Ministry of Economy, Trade and Industry

Japanese challenges for Accelerating Realization of a Hydrogen Society

How can national initiatives impact deployment?

23rd November 2016

Shinya Kawamura
Ministry of Economy, Trade and Industry
JAPAN

For Accelerating Realization of a Hydrogen Society

1.Just started market introduction

- *Success to introduce Fuel Cell (FC) to the market*
- *Need to enhance FC applications*

2. Develop new role of hydrogen

- *H_2 gas turbine : Develop large H2 demand*
- *Power to Gas : Low carbon energy system*

3. Well public / private and national/regional communication and cooperation

- *H_2 and FC Roadmap / Share the targets*
- *Long history / Demonstration project (Stationary Fuel Cell / Fuel Cell Vehicle)*

Revised Points of the Hydrogen / FC Strategy Roadmap

Phase 1: Installation Fuel Cell (Current-)

1. Stationary FC

- ✓ Clarifies price targets of residential FCs ⇒ disseminates without government support by around 2020
  - ■ PEFC: **800,000 yen** by 2019
  - ■ SOFC: **1,000,000 yen** by 2021

2. Fuel Cell Vehicles

- ✓ Sets the goals of market introduction
  - ■ **About 40,000 FCVs by 2020, 200,000 by 2025, 800,000 by 2030**
- ✓ Aims at introducing FCVs in main market segment (price range) by around 2025

3. Hydrogen Refueling Stations

- ✓ Sets the goals of installations and self-sustaining business
  - ■ **About 160 stations by FY2020, 320 by FY2025**

    *Needs around 900 stations in case of 300Nm3/h refueling capacity by 2030
  - ■ **Self-sustaining business of HRSs by the late 2020s**

    Thereafter establishes adequate amount of stations in response to the spread of FCVs

Phase 2: H2 Power Plant/ Mass Supply Chain (Realized in the late 2020s)

4. Hydrogen Power Plant

- ✓ reflects a report by study group on H2 power plant (March 2015) , embodies the description

Phase 3: CO_2-free Hydrogen (Realized in around 2040)

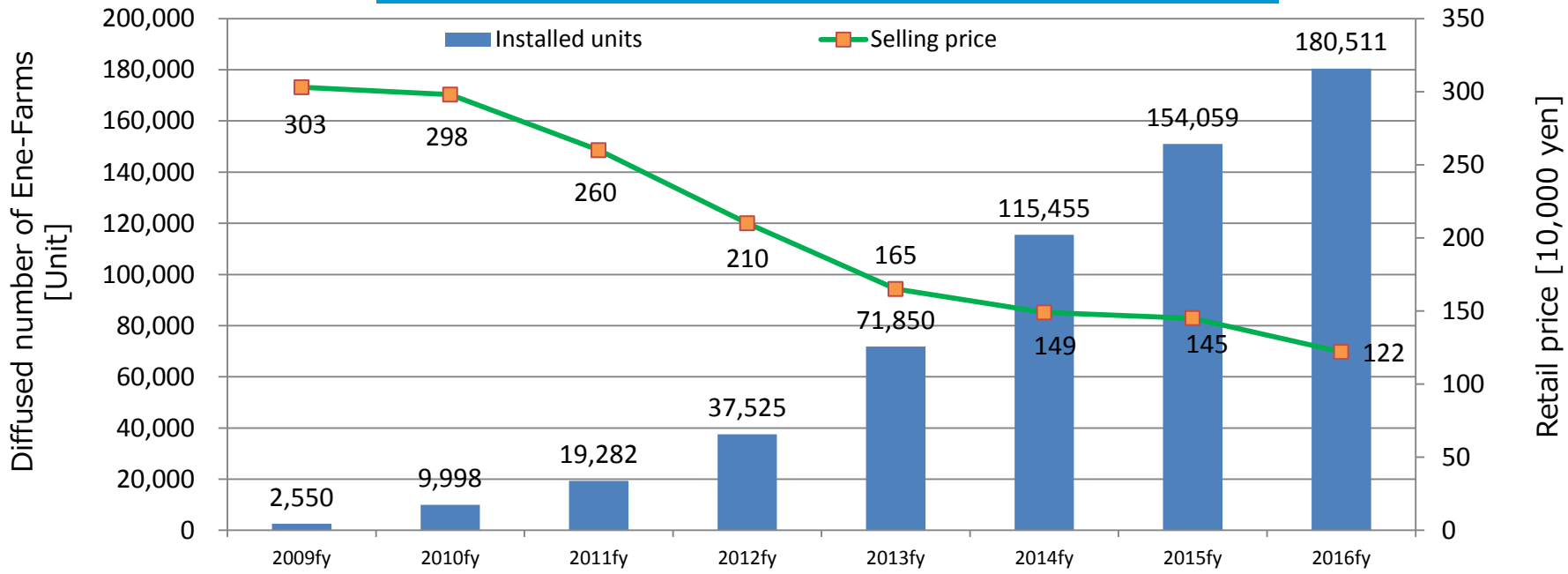
5. Hydrogen derived from Renewable Energy

