Activities of NEDO for practical use of stationary fuel cell systems

1st March, 2011

New Energy and Industrial Technology Development Organization

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Japan's Policy on Energy Innovations and the Outline of NEDO Fuel Cell and Hydrogen Development

Fuel Cell/Hydrogen Technology in Government Policies

- **Science and Technology Basic Plan (2006.3)**
- **New National Energy Strategy (2006.5)**
- **Basic Energy Plan (2007.3)**
- **Next-Generation Automobile Fuel Initiative (2007.5)**
- **Cool Earth – Innovative Energy Technology (2008.3)**
- **Basic Energy Plan (2010.3) 2nd revision**

- Japan proposed globally sharing a long-term vision such as halving global GHG emissions by 2050 -"Cool Earth 50". – 2007.5
- Selection of 21 technologies as innovative technologies that should be given higher priority
- Presentation of a technology roadmap on these technologies
- Proposal of desirable ways of international cooperation (e.g., sharing the roadmap with the international community)
- The former Prime Minister Hatoyama stated that "Japan will aim to reduce GHG emissions by 25% by 2020, if compared to the 1990 level."

UN Summit on Climate Change

"Cool Earth" Innovative Energy Technologies

Efficiency improvement ***Low carbonization***

Supply side

Power Generation

1. Efficient LNG-fired power plants

2. Efficient coal-fired power plant

3. CCS

4.Innovative solar power

5. Advanced nuclear power

6. Superconducting power transmission

Demand side

Transport

7. ITS

8. FCV

9. PHEV/EV

10. Biofuel

Industry

11. Innovative materials/ manufacturing process

12. Steel making process with Hydrogen

Residences/ Buildings

13. Efficient houses/buildings

14. Efficient lighting

15. Fuel Cell for residential use

16. Efficient Heat pumps

17. Efficient IT devices/networks

18. HEMS/BEMS/Regional EMS

Cross sectional

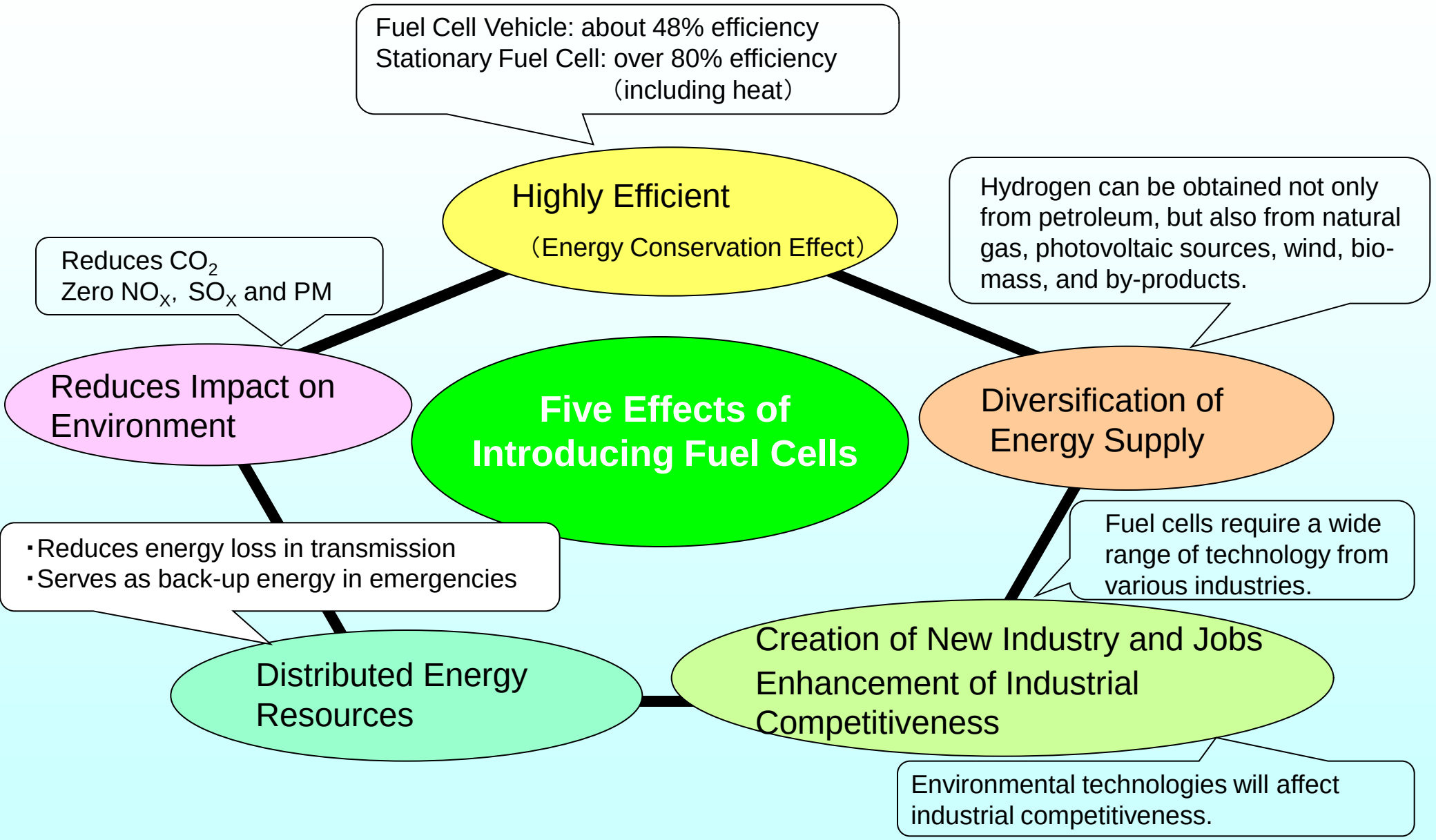
19. Power storage

20. Power electronics

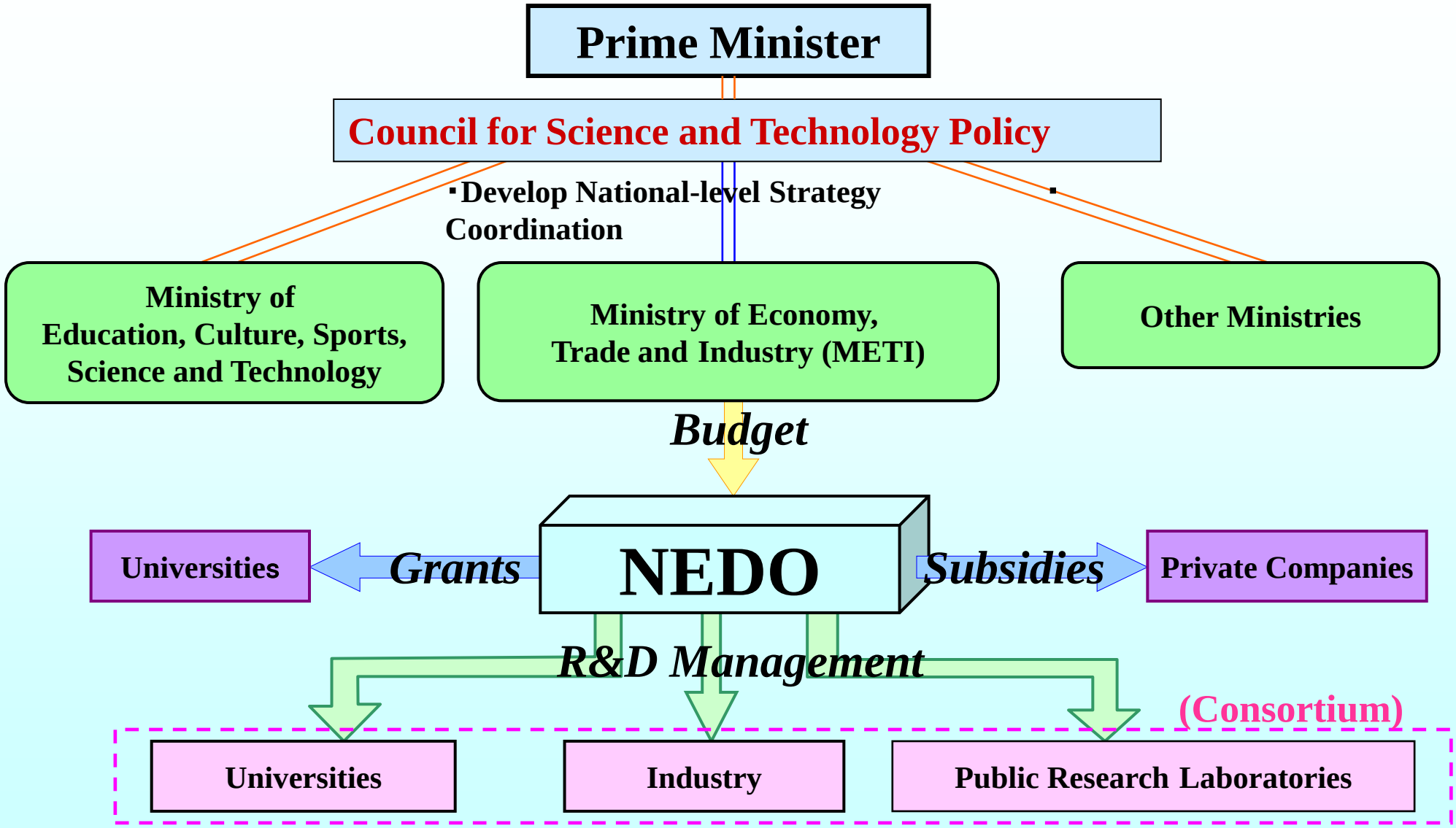
21. Hydrogen production/storage/transport

