td></td>
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<tr>
<td>expansion of the FC bus fleet.</td>
<td></td>
</tr>
</tbody>
</table>
1. FCV

① Heads of the Japanese car manufacturers mentioned the 2015 targets.
② Domestic leasing of the new FCV has commenced.
③ Japanese car manufacturers participate in the aforesaid European LoU.

2. Hydrogen Infrastructure

① Opening of three Cooperative Hydrogen Stations (keep on increasing)
   • Started operation in Kita-Kyushu, Kyushu University & in Nikko in September 2009
② Founding of the Research Association of Hydrogen Supply / Utilization Technology (HySUT)
   • On July 31st, 2009
     In preparation for the year 2015 when propagation is predicted to begin, a research association was founded by 13 Japanese domestic infrastructure companies (oil, gas, equipment manufacturers), engaged in undertaking field tests.
**FCV and Eco-cars Feature Comparisons**

- FCV and BEV are most promising in aspects of CO₂ emission and energy sustainability.
- FCV has a major problem in vehicle cost and infrastructure improvement.
- BEV has a major problem in battery performance improvement.

<table>
<thead>
<tr>
<th>Item</th>
<th>FCV</th>
<th>BEV</th>
<th>PHEV</th>
<th>HEV</th>
<th>ICE (gasoline)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>CO₂ emission</strong></td>
<td>★★★★★</td>
<td>★★★★</td>
<td>★★★★</td>
<td>★★★</td>
<td>★</td>
</tr>
<tr>
<td>Cold district performance</td>
<td>★★★★</td>
<td>★ (Battery degradation)</td>
<td>★★★★</td>
<td>★★★★</td>
<td>★★★★</td>
</tr>
<tr>
<td>Driving range</td>
<td>★★★★★ (10-15 mode ~830km)</td>
<td>★★ (~160km)</td>
<td>★★ (for EV, 30km) ★★★★ (EV+HV)</td>
<td>★★★★</td>
<td>★★★★</td>
</tr>
<tr>
<td>Vehicle cost</td>
<td>★</td>
<td>★★</td>
<td>★★</td>
<td>★★★★</td>
<td>★★★★</td>
</tr>
<tr>
<td>Durability (Performance degradation)</td>
<td>★★★★ (Stack 10years)</td>
<td>★★ (Battery)</td>
<td>★★★ (Battery)</td>
<td>★★★★</td>
<td>★★★★</td>
</tr>
<tr>
<td>Filling, charging, or refueling time</td>
<td>★★★★ (5 min)</td>
<td>★ (Normal charge 8hr) ★★ (Quick charge 20min)</td>
<td>★ (Normal charge 4hr) ★★★★★ (Refueling gasoline)</td>
<td>★★★★</td>
<td>★★★★</td>
</tr>
<tr>
<td>Infrastructure availability</td>
<td>★</td>
<td>★★★</td>
<td>★★★★</td>
<td>★★★★</td>
<td>★★★★</td>
</tr>
<tr>
<td>Energy sustainability</td>
<td>★★★★</td>
<td>★★★★</td>
<td>★★★★</td>
<td>★★★</td>
<td>★</td>
</tr>
</tbody>
</table>
Segmentation of FCV and BEV

- FCV can replace existing gasoline vehicle in aspects of vehicle size and driving range.
- For small and short-distance applications, BEV and FCV can coexist to spread more widely.
The new estimate of long-term energy requirements issued by METI in August 2009 predicts that by 2020, 50% of new cars will be the next generation vehicles such as FCV.