- ✓ States to launch a working group which handles technical and economic issues regarding introduction of CO2-free Hydrogen and come to conclusion by March 2017.
- ✓ Describes the promotion of advanced initiatives such as **the reform 2020 project** and **Fukushima new energy society initiative**

Residential Fuel Cells

Goals in the road map	Progress
• Establish the self-sustaining market of “Ene-Farms” at the early stages, and disseminate 1.4 million units by 2020, and 5.3 million units by 2030.	Over 180,000 units diffused. (*As of September 2016)
• For the retail price of “Ene-Farms” (including construction cost for installation), aim at the price that can recover the investment within 7 or 8 years (PEFC: 0.8 million yen, SOFC: 1 million yen) by 2020, and within 5 years by 2030.	Average retail price of Ene-Farms (Including construction cost for installation) is about 1,220,000 yen. Payout time is about 15 years. * Excluding support by subsidized charge

Changes in the diffusion number and retail price



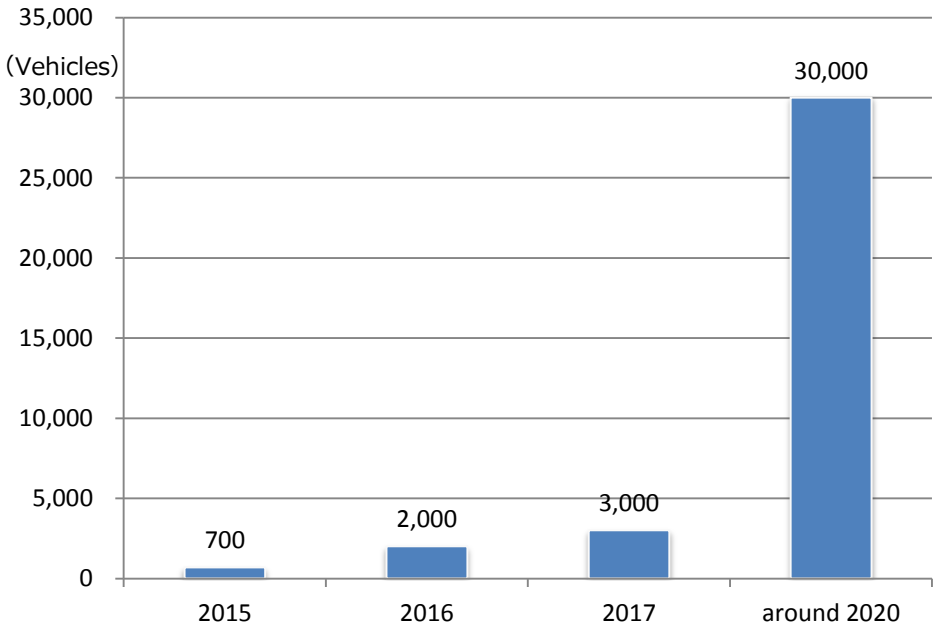
* Based on determination subsidization base

(As of the end of January)