3. CCS (restated)

Significance of Introducing Fuel Cells



Japan's R&D Promotion Scheme



NEDO Activities on Fuel Cells and Hydrogen Technologies

Stationary Fuel Cell system

Fuel Cell Vehicles

Hydrogen Infra.

Polymer Electrolyte Fuel Cell（PEFC）

- Basic Technology
- Application Technology
- Next Generation
- Code and Standard

Solid Oxide Fuel Cell（SOFC）

- Durability and the reliability
- Cost reduction
- Application Technology

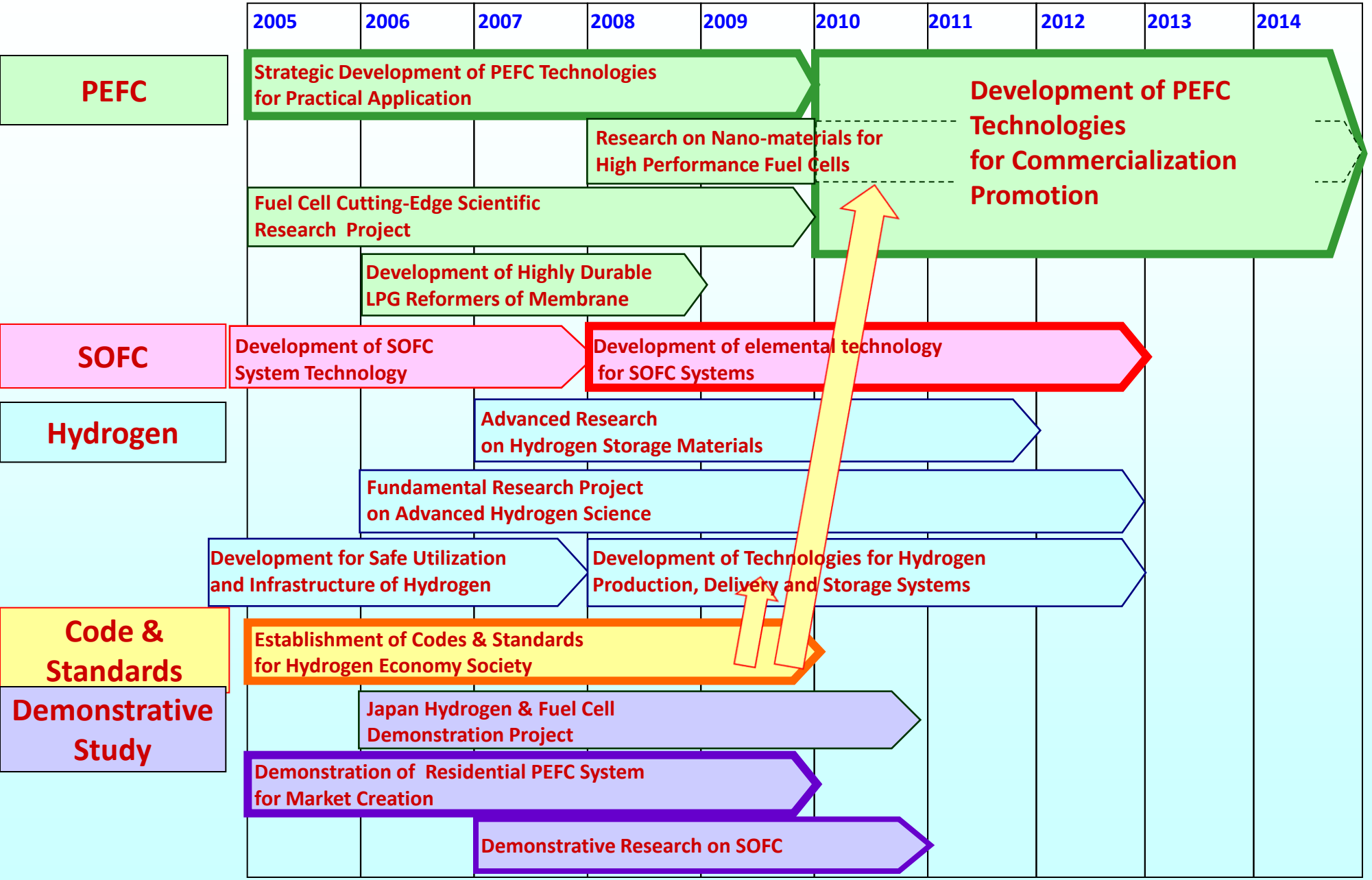
Hydrogen Infrastructure

- Technology for 700bar High Pressure Hydrogen
- Basic Research for High pressure Hydrogen
- Storage Materials
- Production
- Code and Standard