<table>
<thead>
<tr>
<th>Manufacturer</th>
<th>2008</th>
<th>2009</th>
<th>2010</th>
<th>2011</th>
<th>2012</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electric cars</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mitsubishi</td>
<td></td>
<td></td>
<td>![Arrow]</td>
<td></td>
<td>Launch in 2009</td>
</tr>
<tr>
<td>Fuji Heavy Industries</td>
<td></td>
<td>![Arrow]</td>
<td>![Arrow]</td>
<td></td>
<td>Launch in 2009</td>
</tr>
<tr>
<td>Nissan</td>
<td></td>
<td></td>
<td>![Arrow]</td>
<td></td>
<td>Launch in 2010</td>
</tr>
<tr>
<td>Toyota</td>
<td></td>
<td></td>
<td>![Arrow]</td>
<td></td>
<td>Launch by 2012</td>
</tr>
<tr>
<td>Plug-in hybrids</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Toyota</td>
<td></td>
<td>![Arrow]</td>
<td>![Arrow]</td>
<td></td>
<td>Launch in 2009</td>
</tr>
<tr>
<td>Biofuel</td>
<td></td>
<td>![Arrow]</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Members of the PAJ</td>
<td></td>
<td>![Arrow]</td>
<td></td>
<td></td>
<td>Launch by makers from 2009</td>
</tr>
</tbody>
</table>

Information regarding cars is based on makers' reports. Information regarding biofuel is from PAJ web site.
NEDO Fuel Cells / Hydrogen Technology Development Project

-2004

(2005-2009) Development of strategic technologies for applying polymer electrolyte fuel cell:
- Basic common issue solution technology (degradation analysis, etc.)
- Element technology (MEA, catalyst, stack, etc.)
- Basic produce technology (1/2 cooperative study)
- Next generation fuel cell (Utilize university researchers)

(2005-2007) Study of advanced fuel cell science (METI operation)

(2005-2008) Large scale demonstration of fixed fuel cell

(2002-2005) (JHFC-1) (METI operation)
(2003-2007) Develop technologies for hydrogen safe use

(2006-2008) (JHFC-2) Fuel cell system demonstration (METI)

(2005-2009) Improvement of common infrastructure for hydrogen society

(2006-2012) Base study of advanced hydrogen science

(2008-2010) (JHFC-2) NEDO business

(2008-2014) Basic material study for hi-performance cell integrating degradation mechanism analysis and nano technology (HiPer-FC)

(2008-2009) (FC-Cubic) Study of advanced fuel cell science

(2006-2009) (JHFC -2) Fuel cell system demonstration (METI)

(2007-2011) Base study of advanced hydrogen storage material

Brand new operation
Develop promotion technology for applying polymer electrolyte fuel cell (tentative)

Partially integrated
Establishment of a hydrogen society

Technology development

Evidence in technology

Evidence in society

Regulation • Standardize

Establishment of Codes & Standards for Hydrogen Economy Society

(Evaluation of safety, revision of standards)

Development of Technologies for Hydrogen Production, Delivery and Storage Systems

(Establish a hydrogen supply technology with high efficiency at low cost)

Fundamental, Basic research

Fundamental Research Project on Advanced Hydrogen Science

Advanced Research on Hydrogen Storage Materials

(Joint density storage technology, quality, hydrogen embrittlement etc.)

JHFC Japan Hydrogen & Fuel Cell Demonstration Project

(Feedback, evidence from the results obtained by NEDO)

Intended milestones for the propagation of FCV and hydrogen infrastructure by 2015

(Creation of a new industry, knock-on effects from the increase of competition in the industry are expected)
Contents

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3. Summary and intended measures for 2010
   - Summary of 2009
   - Clarification of technical issues to be verified for commencement of FCV hydrogen infrastructure expansion
   - Intended measures for 2010
Results of JHFC-2 until FY 2008

The followings have been achieved by the operation of fuel cell vehicles and hydrogen infrastructure.

1. Demonstrated the utilization benefits mainly by 35MPa vehicles
2. Implementation of improvement and standardization work derived from topics and data
3. Clarification of energy efficiency and costs for facilities and operations etc.
4. Verification of improvement of the awareness level from the promotional / educational activities
5. Demonstrated that the performance at low temperatures of FCV equals that of ICE etc.
6. Demonstrated the low energy efficiency (fuel consumption) of FCV, or the efficiency in the reduction of environmental pollution
7. Begun 70MPa refueling (in the second half of last year)
The JHFC-2 Targets (for 2015)

Our priorities from 2009 onwards

1. Suggested infrastructure model for commercialization
2. Clarification of effective counter-measures for common areas of concern relating to vehicles and infrastructure (such as best refueling pressure)
3. Development of an actual plan concerning safety verification of hydrogen infrastructure, reexamination of regulations
4. Strengthen co-operation with other operators of hydrogen-based systems and feedback the results of demonstrative research
5. Measures for the promotion of system acceptance and education (development of strategic promotional measures), research, clarification of the regional points of emphasis
6. Clarification of the technical items to be verified required for the commencement of propagation in 2015
Under the framework of new NEDO supported projects, the 2 existing groups were complemented and 4 core groups were constituted under the umbrella of the JHFC.