Goals of Fuel Cell Vehicles for Dissemination

Goals in the Roadmap	Progress
• Launch FCVs onto the market by 2015, and aim at the market introduction as around 40,000 FCVs by 2020, 200,000 by 2025, 800,000 by 2030.	• Toyota began selling its Mirai in December 2014. • Honda began selling its Clarity Fuel Cell in March 2016. • In September 2015, Toyota announced the estimated global sales of FCVs around 2020 as 30,000 or higher.
• Aim at realizing the price of FCVs having price competitiveness equivalent to that of hybrid vehicles at the same class by around 2025.	• The retail price of Toyota Mirai and Honda Clarity Fuel Cell are both around 7million yen. Further efforts to reduce costs for FC system and platinum catalyst are promoted.

Toyota's expected global sales of FCVs (Single year)



Honda's new release

Auto manufacturer	Honda Motor
Car's name	Clarity Fuel Cell
Retail price (including tax)	7,660,000 yen
Launch	March 2016

Progress of Hydrogen Refueling Stations for Goals①

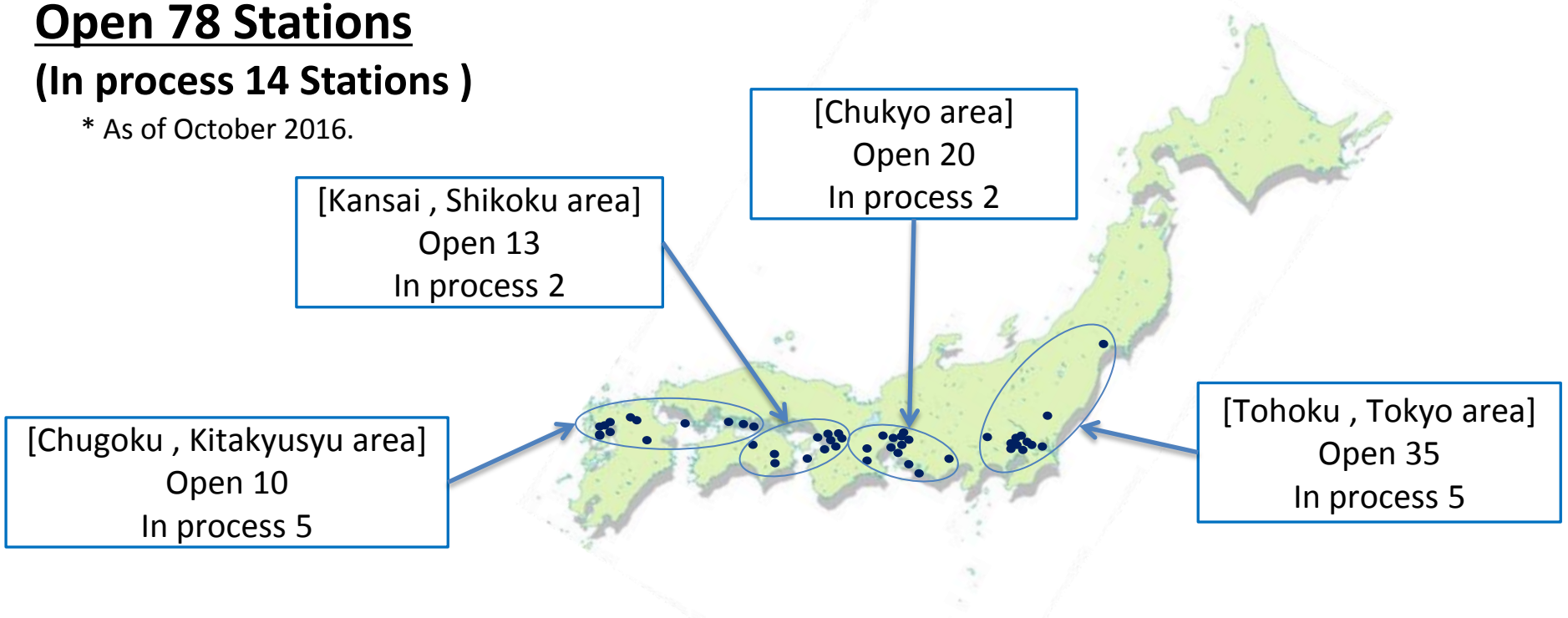
Goals in the Roadmap	Progress
• Ensure about 160 HRSs in FY2020 and 320 in FY2025.	• 78 HRSs are commercially available and 14 in process. (*As of October 2016)
• For the price of hydrogen, aim at offering at the same or lower price as compared with the fuel cost of gas vehicles in 2015, and as compared with the fuel cost of hybrid vehicles by around 2020.	• In HRSs currently opened, the price of 1,000-1,100 yen/kg, which is close to the fuel cost of hybrid vehicles, is strategically set.