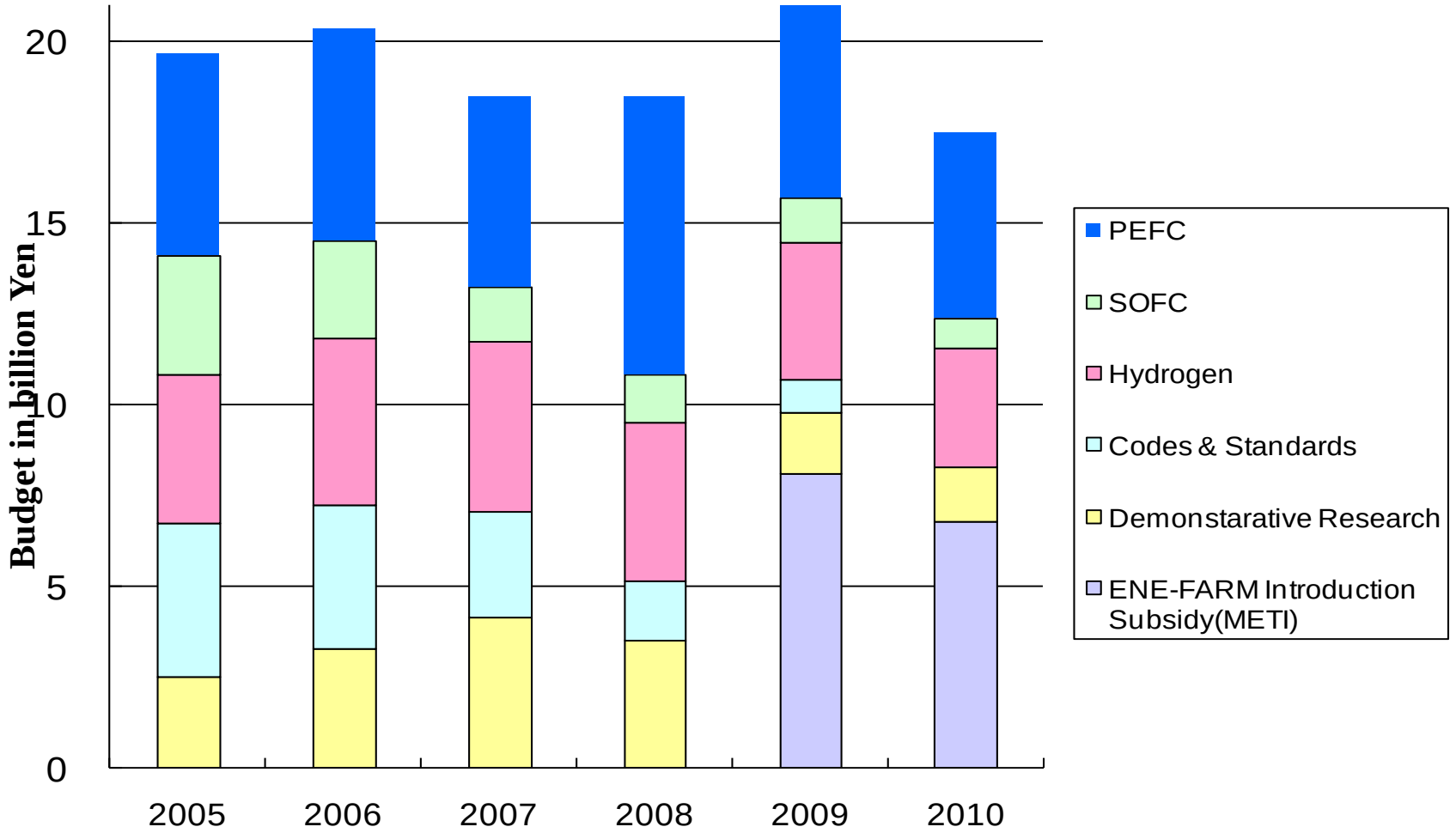
Demonstration Program
（PEFC・SOFC）

Demonstration Program for FCVs and Hydrogen stations
(JHFC)

NEDO Projects on Fuel Cells and Hydrogen Technologies



Budget of NEDO R&D on Hydrogen and Fuel Cell Technologies



* Budget of ''Code & Standards'' included in PEFC and Hydrogen from 2010

The Stationary Fuel Cell Application Becoming Reality and NEDO Projects

Start Selling PEFC system from FY2009

Pioneer of the World

ENE･FARM launches fuel cell lifestyle

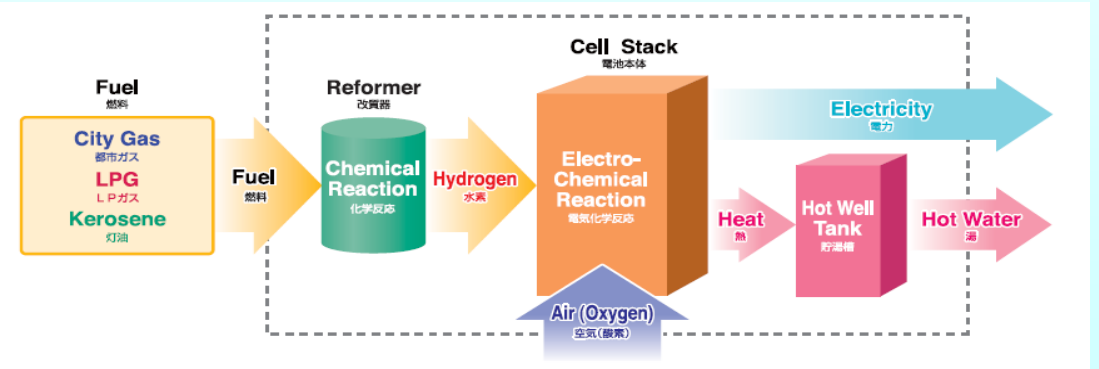
Japanese manufacturers (Panasonic, ENEOS-CELLTECH, Toshiba Fuel Cell Power Systems) and energy companies (Nippon Oil, Osaka Gas and Tokyo Gas) start selling of residential fuel cell system from FY2009.

Union name is “ENE-FARM”.

RESIDENTIAL FUEL CELL ENE･FARM

Specification of residential fuel cell system

- **Electricity output: 700W - 1000W**
- **Electrical efficiency: exceeding 35%**
- **Overall efficiency: exceeding 85%**
- **Operating mode: Intelligent Fully Automatic Control (with Load Following)**
- **Input Fuel: Natural Gas, LPG (Propane), Kerosene**
- **Hot water temperature: Approx. 60℃**
- **Hot well Tank capacity: 150 - 200 liter**



METI prepared the budget for introduction and dissemination of residential fuel cell systems.

NEDO Activities on Stationary Fuel Cell Systems

Stationary FC

20~100MW (2010)
2,500MW (2030)

	R&D Stage	Introduction Stage	Dissemination Stage	Full Dissemination Stage
Dissemination	Demonstration Project	Stepwise Construction	Market growth without support	Organic Growth
R&D	R&D on FC and H_2	Further R&D for higher performance and low cost		
Codes	Review of Regulations			

8millon yen /Unit

3~3.5millon yen /Unit

0.5millon yen /Unit

Market size

Start Selling from 2009

30,000< units/yr

10,000< units/yr

<1000 units/yr

Cost / unit

Large-scale Demonstration

Introduction stage

Full commercialization

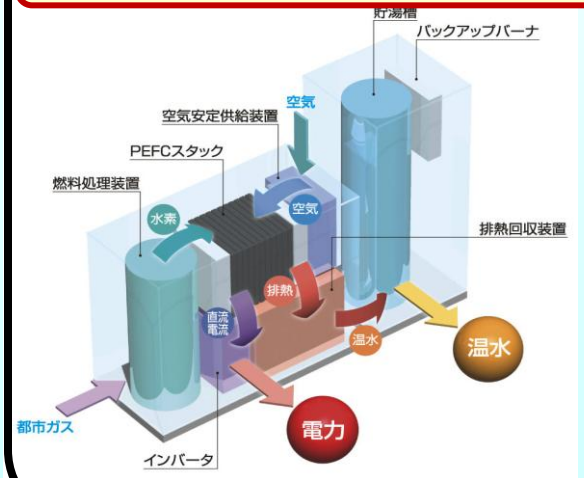
NEDO Activities on Stationary Fuel Cell Systems

Market launch of "*ENE-FARM*" in 2009

The achievement of NEDO "integrated activities" among technological development, demonstration project and activities of code and standard.