**JHFC Project**

*Japan Hydrogen & Fuel Cell Demonstration Project*

- **METI**
  Ministry of Economy, Trade and Industry

- **NEDO**
  New Energy and Industrial Technology Development Organization (NEDO), an independent government agency

- **PEC**
  Petroleum Energy Center
  Member since 2009

- **JARI**
  Japan Automobile Research Institute
  Member since 2009

- **ENAA**
  Engineering Advancement Association of Japan

- **JGA**
  Japan Gas Association
  Member since 2009

1st phase: FY 2002-2005

2nd phase: FY 2006-2010
2009 Promotion Structure (6 WGs, 12 Committees)

**Steering committee**

**JHFC Executive Planning and Promotion Committee**

**Chairperson** Hisasi Ishitani (NEPC)
**Vice Chairperson** Ken Okazaki (Tokyo Inst. Tech.)

**METI**
Ministry of Economy, Trade and Industry

**NEDO**
New Energy and Industrial Technology Development Organization (NEDO), an independent government agency

**WG1: Hydrogen infrastructure WG**
- **PM** Ken Okazaki (Tokyo Inst. of Tech)
- **Vice PM** Masanori Monde (Saga Univ.)

**WG2: Fuel cell vehicles WG**
- **PM** Yoichi Hori (Tokyo Univ.)

**WG3: Vehicle / Infrastructure interface WG**
- **PM** Yasuo Takagi (Tokyo City Univ.)
- **PM** Masanori Monde (Saga Univ.)

**WG4: Public Relations WG**
- **Advisor** Hisashi Ishitani (NEPC)

**WG5: International collaboration WG**
- **Advisor** Hisashi Ishitani (NEPC)

**WG6: Regional demonstration test WG**
- **PM** Ken Okazaki (Tokyo Inst. Tech)
- **Vice PM** Masanori Monde (Saga Univ.)

- **Demonstration liaison conference** (PEC/JARI)
- **Operation section** (PEC/JARI)
- **Office conference** (PEC/JARI)
- **Commercial infrastructure model section** (JGA/PEC)
- **Hydrogen infrastructure demonstration section** (ENAA)
- **Security/Regulation review section** (PEC/ENAA)
- **Data analysis section** (JARI)
- **Fleet section** (JARI)
- **Common issue section** (PEC/JARI/ENAA/JGA)
- **Operation/Refuel section** (ENAA/JARI/PEC/JGA)
- **Event section** (JARI/PEC)
- **Education section** (JARI/PEC)
- **Overseas study section** (JARI/ENAA)
- **International forum section** (JARI/ENAA)
- **Osaka demonstration section** (OSTEC)

**PM** Yoichi Hori (Tokyo Univ.)

**PM** Ken Okazaki (Tokyo Inst. of Tech)
With the opening of Three new stations in 2009, the total now is 15 stations (including cooperative ones)

1) Osaka (2007/8)
2) Kansai Int’l Airport (2007/3)

Chubu area
1) Centrair (2006/7)

Kyushu
1) Kyushu Univ. (2009/9)
2) Kita Kyushu (2009/9)

Kansai area

Nikko
1) Nikko (2009/9)

Tokyo area
1) Daikoku (2003/3, 70MPa:2008/12)
2) Asahi(2003/4, 70MPa:2009/2)
3) Senju(2003/5, 70MPa:2008/9)
4) Kawasaki(2003/8)
5) Sagamihara(2004/4)
6) Kasumigaseki (2002/12, 70MPa:2009/2)
7) Funabashi(2007/6)
8) Ariake(2003/5)
9) Ichihara(2006/12)
December 2002 ~ December 2009 in total

