Research and Development for Safety Improvement of Hydrogen Refueling Stations in Japan

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Masanori Hirose
General Manager
Hydrogen Infrastructure Safety Department
The Research Association of Hydrogen Supply / Utilization Technology (HySUT)
ma-hirose@hysut.or.jp http://hysut.or.jp/
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2. Japan’s activities for commercialization
3. Safety and reliability technology for HRS
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1. Introduction 1-1. About HySUT*

*The Research Association of Hydrogen Supply / Utilization Technology

Goals and Objectives

✓ Our goal is to develop hydrogen supply business and promote the commercialization of FCVs by private companies.
✓ Our objective is to solve the issues of technology, consumer awareness, and social acceptance, and to assist businesses to become viable through our demonstration programs.

Established on: July 31st, 2009

<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>6</td>
<td>Iwatani Corporation; Air Liquide Japan Ltd.; Kawasaki Heavy Industries, Ltd.; Mitsubishi Kakoki Kaisha, Ltd.; Taiyo Nippon Sanso Corporation; The Japan Steel Works, 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>
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</tbody>
</table>
## 1-2. Current status of national projects in Japan

<table>
<thead>
<tr>
<th>Year</th>
<th>Project</th>
</tr>
</thead>
<tbody>
<tr>
<td>FY2009</td>
<td>Hydrogen Highway Project supported by METI [3 HRSs]</td>
</tr>
<tr>
<td>FY2010</td>
<td>JHFC2 by NEDO [11 HRSs + 4 HRSs]</td>
</tr>
<tr>
<td>FY2011</td>
<td>JHFC3 Technical &amp; Social Demonstration Project by NEDO and HySUT [13 HRSs]</td>
</tr>
<tr>
<td>FY2012</td>
<td>JHFC3 Regional Demonstration by NEDO and Local Governments [4 HRSs]</td>
</tr>
<tr>
<td>FY2013</td>
<td>NEDO’s R&amp;D Project “Hydrogen Utilization Technology Development”</td>
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<tr>
<td>FY2014</td>
<td>METI’s new subsidy scheme for installation of commercial HRSs</td>
</tr>
<tr>
<td>2015</td>
<td>Market launch of FCV</td>
</tr>
</tbody>
</table>

- JHFC: Japan Hydrogen & Fuel Cell Demonstration Project
- HRS: Hydrogen Refueling Station
- NEDO: New Energy and Industrial Technology Development Organization
- HySUT: Hydrogen Supply Utilization Technology
- METI: Ministry of Economy, Trade and Industry

### Joint Announcement

Cooperation

- JHFC3 Technical & Social Demonstration Project
- JHFC3 Regional Demonstration

Other projects include:
- 1. Hydrogen Quality Control
- 2. Hydrogen Fueling Protocol
- 3. Hydrogen Fueling Hose
- 4. Hydrogen Metering Technology
- 5. Infrastructure Safety
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2. Japan’s activities for commercialization

2-1. Joint announcement by 13 Japanese companies

Automotive: Toyota Motor Corporation; Nissan Motor Co., Ltd.; Honda R&D Co., Ltd.
Petroleum: JX Nippon Oil & Energy Corporation; Idemitsu Kosan Co., Ltd.; Cosmo Oil Co., Ltd.; Showa Shell Sekiyu K.K.
City Gas: Tokyo Gas Co., Ltd.; Osaka Gas Co., Ltd.; Toho Gas Co., Ltd.; Saibu Gas Co., Ltd.
Industrial Gas: Iwatani Corporation, Taiyo Nippon Sanso Corporation

On January 13, 2011, 13 Japanese companies (automakers and hydrogen fuel suppliers) jointly announced the launch of FCVs in the Japanese market by 2015 and the development of hydrogen supply infrastructure.

1. Automakers are aiming to launch FCVs in the Japanese market—mainly in the country’s four major metropolitan areas—in 2015.

2. Hydrogen fuel suppliers are aiming to build approximately 100 hydrogen refueling stations by the end of 2015.

3. Automakers and hydrogen fuel suppliers will work together to increase the number of FCVs and develop a hydrogen supply network throughout Japan.
2-2. Introduction of commercial HRSs

NeV: Next Generation Vehicle Promotion Center
Total 81 HRSs approved (23 opened) as of July 1st 2015
“Blue” shows mobile stations (total 26)

North Kyushu Area (12)
- Fukuoka Pref. Kitakyushu-shi
  Iwatani 10/2014

Under Construction:
- Fukuoka Pref. / Fukuoka-shi (3) (1)
  Kitakyushu-shi
  Ono-shi
  Koga-shi
  Shime-cho
- Yamaguchi Pref. / Shunan-shi
- Saga Pref. / Saga-shi
- Oita Pref. / Oita-shi