NEDO Activities

Technological Development



Demonstration

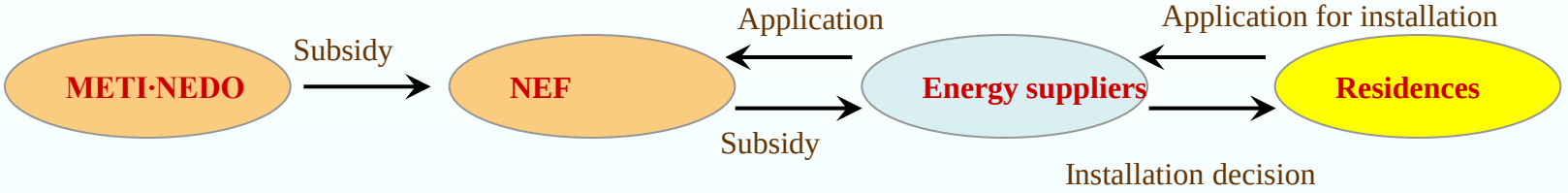
Code and Standard

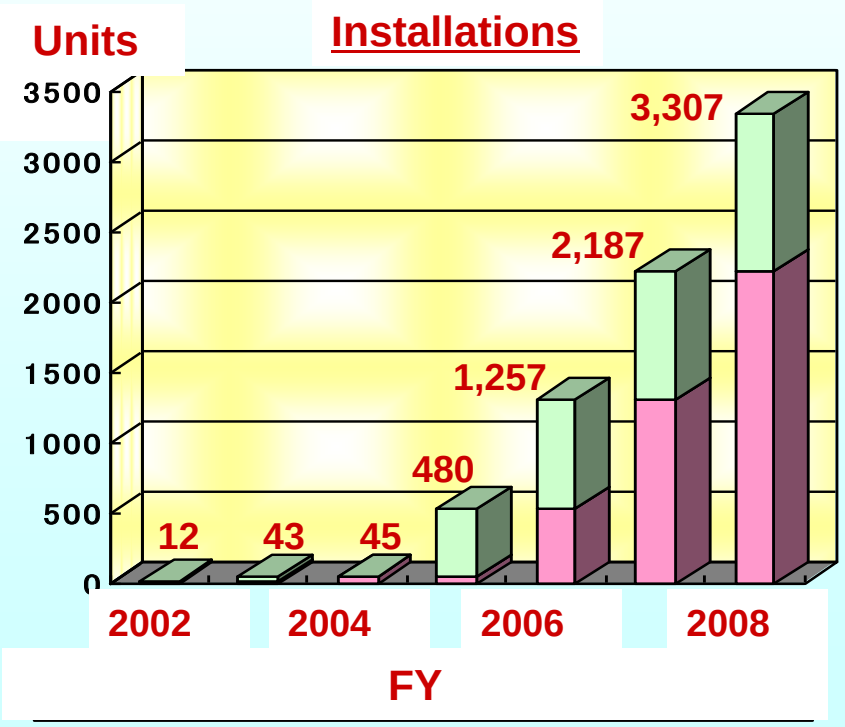
Subsidy

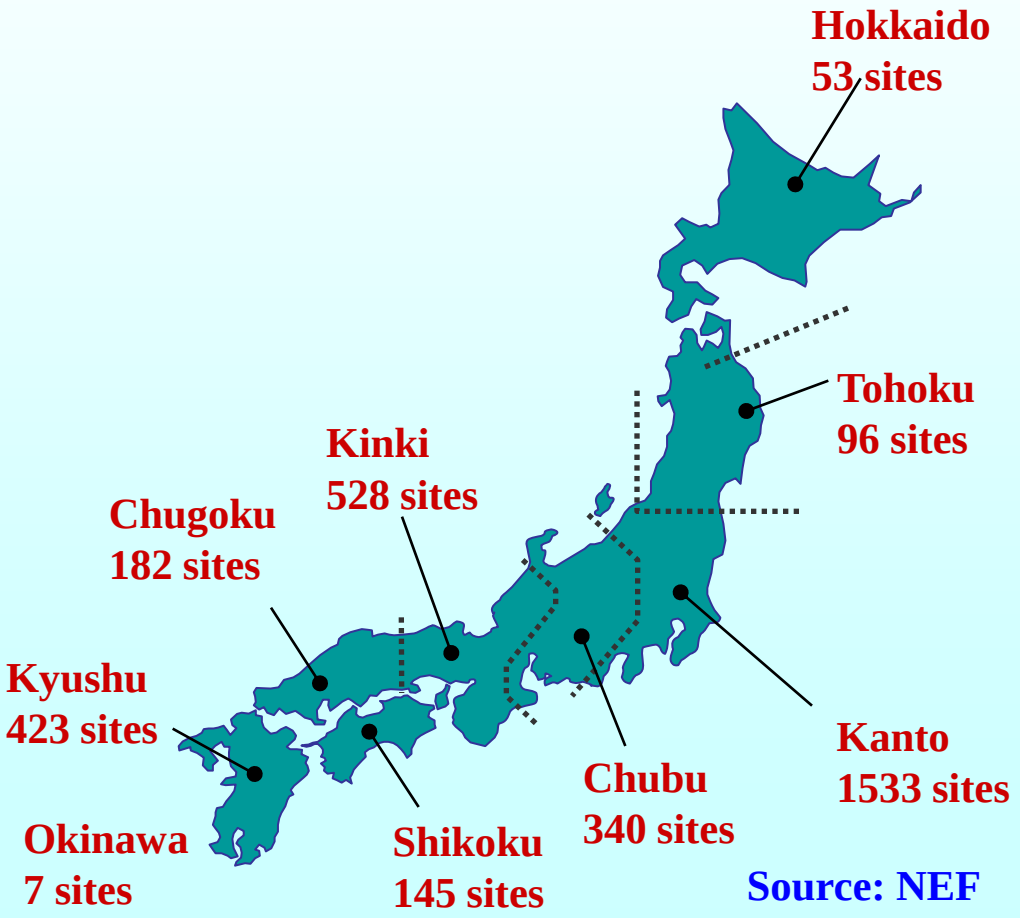
家庭用燃料電池コージェネレーションシステム
ENE・FARM
エネファーム

Demonstration (PEFC)

Provide feedback on various demonstration data, for research and development
Step up to mass production and inspection of learning curve
Price target: 1.2 million yen/system







Web site:
http://happyfc.nef.or.jp

Demonstration (PEFC)

Environmental Performance of Stationary Fuel Cell Systems

Result of Large-Scale Stationary Fuel Cell Demonstration Project（Top model）

Average Results

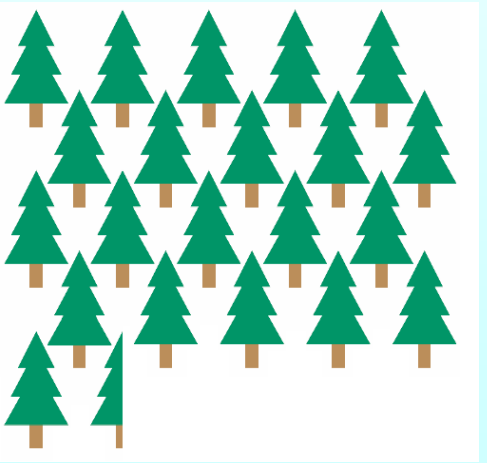
	FY2005	FY2007
Efficiency（HHV）	29.4 %	31.5 %
Energy Conservation	13.36 %	17.1 %
CO_2 Emission Reduction	25.8 %	28.9 %

Primary Energy Conservation : 25% (12,180 MJ/year)

CO_2 Emission Reduction:39% (1,200 kg-CO_2/year)

Energy saving of 18 tanks with 18L kerosene tanks

It corresponds to CO_2 that the forest of 2,200m^2 absorbs.