Car: Total driving distances 1,100,000 km, hydrogen refueling amount 20.5 tons
Bus: Total driving distances 290,000 km, hydrogen refueling amount 28.4 tons

① Driving distances
- FC bus
  - JHFC1
  - JHFC2
  - Total driving distance: 290,000 km, 1,100,000 km

② Hydrogen refueling amount
- Demonstrative and user FCV
  - JHFC1
  - JHFC2
  - 20.5 tons

- FC bus
  - JHFC1
  - JHFC2
  - 28.4 tons

Note: Not all the refueled hydrogen is used for driving, therefore these numbers are not suitable for calculating energy consumption.
Latest demonstrated vehicles have improved fuel economy steadily in both local road and highway.
1. The infrastructure specifications

13 types of hydrogen station transportation facilities

Onsite hydrogen station (Portable 100Nm³/h ST 70/35MPa)

Onsite hydrogen station (300Nm³/h ST 70/35MPa)

Offsite hydrogen station (non-compressor ST* 70/35MPa)

Offsite delivery/transport facility

City gas

Desulfurized Refiner PSA Compressor

High-pressure storage cylinder

Dispenser (x2-3)

FCV

80MPa 40MPa 35/70MPa

Results of the Primary Technology Verification (1)

Infrastructure models for commercial use (Propagation in 2015)

2. A specification of a method for direct refueling by compressor (Method of refueling directly from the compressor into FCV)

• Verification in addition to the conventional “Cascade”
• While it has the benefit that the expensive high pressure storage cylinder becomes unnecessary, a large capacity compressor is required

Low cost

Hydrogen fuel

35MPa

Compressor

Direct refueling compressor

70-100MPa

Dispenser

70MPa

Pre-cool

High pressure storage cylinder is not necessary

40MPa

High-pressure storage cylinder

Offsite hydrogen station (non-compressor ST* 70/35MPa)
Results of the Primary Technology Verification (2)

Example of an approximate estimate of hydrogen / infrastructure costs (on-site)
(costs during the first phase of propagation 2015~20)

(Conditions for rough estimate)
Improvement of costs targeting the main cost reduction factors in the development of equipment, revision of regulations, etc.

<table>
<thead>
<tr>
<th>Name</th>
<th>Cost reduction rate (vs. current)</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hydrogen producer</td>
<td>50%</td>
<td>Target value of NEDO to produce/transport/storage Pr</td>
</tr>
<tr>
<td>Compressor</td>
<td>30%</td>
<td>Maker hearing &amp; CNG station result are used</td>
</tr>
<tr>
<td>Hi-pressure storage cyl.</td>
<td>20%</td>
<td>Cost study section hearing</td>
</tr>
<tr>
<td>Dispenser</td>
<td>50%</td>
<td>Target value of NEDO to produce/transport/storage PJ</td>
</tr>
<tr>
<td>Pre-cooler</td>
<td>20%</td>
<td>Target cost reduction of NEDO cost structure study WG</td>
</tr>
<tr>
<td>Others (Const. fee, etc.)</td>
<td>30%</td>
<td>CNG station results are used</td>
</tr>
</tbody>
</table>

Hydrogen station

<table>
<thead>
<tr>
<th>Costs</th>
<th>35MPa (Cascade)</th>
<th>70MPa (Cascade)</th>
<th>70MPa (Direct refueling)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Station construction costs (100 Mil. Yen)</td>
<td>300Nm³/h (on site)</td>
<td>2.9</td>
<td>6.8</td>
</tr>
<tr>
<td>Hydrogen costs* (Yen/Nm³)</td>
<td>100% supply Base (365 days * 13 hours)</td>
<td>70</td>
<td>110</td>
</tr>
</tbody>
</table>

(Information) Driving range costs for gasoline (Note) (JPY 105/L) (JPY 165/L) (JPY 120/L)

(Note) Estimation of fuel consumption FCV: approx. 10km/Nm³ with H₂, HEV: approx. 15km/L with gasoline