Kansai Area (12)
- Hyogo Pref. Amagasaki-shi
  Iwatani 7/2014
- Osaka Pref. Ibaraki-shi
  Osaka Gas 4/2015

Under Construction:
- Shiga Pref. / Otsu-shi
  Kyoto Pref. / Kyoto-shi (1)(1)
- Osaka Pref. / Osaka-shi (3) (1)
  Ibaraki-shi
  Sennan-gun
- Tokushima Pref. / Tokushima-shi

Under Construction:
- Aichi Pref. / Nagoya-shi (2) (2)
  Kariya-shi (2)
  Anjo-shi
  Kiyosu-shi
  Toyota-shi
- Shizuoka Pref. / Hamamatsu-shi
  Mie Pref. / Yokkaichi-shi, Tsu-shi
  Gifu Pref. / Hashima-gun

Chukyo Area (20)
- Aichi Pref. Miyoshi-shi
  JX 2/2015
- Aichi Pref. Okazaki-shi
  JX 3/2015
- Aichi Pref. Nagoya-shi
  Toyota-Tsusho/Air Liquide 3/2015
- Aichi Pref. Nagoya-shi
  JX 3/2015
- Aichi Pref. Toyota-shi
  Toyota-Tsusho/Air Liquide 4/2015
- Aichi Pref. Toyota-shi
  Toyota-Tsusho/Air Liquide 4/2015
- Aichi Pref. Nishin-shi
  Toho Gas 4/2015
- Aichi Pref. Toyota-shi
  Iwatani / Toho Gas 5/2015

Under Construction:
- Tokyo / Koto-ku (2), Meguro-ku, Ota-ku (1) (1)
  Arakawa-ku, Itabashi-ku
- Kanagawa Pref. / Yokohama-shi (2) (2), Sagamihara-shi
  Fujisawa-shi, Isehara-shi
- Saitama Pref. / Saitama-shi (1) (2)
  Kawagoe-shi, Koshigaya-shi
- Chiba Pref. / Matsudo-shi, Narita-shi
  Yachiyo-shi, Inba-gun
- Yamanashi Pref. / Kofu-shi

Source: http://fccj.jp/hystation/index.html

Metropolitan Area (37)

Under Construction:
- Tokyo / Koto-ku (2), Meguro-ku, Ota-ku (1) (1)
  Arakawa-ku, Itabashi-ku
- Kanagawa Pref. / Yokohama-shi (2) (2), Sagamihara-shi
  Fujisawa-shi, Isehara-shi
- Saitama Pref. / Saitama-shi (1) (2)
  Kawagoe-shi, Koshigaya-shi
- Chiba Pref. / Matsudo-shi, Narita-shi
  Yachiyo-shi, Inba-gun
- Yamanashi Pref. / Kofu-shi

Source: http://fccj.jp/hystation/index.html
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3. Safety and reliability technology for HRS
3-1. Basic concept of the program

- Incident/trouble data collection and construction of reliability database
- Training and education for HRS operators
- Development of safety and reliability improvement technology for future
- Enhancement of social acceptance

Construction of reliability database

Hydrogen Refueling Station

Training & education
May 21 @Narita HRS July 8 @Osaka HRS

Enhancement of social acceptance
48,414 visitors @FC Expo 2015
3-2. Organizational structure for the project (FY2015)

- **NEDO**
  - Role-Sharing for R&D

- **HySUT**
  - a Construction of reliability database
  - b Training and education for HRS operators
  - c Establishment of total operation
  - d Development of safety and reliability improvement technology for next-generation HRSs

- **Technova**
  - [Sharing of R&D]
  - Iwatani Corp. (Toyota Ecoful Town, Ariake, Kansai Airport, Kitakyushu)
  - JX Nippon Oil & Energy Corp. (Kitakyushu)
  - Taiyo Nippon Sanso Corp. (Kasumigaseki)
  - Tokyo Gas Co., Ltd. (Senju, Haneda)
  - Toho Gas Co., Ltd. (Toyota Ecoful Town, Centrair)
    - a Construction of reliability database

- **Toray**
  - [Sharing of R&D]
  - Nissan Motor Co., Ltd. (FCV)
  - Honda R&D Co., Ltd. (FCV)
    - b Training and Education for HRS operators

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Role-Sharing for R&D

- Idemitsu Kosan Co., Ltd. (Narita)
- Osaka Gas Co., Ltd. (Osaka)
- Engineering Advancement Association of Japan
3-3. Organizational structure of HySUT

Hydrogen Infrastructure Safety Steering Committee

→ Guidance and coordination of the project as a whole as well as supervision of progress of each WG.