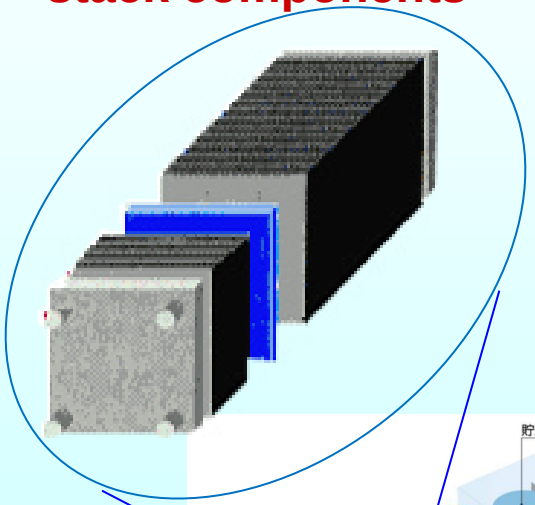
Source : New Energy Foundation (NEF)

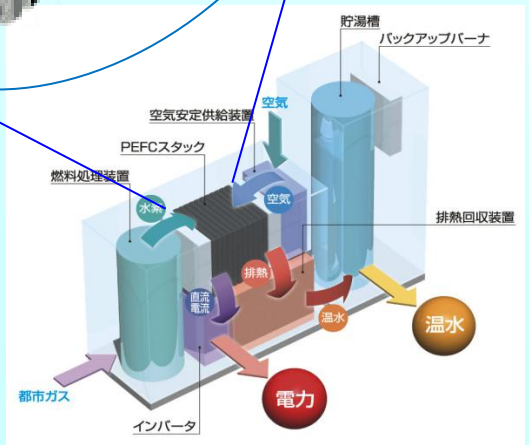
Source: NEF

Technological Development (PEFC)

R&D on PEFC stack components to reduce costs and improve performance of stationary co-generation system

Development activities to improve reliability and robustness for major cell stack components

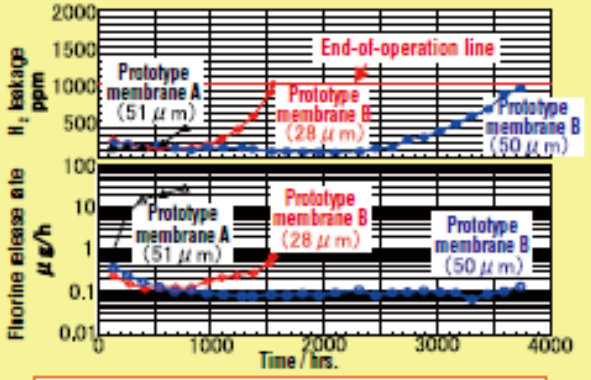




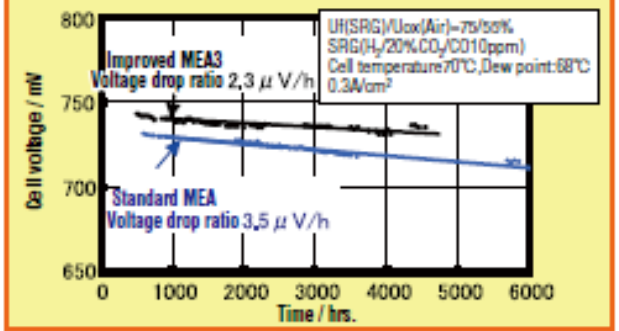
Improved reliability of electrolyte membrane and MEAs

Reducing rate of electrolyte membrane degradation (Asahi Kasei Chemicals)

Start/stop tests (Cell temperature: 80℃, Dew point: 50℃, cycle: 3 hours of power generation followed by 3 hours off, 0.3 A/cm² during power generation)



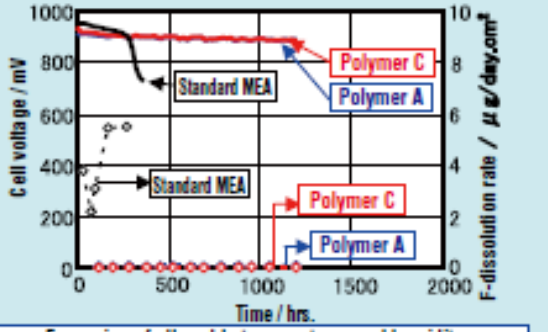
Control of serial voltage drop (ENEOS Celltech)



Improved robustness of electrolyte membranes and MEAs

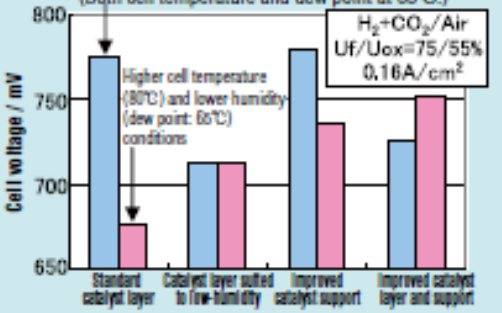
Improved chemical durability of polymers (Asahi Glass)

OCV conditions (H_2/Air, cell temperature: 90℃, dew point: 50℃)



Expansion of allowable temperatures and humidity (Panasonic Corporation (formerly Matsushita Electric Industries))

Full-humidification conditions (Both cell temperature and dew point at 65℃.)



Attaining the final targets

- The absolute value of cell voltage should be "the standard level - 20mV or higher" and "over 750mV" under the conditions of high temperature (the cell temperature is 80℃ or higher) and low humidity ("the cell temperature - the dew point" is 15℃ or higher, or the anode dew point is 65℃ or lower)
- The cell voltage drop ratio with respect to time should be 1.5 μV/hr or lower under the above high-temperature low-humidity conditions

Technological Development (PEFC)

R&D Project on Cost Reduction of BOP

Solenoid valves

Pressure transducers

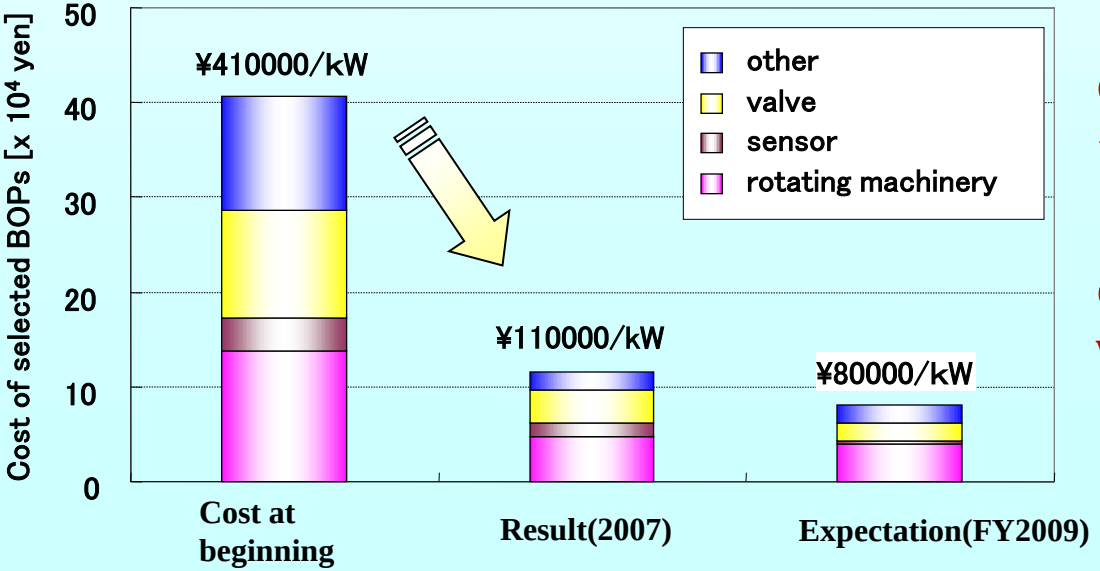
Flow meters

Blowers

Precision pumps

- System manufacturers selected some BOP devices (0.41million yen/kW) which specification can be harmonized among the participating system manufacturers.

- Concentrated R&D for the selected BOPs to satisfy durability, performance and cost.



○ **As a results of the effort in this R&D ('06 ～' 07), drastic cost reduction has been achieved: ¥410,000/kw ⇒ ¥110,000/kw**

○ **By continuous R&D, improvement of BOPs as well as the further cost reduction was achieved ~\80,000/kw by FY2009 (2nd phase)**

Subsidizing Policy for Residential Fuel Cells (METI)

FY2009-2013

Subsidy for the purchase expanse to promote the introduction of Residential Fuel Cell system.