Map of Hydrogen refueling stations

Open 78 Stations

(In process 14 Stations)

* As of October 2016.



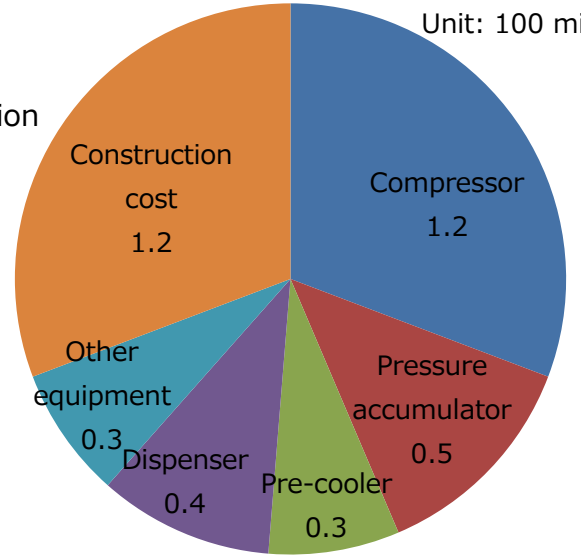
Progress of Hydrogen Refueling Stations for Goals②

Goals in the road map	Progress
① Aims at reducing the installation cost into a half of the current cost by around 2020.	• Costs for installation: About 390 million yen * Average of actual benefit of grant money (as of the end of 2014) (fixed off site , 300 N m³/h) * Meanwhile, please note various facility expenses that are not covered by the support will be needed in addition to the above.
② Manufacturers providing equipment constituting the station aim at realizing lower equipment cost having competitiveness against manufacturers in Europe.	
③ Aims to reduce the annual operating cost of hydrogen refueling station (except for depreciation expense) to closer to 20 million yen level.	• Operating cost About 47 million yen * Average amount of grant money applied (as of FY 2015) (fixed off site 300 N m³/h)

Breakdown of costs for installation of hydrogen refueling station

Total cost for establishment: About 390 million yen

Unit: 100 million yen

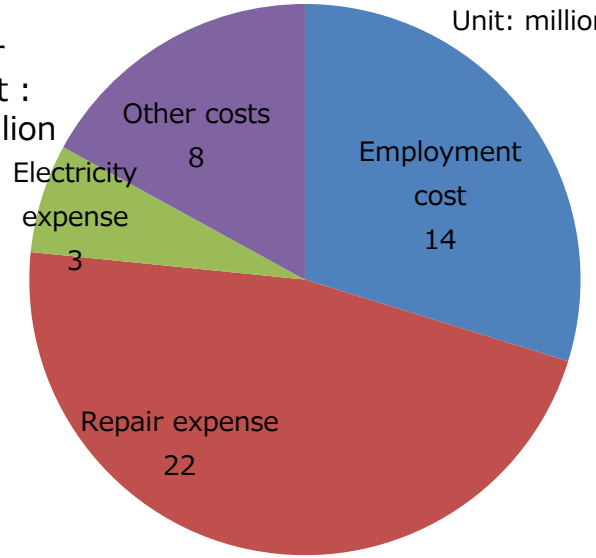


* Average of actual benefit of grant money (as of the end of 2014) (fixed off site , 300 N m³/h)
* Meanwhile, please not various facility expenses that are not covered by the support will be needed in addition to the above