⇒ Continuation of verification for further cost reductions is necessary

* Material city gas: JPY 44/Nm³
## Concept of Key Rank

**Special A:** Points that will cause serious problems for the propagation if not revised by 2015

**A:** Points that will cause problems due to high costs etc. for the commercial operation if not revised by 2015.

**B:** Points that at the commencement of propagation might become mandatory

### Key Regulation Review Tasks Regarding Hydrogen Infrastructure

<table>
<thead>
<tr>
<th>Rank</th>
<th>Key Task</th>
<th>Statute</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Development of 70MPa Laws</td>
<td>High Pressure Gas Safety Act</td>
</tr>
<tr>
<td></td>
<td>• Revision of Safety Distance</td>
<td>High Pressure Gas Safety Act</td>
</tr>
<tr>
<td>Special A</td>
<td>• Revision of Safety Administrator Resident Obligations</td>
<td>High Pressure Gas Safety Act</td>
</tr>
<tr>
<td></td>
<td>• Allows Establishing Stations Alongside the Gasoline Stands</td>
<td>Fire Service Law</td>
</tr>
<tr>
<td></td>
<td>• Expansion of Area Where Hydrogen Stands Can Be Built on</td>
<td>Building Standards Act</td>
</tr>
<tr>
<td></td>
<td>More Steel Materials Sanctioned for Use</td>
<td>High Pressure Gas Safety Act</td>
</tr>
<tr>
<td></td>
<td>Review Regulations Regarding Steel Materials</td>
<td>High Pressure Gas Safety Act</td>
</tr>
<tr>
<td></td>
<td>Review of Design Standards (Pressure Resistance Coefficient)</td>
<td>High Pressure Gas Safety Act</td>
</tr>
<tr>
<td></td>
<td>Wider Scope for Compound Vessels in Vessel Regulations (for Transportation)</td>
<td>High Pressure Gas Safety Act</td>
</tr>
<tr>
<td></td>
<td>Increase Hydrogen Storage in Urban Area</td>
<td>Building Standards Act</td>
</tr>
<tr>
<td></td>
<td>Rectify inconsistencies regarding the Safety Distance among CNG and Hydrogen Stands</td>
<td>High Pressure Gas Safety Act</td>
</tr>
<tr>
<td></td>
<td>Review of Design Standards (Pressure Resistance Coefficient)</td>
<td>High Pressure Gas Safety Act</td>
</tr>
<tr>
<td></td>
<td>Wider Scope for Compound Vessels in Vessel Regulations (for Transportation)</td>
<td>High Pressure Gas Safety Act</td>
</tr>
<tr>
<td>A</td>
<td>Extension of the overhaul inspection period, simplify the safety inspection</td>
<td>High Pressure Gas Safety Act</td>
</tr>
<tr>
<td></td>
<td>Further Revision on Safety Distance</td>
<td>High Pressure Gas Safety Act</td>
</tr>
<tr>
<td></td>
<td>Permit Reformer’s Unattended Hot Air Operation</td>
<td>High Pressure Gas Safety Act / Fire Service Law</td>
</tr>
<tr>
<td></td>
<td>Review of Explosion-proof Performance Criteria</td>
<td>High Pressure Gas Safety Act</td>
</tr>
<tr>
<td></td>
<td>Installation of High-pressure storage Cylinders, Compressors, etc. on Canopies.</td>
<td>High Pressure Gas Safety Act / Fire Service Law</td>
</tr>
<tr>
<td></td>
<td>Parallel installing of dispensers</td>
<td>Fire Service Law</td>
</tr>
<tr>
<td></td>
<td>Refuel FCV on public roads</td>
<td>High Pressure Gas Safety Act / Road Traffic Law</td>
</tr>
<tr>
<td></td>
<td>Review reference temperature / consistency with overseas</td>
<td>High Pressure Gas Safety Act</td>
</tr>
</tbody>
</table>

Note) Hatched area: Items require a new test method or data acquisition.
## Results of the efficiency measurement of 70MPa stations (4 stations)