Summary

To stimulate the initial domestic market demand of the Residential Fuel Cells, "*ENE-FARM*", the subsidization program was started in April 2009.

Requirements , etc

ENE·FARM エネファーム

<u>The target system</u>

- System capacity : 0.5~1.5kW per unit
- Total energy efficiency : 80% or larger
- Hot-water tank : 150L or larger

<u>Amount of the subsidy</u>

A half of the installation expense. (up to 1.4M JPY(2009))

More than 5000 units were offered in FY2009

More than 5200 units were offered in FY2010 as of the end of January.

Current NEDO projects on the Stationary Fuel Cells

Technological Development (PEFC)

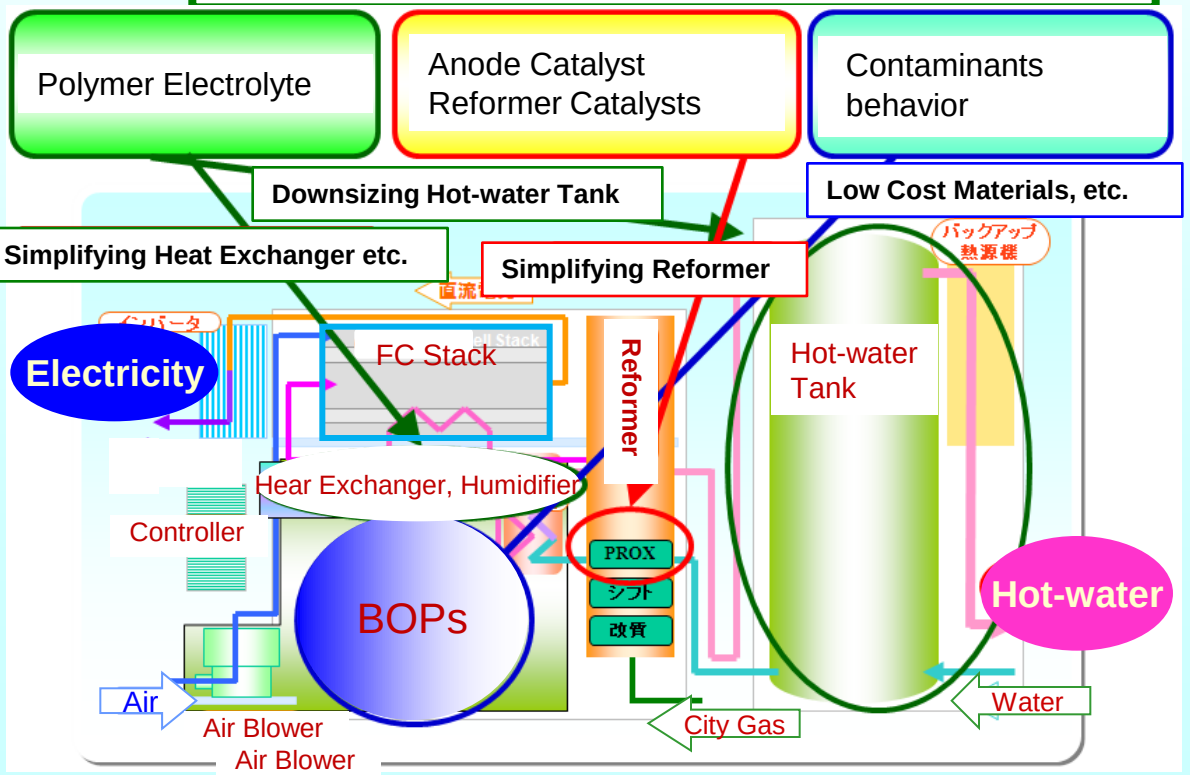
“R&D on MEAs to reduce the cost of stationary fuel cell systems”

Cost reduction of ENE･FARM

Improve durability and performance

【Subjects】

Ⅰ.High Performance Polymer Electrolyte
Ⅱ.High CO Tolerance Anode Catalyst
Ⅲ.High Performance Reformer Catalysts
Ⅳ.Research on Contaminants behavior



【Objective】

New residential fuel cell system; Higher efficiency, more durability, cost reduction and downsizing.

Ⅰ High performance polymer electrolyte: Higher temperature and less humidity

Ⅱ. High CO Tolerance Anode Catalyst: Simplify and reduce the cost of reformer

Ⅲ. High Performance Reformer Catalysts: Simplify and reduce the cost of reformer

Ⅳ. Research on Contaminants behavior: Investigate the effect of contaminants on system performance

Technological Development (PEFC)

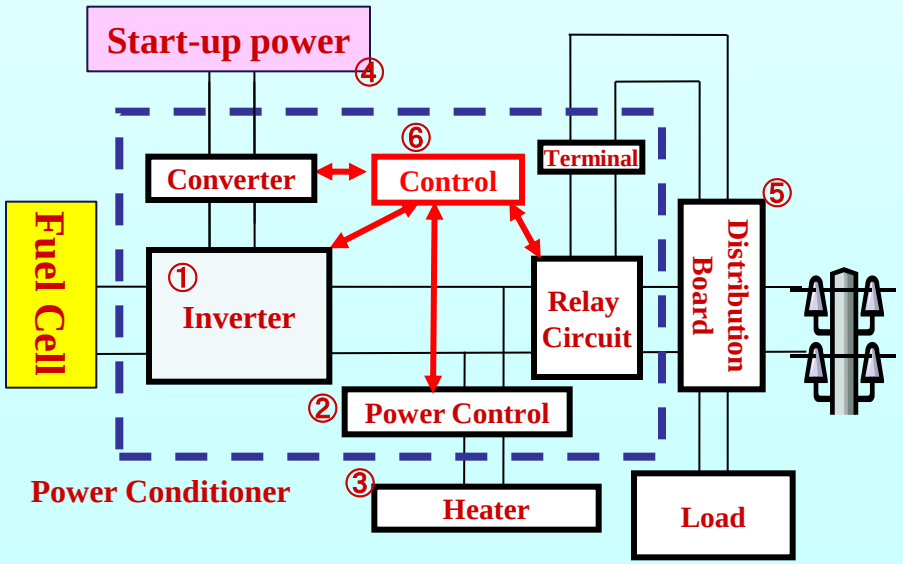
Application development

Stand-Alone Residential Fuel Cell System

Enable to operate residential fuel cell system without supply power

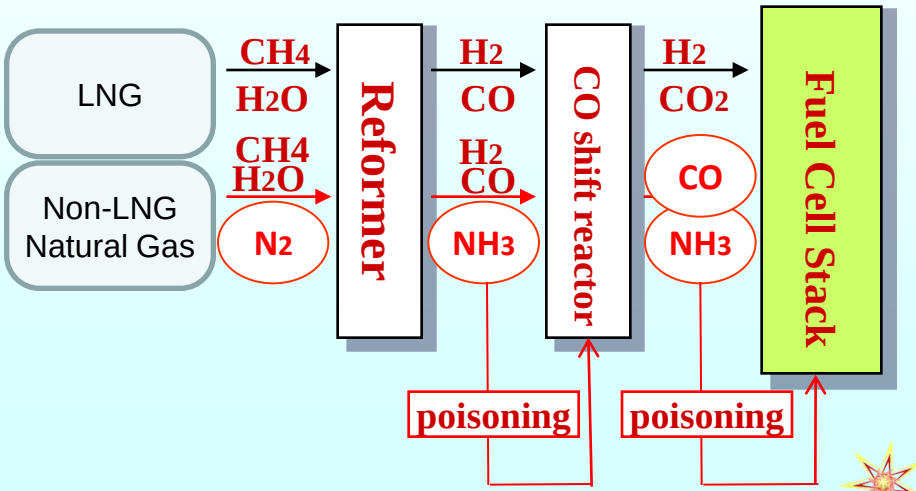
Subjects

1. Common Inverter (Normal / Stand alone-Emergency)
2. Power Controller with high performance
3. Intelligent Heater
4. Battery Start-up System
5. Intelligent Power Distribution Board
6. Integrated Control System



Fuel cell system for various fuels

Enable to operate residential fuel cell system with various kind of fuels



Demonstration (SOFC)

The environmentally and meteorologically different sites in Japan have been widely selected for collecting various data.