Breakdown of operating cost of hydrogen refueling station

Total cost for management : About 47 million yen

Unit: million yen



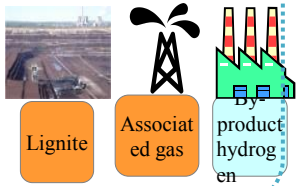
* Average amount of grant money applied (as of FY 2015) (fixed off site 300 N m3/h

[Source] Created by the Agency for Natural Resources and Energy based on amount of grant money applied for projects for installation of hydrogen supply facility and reported amount of actual benefit.

Establishing an Inexpensive, Stable Supply System

Production of hydrogen: Conversion into hydrogen carriers → **Transportation of hydrogen carriers** → **Storage of hydrogen carriers** → **Takeout of hydrogen**

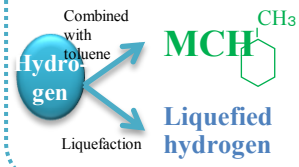
Hydrogen sources in foreign countries



Production of hydrogen: Gasification, reforming of steam, etc.

Refinement of hydrogen

Conversion into hydrogen carriers



Organic hydride

Hydrogen is combined with toluene into methylcyclohexane.
→ Hydrogen in this state can be compressed to a volume equal to 1/500 of the volume under normal pressure.

Technology has been established.

- Transportation under normal temperature and normal pressure

→ Use of chemical tankers

Technology has been established.

- Storage under normal temperature and under normal pressure

→ Use of petroleum tanks, etc.

It is necessary to adopt large-scale dehydrogenation equipment and to achieve high efficiency in dehydrogenation.

Liquefied hydrogen

Hydrogen is liquefied by being cooled to -253°C.
→ Hydrogen in this state can be compressed to a volume equal to 1/800 of the volume under norm pressure.

It is necessary to develop hydrogen ships.

It is necessary to adopt large-scale hydrogen tanks and to reduce boil off.

Technology has been established.

Use of hydrogen:

Hydrogen power generation,

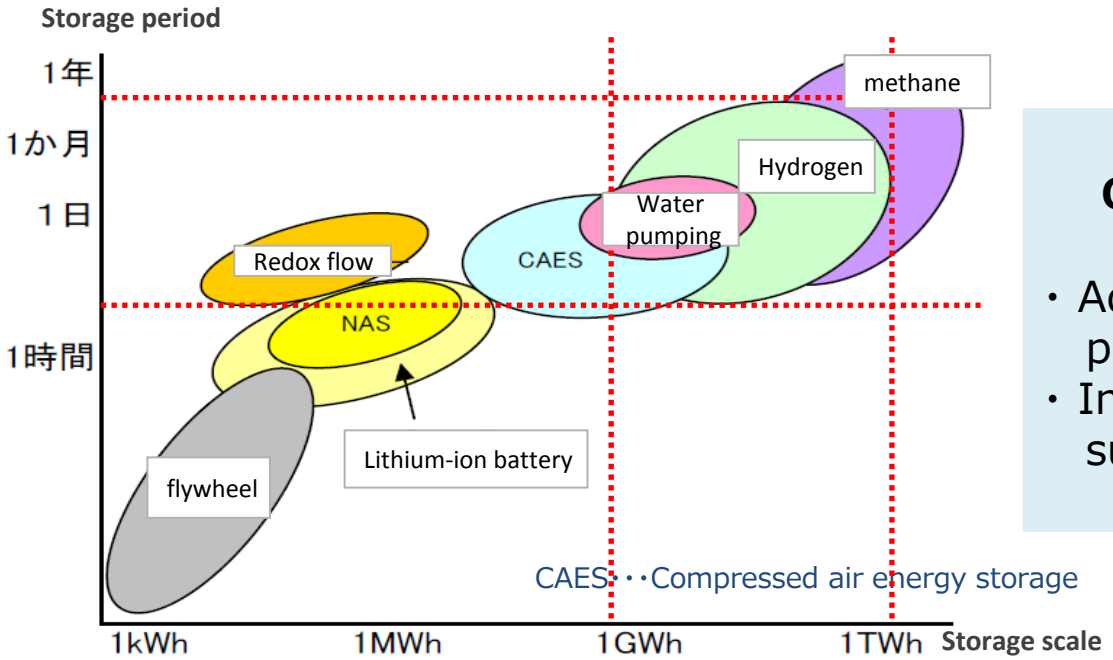
fuel cells,

Industrial gas, etc.