<table>
<thead>
<tr>
<th>Station</th>
<th>Refueling pressure</th>
<th>35MPa</th>
<th>70MPa</th>
</tr>
</thead>
<tbody>
<tr>
<td>Senju</td>
<td>On-site (City gas steam reforming)</td>
<td>64.0 (60.0) %</td>
<td>62.1 (58.0) %</td>
</tr>
<tr>
<td>Yokohama / Daikoku</td>
<td>On-site (Desulfurized gasoline steam reforming)</td>
<td>56.5 (50.5) %</td>
<td>55.6 (49.6) %</td>
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<tr>
<td>Yokohama / Asahi</td>
<td>On-site (Naphtha steam reforming)</td>
<td>66.4 (59.3) %</td>
<td>64.0 (57.0) %</td>
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<tr>
<td>Kasumigaseki</td>
<td>On-site (High pressure steam storage)</td>
<td>–</td>
<td>96.2 (95.3) %</td>
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From 35MPa ⇒ 70MPa, the efficiency drops by 1~2 points.

### Reasons for the decrease in efficiency from 35MPa ⇒ 70MPa

- Increase in electricity consumption: ① High pressure compressor (80MPa)
  ② Pre-cooling equipment (only in Senju, Yokohama / Asahi, Kasumigaseki*1)

*1: The pre-cooling equipment in Kasumigaseki is a liquid nitrogen cooling system
Study of Pre-cooling (Simulation Results)

Conclusion: 70MPa/3 minute-refueling requires -40°C specification (capability)
(-20°C pre-cooling cannot refueling in 3 minutes at 0°C or above)

• Analyzing method:
  MONDE simulation

• Study condition
  tank : Type4
  internal volume : 157 L
  end temperature : 85°C
  end pressure : 70MPa
  initial pressure : 2MPa

Relation between ambient temperature and filling period according to pre-cooling temperature
Results of the Primary Technology Verification (6)

Verification of 2 refuelings in a 1100 km long distance drive

Aichi

Kasumigaseki

Kita Kyushu

Kyushu Univ.

Osaka

11/11 Prefectural government courtesy call

11/11 Departing ceremony Kasumigaseki

11/10 Pre-event Nikko hydrogen station opening ceremony

11/12 Osaka prefectural government courtesy call

11/12 Goal Kitakyushu

2nd hydrogen refuel

11/13 Post event Finishing ceremony Kyushu Univ.

2nd hydrogen refuel Okayama

1st hydrogen refuel

2st hydrogen refuel Aichi

1st hydrogen refuel

Japan Hydrogen & Fuel Cell Demonstration Project

23
Contents

1. The situation surrounding FCVs
   - Energy trends in Japan
   - The trends on FCV hydrogen infrastructure in Japan and abroad
   - Merits and positioning of FCVs
   - Trends in other next generation vehicles
   - Positioning of JHFC with NEDO related projects

2. The progress of JHFC in 2009
   - JHFC activities: up to now, objectives from this point, enhancement of the structure
   - Results achieved with FCV driving performance, hydrogen refueling, fuel economy etc.
   - The research results of primary technology verifications

3. Summary and intended measures for 2010
   - Summary of 2009
   - Clarification of technical issues to be verified for commencement of FCV hydrogen infrastructure expansion
   - Intended measures for 2010
Summary of 2009

- JHFC promotes the valuation of FCV / infrastructure technology towards the scenario “Beginning of the propagation in 2015” on schedule.

- The verification of important topics like “Infrastructure model for commercial use”, “Revision of regulations / laws”, etc. has also been intensively promoted.

- During the advancement of verification of 70MPa vehicles, new topics have been found and the necessity for the development of new technologies as well as their verification has been acknowledged.

- The further improvement with FCV fuel consumption has been shown. Furthermore, with the “1,100 km long range driving” test, the range of gasoline vehicles has been verifiably equaled.

- In Japan, there is a new development in the FCV / hydrogen operation field because of the construction of three cooperating stations and the Research Association of Hydrogen Supply / Utilization Technology.

- In America and Europe, with the introduction of the BEV-PHV stage, a new phase of introductory promotion for hydrogen / fuel cell vehicles can be seen.
Clarification of technical issues to be verified for commencement of FCV hydrogen infrastructure expansion

Objective: Suggestion of technology topics to be verified concerning FCV / hydrogen infrastructure and selection of those with a high priority for tests until 2015. Summary of the contents and procedure for these topics.

