Japan’s Hydrogen Policy and Fuel Cells Development in NEDO

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WHY HYDROGEN?
Japan’s Vulnerable Energy Supply

Energy import dependencies in major energy consumer countries

Power generation mix in Japan
Increasing CO2 emissions

CO2 Emissions in Japan
[ a million tons– CO2 equivalent ]

Year | CO2 Emissions
--- | ---
2000 | 1,250 million tons
2001 | 1,260 million tons
2002 | 1,280 million tons
2003 | 1,290 million tons
2004 | 1,300 million tons
2005 | 1,310 million tons
2006 | 1,320 million tons
2007 | 1,330 million tons
2008 | 1,340 million tons
2009 | 1,350 million tons
2010 | 1,360 million tons
2011 | 1,370 million tons
2012 | 1,380 million tons
Clean Transport: Future of Automotive Industry

- **HV・PHV**: TOYOTA 「PRIUS」
- **EV**: NISSAN 「LEAF」
- **FCEV**: HONDA CLARITY, TOYOTA MIRAI, NISSAN TERRA
Why Hydrogen?

• **Clean energy**: achieving higher level of energy security and zero emission

• **Flexible energy carrier**: made from various energy sources and used for many energy demand

• **Long experience in H2 development**: Japan has more than 30 years experience in H2 R&D including commercial sale of FC system
ENE-FARM
ENE FARM

- 700W FC cogeneration system for households
- NG/LPG dual fuel
- Total efficiency 95%, 10 years warranty
- Commercial sale since 2009
- 50% capex subsidy by government
- More than 113,000 installations by March 2015
History of ENE-FARM development

〜2000年
★ Basic R&D phase for PEM（1992〜）

2001〜2004年
★ Developing small scale co-generation system using PEFC
- Improving cell stack efficiency
- Reducing system cost
- Proving system durability
- Develop commercial model of PEFC system

2005〜2008年
★ Large-scale Demonstration program
- Verification with various fuels and load patterns in Japanese market
- Creation of initial market
- Common design for peripherals
- Modify codes and regulations

2009年〜
★ Commence commercial sale in 2009
System Price Reduction

- In six years after 2009, more than 100,000 units were installed.
- Market expansion significantly reduced system price to below 2M yen which is ¼ of its beginning.

(Source) Sales Number : Advanced Cogeneration and Energy Utilization Center JAPAN.
Sales Price : NEDO.
PEFC DEVELOPMENT FOR FCV
NEDO’s role in FCV development

In Japan, Car manufacturers take initiative in development of fuel cell technologies for vehicle, while NEDO provide support in developing scientific knowledge and generic technologies.

• Catalyst research for reducing platinum use
• Developing common evaluation method for fuel cell
• Providing highest time and space resolutions in electrochemical reactions analysis
Catalyst Research

• Improving Platinum Activity by using Core-Shell Structure (reduce Pt usage to 1/10)
• Improvement of Higher dispersion catalyst by using:
  – Developing common cell evaluation technique
  – Highest time and space resolutions in electrochemical reaction and mass transfer analysis of MEA materials.
Next Five Years’ Project

• Continue research of Catalyst for reducing platinum amount and increasing durability.
• New approach in evaluation: both output power density and the durability are considered.
• New target:
  – Cell Stack power density: 4kW/L
  – Durability: 50,000hrs and 600,000 cycle (for use in commercial vehicles)
NEDO’S PROGRAMME FOR SOFC
NEDO Development on SOFC

For Housing

700W

5kw ~ 250kw

10Mw ~

1Gw
Hybrid SOFC System

250kW hybrid system of tubular SOFC and gas-turbine system

Output: 206kW (183 + 23)
Power Efficiency: 55%+
Total efficiency: 73%+
Durability: 5000 hrs

Pre-commercial model
In the process of 8000hrs test
Rapid Evaluation Method for SOFC Durability

Results are applied to various type of cells

Improvements

Tests

Evaluation/Analysis

R&D cycle

Forecast 90,000 hour durability with short term data by using thermodynamics, chemical and mechanical analyses
Conclusion

• H2 is useful not only as zero emission fuel but also flexible energy carrier that contribute to energy security. Additionally, H2 is hopeful as a new industrial sector that will boost national economic growth.

• Japan has been successful in developing residential FC CHP system. Key of the success was the cooperation of suppliers and energy providers in launching market.

• Further FC developments are ongoing in order to expand the use of FCV and also stationary use of FC in power and heat supply.
Thank you for your attention

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Large-scale Demonstration programme (FY2005-2008)

- 3,307 units installed broadly in Japan
- System performance verified under various fuels and load patterns in Japan
- System suppliers and energy providers worked together which contributed to establish new market

<table>
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<th>Manufacturer</th>
<th>LPG</th>
<th>CH4</th>
<th>Kerosene</th>
<th>Total</th>
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<td><strong>Total</strong></td>
<td>1,614</td>
<td>1,379</td>
<td>314</td>
<td>3,307</td>
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</table>
System manufacturers agreed to develop common designs for some peripherals in PEFC co-generation systems.

- Peripherals suppliers participated in the development of common designs.
- Contributed to standardize the performance, durability, and further reduced cost.

- As a result of this programme (06〜07)
  \( ¥410,000/kW \Rightarrow ¥110,000/kW \)

- Suppliers further continued efforts to
  \( ¥80,000/kW \) (2009)
Expanding market for ENE-FARM

ENE-FARM to Europe!

VIESSMANN / Panasonic model

ENE-FARM for Apartment housing

Senertec / Toshiba model