Reliability Database Working Group *

→ Collection of accident/incident data and study for compiling a database

Education & Training Working Group *

→ Drafting a guideline document for education facilities and training programs for hydrogen stations

Next-generation Technology Working Group

→ Discussion of next-generation concepts for stations and development of fuel services based on them; scoping study of related development items; activities for improved social acceptance

Next-generation HRS Sub Working Group

→ Producing original ideas for the above through brainstorming and other activities

* Sub-groups under each WG as needed
3-4. Reliability Database Working Group

3-4-1. Collection and compilation of incident/trouble data

Reliability database
300 and more cases have been collecting

Analysis
Preventive measures
Information sharing

International collaboration
New technology development

Feed Back
Event Data
HySUT HRS
Commercial HRS
### 3-4-2. Reliability database template

<table>
<thead>
<tr>
<th>No.</th>
<th>Category</th>
<th>Hydrogen leakage</th>
<th>Death &amp; injuries</th>
<th>Physical damage</th>
<th>Facility</th>
<th>Place</th>
<th>Occurrence</th>
<th>Causes</th>
<th>Measures taken</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
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</tbody>
</table>

- A: Incident class A (number of casualties: 5 or more)
- B: Incident class B (number of casualties: 1 - 4)
- C: Incident class C
- D: D1: Operation hindrance
  - D2: Minor hydrogen equipment issue
  - D3: Minor non-hydrogen equipment issue
- E: Near-miss

**High Pressure Gas Safety Act**

**HySUT**
The WG is drafting the Guidelines for HRS Education Facilities and Training Programs (provisional name) as the basis for operational guidelines for commercial HRS. A list of safety management parameters, emergency training, and employee education manuals is being prepared for this.
3-5-2. Draft Guidelines for HRS Education Facilities and Training Programs (provisional name)

Contents (draft)

1. Purpose and definitions
2. Physical properties and characteristics of hydrogen
3. Basic knowledge of high-pressure gas – Standards related to compressed H₂ stations
4. Hazard prevention – Explanation of hazard prevention requirements
5. Safety manuals – Equipment and task-oriented manuals
6. Fuel cell vehicles – What every H₂ station operator should know about FCVs
7. Simulation training for HRS – Hydrogen compression, pressure accumulation, guiding and fueling FCVs, routine inspections
8. Emergency training – What to do in combustion, fire fighting, or gas leaks
9. Case study of incidents – From hydrogen stations in and out of Japan
   (Reliability database and others)
3-5-3. Preliminary experiments with training & education for HRS operators (＠Narita HRS & Osaka HRS)

Explaining fueling equipment
Directing an FCV
Directing waiting vehicles

Checking the tank’s expiration date
Filling hydrogen
Explaining FCV
3-6. Next-generation Technology WG

Current status of Next-generation Technology WG

Typical HRS at present

Next-generation HRS

Keywords

- Around 2025
- Further enhancement of safety
- Less labor
- Lower cost

Identified issues (via backcasting)
Postulated an ideal hydrogen station for the next generation and identified the technology needs for development.

List of development items for the next gen. H₂ station

Identified issues (via forecasting)
Analyzed the incident data collected so far and identified the technology needs for the next generation of hydrogen stations.
3-7. Example of activities for better social acceptance

One-stop portal site for hydrogen aiming to gain better recognition for hydrogen (out-sourced to Technova)
The front page of the Hydrogen Energy Navi that has been published from May 25 is seen below:

http://hydrogen-navi.jp/
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4. Summary

1. Since FY2013, HySUT has been working under NEDO’s Hydrogen Utilization Technology Development Project to develop the technology for:

2. In FY2014, development of technology for high-level safety and reliability of hydrogen stations started, with the following results:
   • A reliability database using Microsoft Excel is up and running for the parties involved.
   • A proposal for a training center to train and educate hydrogen station operators and a draft for the Guidelines for Hydrogen Station Education Facilities and Training Programs.
   • A list of new technologies for development projected to be required by next-generation stations around 2025.
   • A one-stop portal site under operation for wider social acceptance.
Thank you very much for your attention!

Masanori Hirose, Tetsufumi Ikeda, Yoichi Sone, Tadashi Abe, Ayumu Okamoto, Yusuke Nagai, Fuminori Yamanashi, Yoshitaka Konishi, Shoichi Kaneko, Kazuhito Matsuda, Tomonari Komiyama, Hisatoshi Ito, Mikihiro Shibata,

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