Hokkaido	1

Kyoto	6
Nara	7
Osaka	9
Hyogo	3

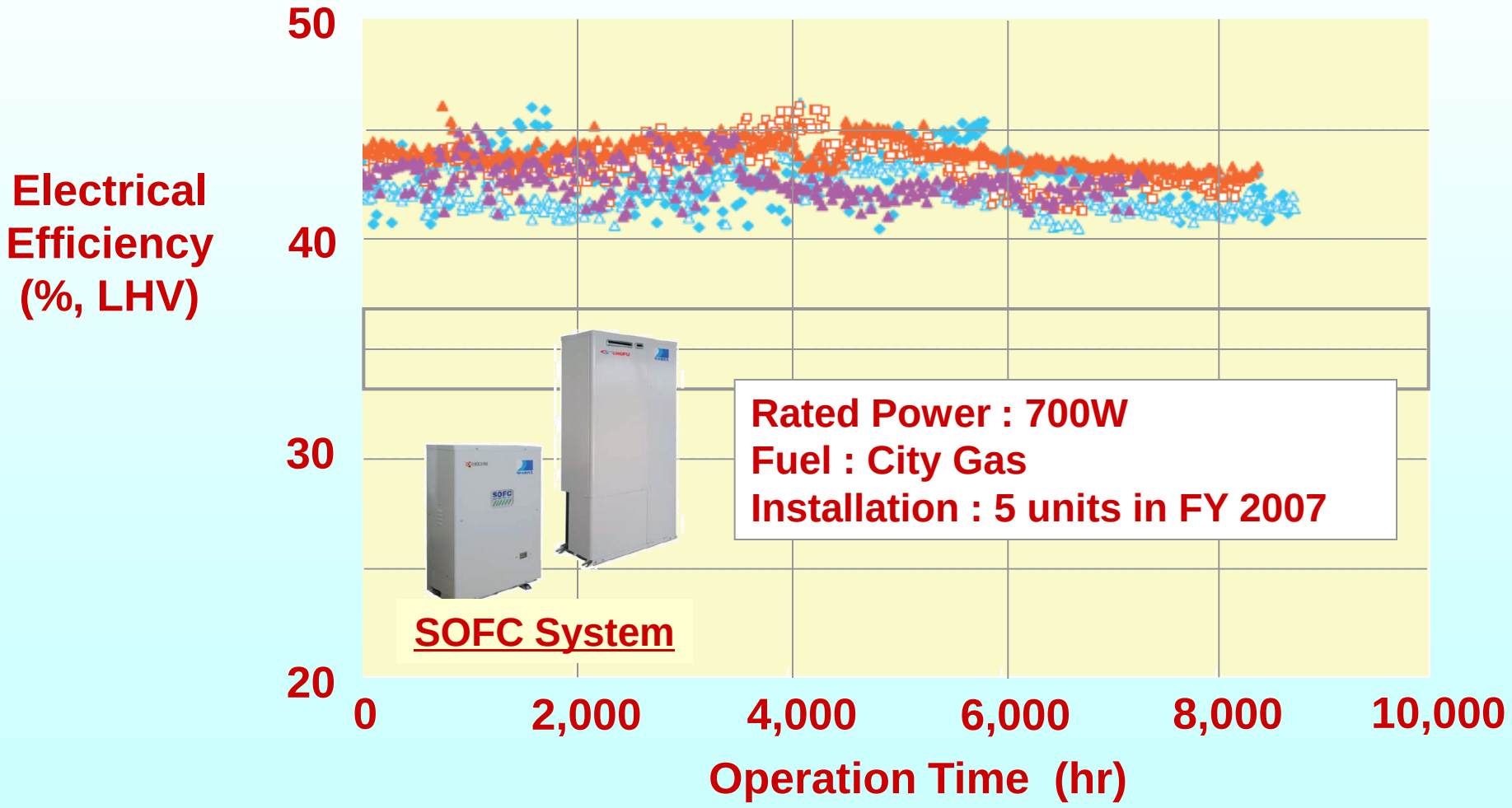
Japan

◎Tokyo

Saitama	1
Tokyo	1
Kanagawa	7

Fukuoka	1

Several units reached longest operation over 8,760 hrs (1 year) verifying durability which is required for the first stage of demonstration.



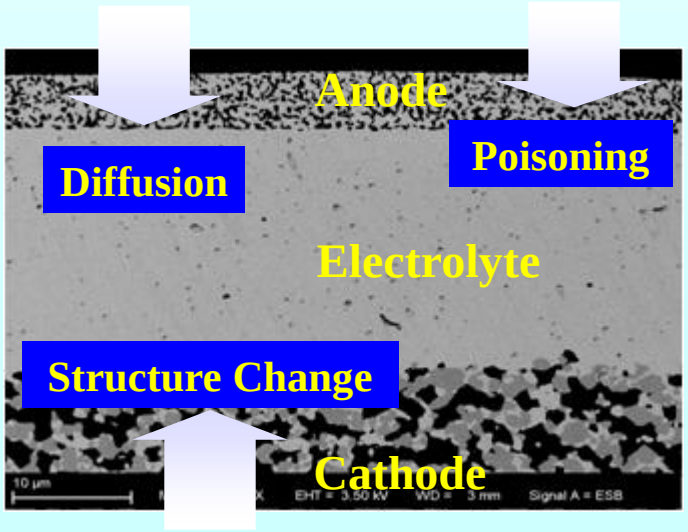
Development of System and Elemental Technology on SOFC

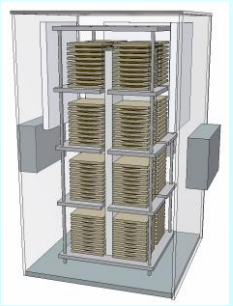
Project : Development of System and Elemental Technology on SOFC

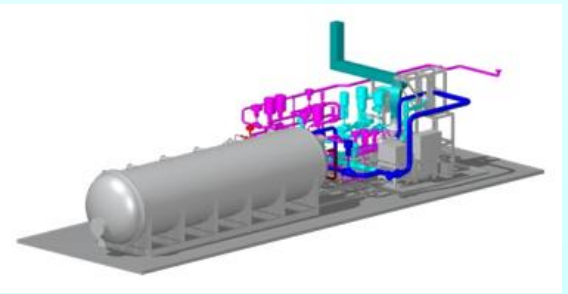
Objective :

To implement the basic research and elemental technology development required in order to introduce SOFC systems to the market, and to establish those basic technologies.