Progression of research

Evaluation of the current situation

Comprehensively organize following articles:
1. Hydrogen produce
2. Transportation
3. Storage
4. Supply
5. FCV

Selection of topics

Organize the results by JHFC targets
→ extract issues

Organize operation condition of JHFC 12 stations
→ extract issues

Counter measure studies

Organize by JHFC targets
extracts concrete issues
⇒ establish countermeasure

Important Technology Topics

• Basic policy
• Summarize primal issue
• List important issues
• Concrete contents
• Technology issues (5 themes)

Verification of procedure

Concept of FCCJ’s Social demonstration

FY 2009→ FY2010
Clarification of technical issues to be verified for commencement of FCV hydrogen infrastructure expansion

[JHFC-2] [Result by FY 2008]

- Verification of steady increase in popularity level due to propagation and educational activities
- Verification of FCV's high energy performance (fuel consumption), lesser environmental pollution
- Verification that FCV's low temperature performance equals that of gasoline
- Gathering driving data on public roads, utilization of analysis results for the development of FCV vehicles
- Verification of safety, safe supply and practical driving with emphasis on 35MPa vehicles
- Demonstration of total system technology
- Demonstration of high frequency/operation, durability
- Demonstration of “70MPa” technology
- Demonstration of “70MPa Full refueling” technology

- Application of the topics and data provided by the administration of the stations for improvement and standardization
- Specification of energy efficiency, facility costs, transportation costs etc. of different kinds of hydrogen stations
- Demonstration of lower-cost station technology

Hydrogen production
Transport
Storage
Hydrogen production
Supply
Clarification of technical issues to be verified for commencement of FCV hydrogen infrastructure expansion

Summary and results of important technology issues that must be verified by 2015

1. Overall system technology
   1. Technology for the continuation of refueling or large quantity refueling of vehicles at peak times
   2. The station's consequent off site performance with H2 production, transportation, storage, refueling, driving
   3. A valid infrastructure model for commercial use for each type

2. High frequency / operation, durability
   1. Improvability of items with long operating times (service life of catalytic converter etc.)
   2. The durability in case of frequent compressor stoppages
   3. Online maintenance for high pressure storage cylinder with NDT technology
   4. An operation mode that perfects the balance of H2 production, supply and volume of the high pressure storage

3. Lower-cost station technology
   1. Verification of the cascade (70MPa)
   2. Verification of direct compression cascade
   3. Cost reduction of the high-pressure storage cylinder (70MPa)
   4. Development and verification of compound containers (above 40MPa)
   5. Cost reduction of planning, fundamental construction, installation

4. 70MPa technology
   1. Development and verification of communication technology
   2. Verification of 3 minute refueling
   3. Verification of pre-cooling (realisation at -40 °C)
   4. Verification of sudden discharge of the coupler, valves or other accessories
   5. Revision of regulations

5. 70MPa full refueling technology
   1. Development and verification of a steel high-pressure storage cylinder for a 70MPa full refueling
   2. Revision of regulations for 70MPa full refueling
Our To Do List for 2010

1. Finalization of the JHFC activities up to now

2. Strategic activities for the promotion of awareness, propagation in Japan and abroad by holding international JHFC seminar, etc.

3. Propagation of necessary technology proofs for communication and direct refueling methods, etc.

4. Explanation of technical issues to be verified, revision of regulations, etc. on the road to commencement of propagation in 2015
• Reference Materials
Toyota FCHV-adv
Nissan X-TRAIL FCV
Honda FCX Clarity
Suzuki SX4-FCV
Mercedes Benz A-Class F-Cell
GM Equinox
Mazda Premacy RE Hybrid
Toyota/Hino FCHV-BUS
Automaker: 8  |  Energy & Infra. Maker: 17

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<td>TAIYO NIPPON SANSO</td>
<td>KURIMOTO, LTD.</td>
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<td>Nippon Steel Corporation</td>
<td>IDEMITSU</td>
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1 co-operative corporation
Date
Feb 28(Mon.) -Mar 1 (Tue.), 2011

Place
Tokyo International Forum
Hall B7
(Chiyoda-ku, Tokyo, near Yuraku-cho)

For more information, visit our website.

http://www.jhfc.jp/e/

THANK YOU!