Characteristics of Power to Gas (P2G) Technology ～Hydrogen Derived from Renewable Energy～

It is considered that a complex system of water electrolysis and hydrogen tank has high potential of application to the area of large scale and prolonged energy storage for the good reason that the complex system has small loss over time and high expandability such as hydrogen tank as compared with competing storage battery technologies in terms of advantage.
It is expected that P2G can be a promising item as a countermeasure against problems related to power system interconnection during introduction and expansion of renewable energy in Japan in the future.

Positioning of various electric power storage technologies



CAES・・Compressed air energy storage

[Source] Fuji Keizai

Characteristics of energy storage using hydrogen (P2G)

- Advantageous to large scale and prolonged energy storage
- Impact from environmental conditions such as geography and geology is small.

Budget for Hydrogen and Fuel Cells in FY 2016 (METI)

Phase 1 Installation Fuel Cell — Focus on implementation from the present

Phase 2 H2 Power Plant/ Mass Supply Chain — Realized in the late 2020s

Phase 3 CO2-free Hydrogen — Realized in around 2040

Disseminate stationary FCs

Subsidies for Residential FCs [9.5 billion yen]

Promote the accelerated introduction of ENE-FARMs. Promote lower cost through mass production.

ENE·FARM

Disseminate FCVs

Subsidies for HRSs [6.2 billion yen]

Support HRS installations and promote creating new FCV demand.

Support for FCVs [Included in 15 billion yen]

Build a H2 supply chain

Demonstrations for global H2 supply chain [2.8 billion yen]

Demonstrate how hydrogen can be produced from untapped overseas energy resources, transported in the form of liquefied hydrogen or organic hydride, and used to generate power. Implement P2G field tests, etc.

R&D of FC, etc.

R&D of FCs [3.7 billion yen]

Conduct R&D for better performance and lower costs of FCs, and demonstrate stationary FCs for business use

Stationary FC for business use

R&D of HRSs [4.15 billion yen]

Develop technologies for lower costs and safety of HRSs, and collect data for reviewing regulations.

Construct of H2 energy network

Construction of a H2 energy network [Included in 4.5 billion yen]

Build a network that effectively connects multiple hydrogen applications in the region.

R&D of H2 production, transport and storage

R&D for producing, transporting and storing H2 derived from renewable energy [1.55 billion yen]

Develop technologies of high efficiency water electrolysis units, tanks for storing liquefied hydrogen, etc. with the use of renewable energy sources.

Conclusion

Public and private sectors should thoroughly discuss the following points.

- *Through national and regional governments subsidies and other incentives, installations of ENE-FARMs, FCV and HRSs are gradually progressing. From now, it will be the time to be taken into consideration for "Breakthrough" and/or "Down to Earth Activities", so various challenges are required.* ***Incentives including government subsidies and R&D will be priority for a few years, and in parallel, Self-sustaining business should be pursued by increasing private sectors commitments through common recognition, understanding and intensive discussions among stakeholders.***

- *Technologies are essential for realization of Hydrogen society. On the other hand, various R&Ds have been implemented so far. From now,* ***it will be imperative to consider that schedule and market to be targeted in each R&D projects should be specifically clarified.***

- *As for FCV and HRSs,* ***further partnership and cooperation between both sectors will be necessary,*** *and various implementations such as sharing information and clarification of strategy will be imperative.*

- ***Deregulation is the key for realization of Hydrogen society.*** *Ordinary review and revision of current regulation should be continued.*

Thank you for your attention.