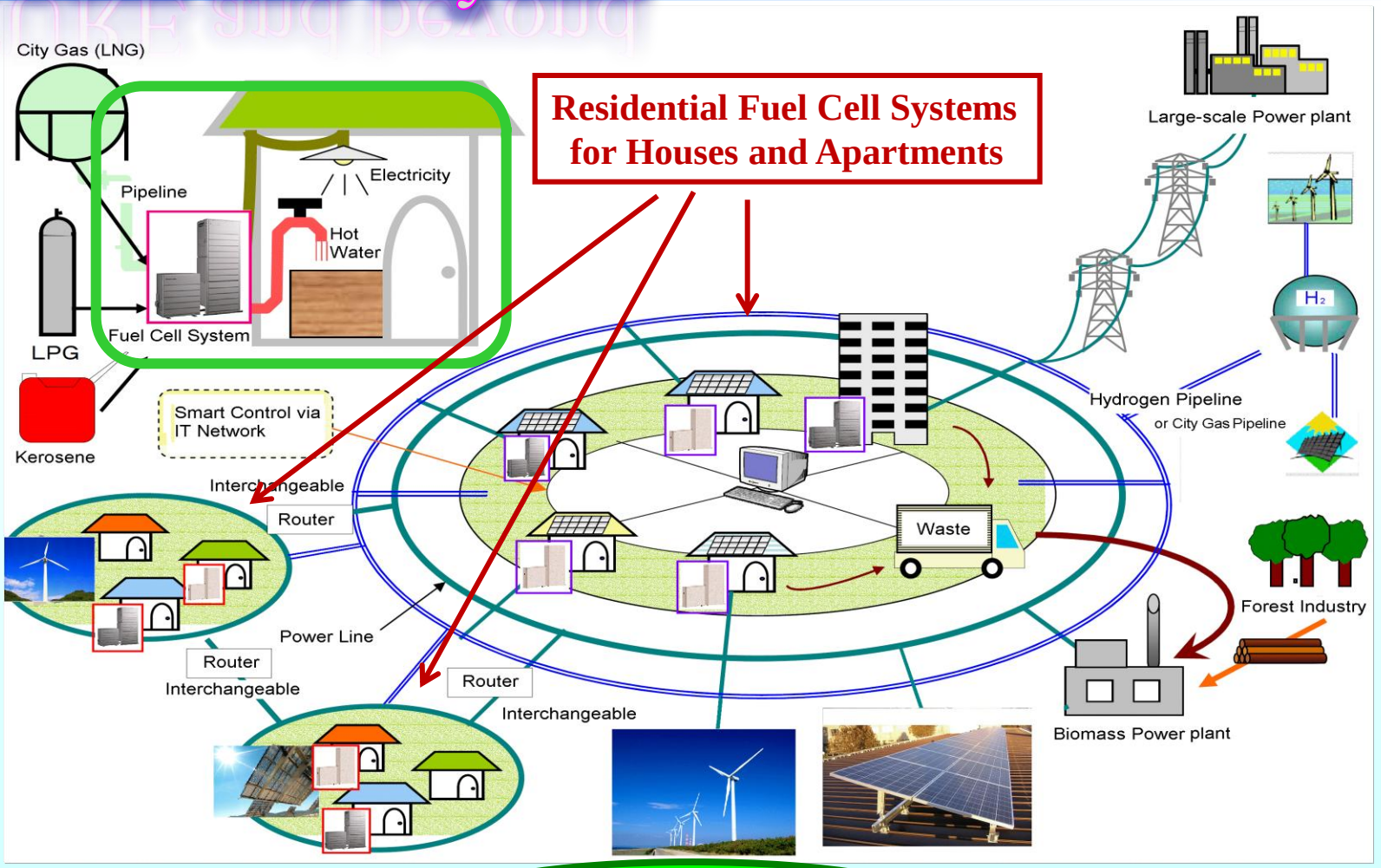
1. Development of 20kW-class Cogeneration System Using Tubular Type SOFC
2. Stop-Start Technology for Improving Operability
3. Development of 10kW-Class Disk-Type SOFC System
4. Development of 100kW-Class SOFC-GT Combined Cycle System
5. High-Pressure Operating Technology for Ultra-High-Efficiency Operation







FUTURE and beyond



Technology Development

Code and Standard

NEDO Integrated Project Management

Demonstration

Thank you !

Concluding Remarks

- Residential fuel cell systems have been commercialized
  - Supported by subsidization by government
  - **5,269 units were offered (as of Mar. 2010)**
- Residential SOFC is under demonstration
- **2nd milestone of FCV and hydrogen station is set in 2025 to contribute to reduction of CO2 emissions.**
  - **Approx. 1,000 H2 stations and approx. 2 million FCVs are set as common perspective.**
- Basic research programs for innovation toward full commercialization of residential fuel cells / commercialization of FCV

SOFC Demonstration Project

To collect data and experience of practical operation of residential SOFC systems.

- Degradation by impurity
- Influence of current density, operating temperature

- Troubles of equipment

⇨ Durability improvement by modification of cell stack structure and system design

Project period: FY2007-2010

Characteristics of SOFC

- High efficiency of electric power generation
- No expensive catalysts (Pt etc.) needed
- Mature ceramic technology applicable
- Scale-up

Fuel Cell Market Entry - Commercialization of Residential Fuel Cells -

ENEOS CELLTECH
Your Choice of Energy

TOSHIBA
Leading Innovation

Panasonic
ideas for life

Design Your Energy 夢ある明日を
OSAKA GAS

TOKYO GAS

NIPPON OIL CORPORATION
Your Choice of Energy

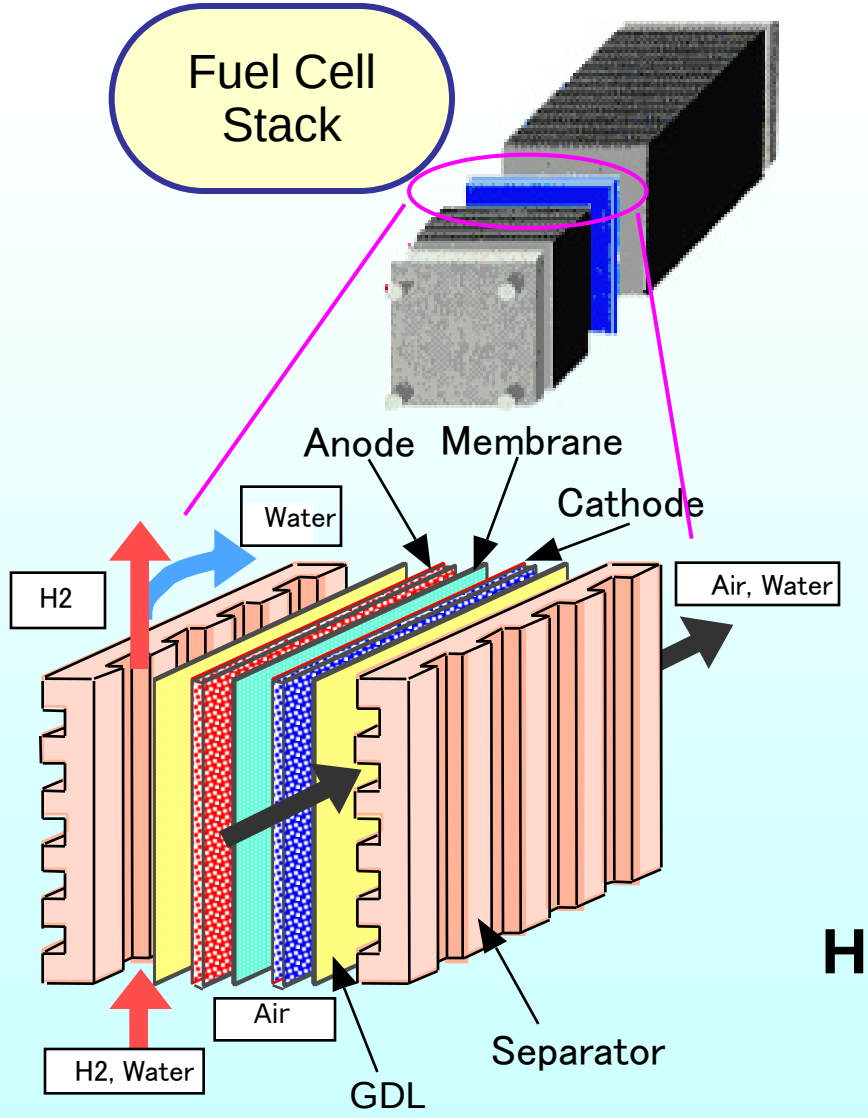
家庭用燃料電池コージェネレーションシステム
ENE・FARM
エネファーム

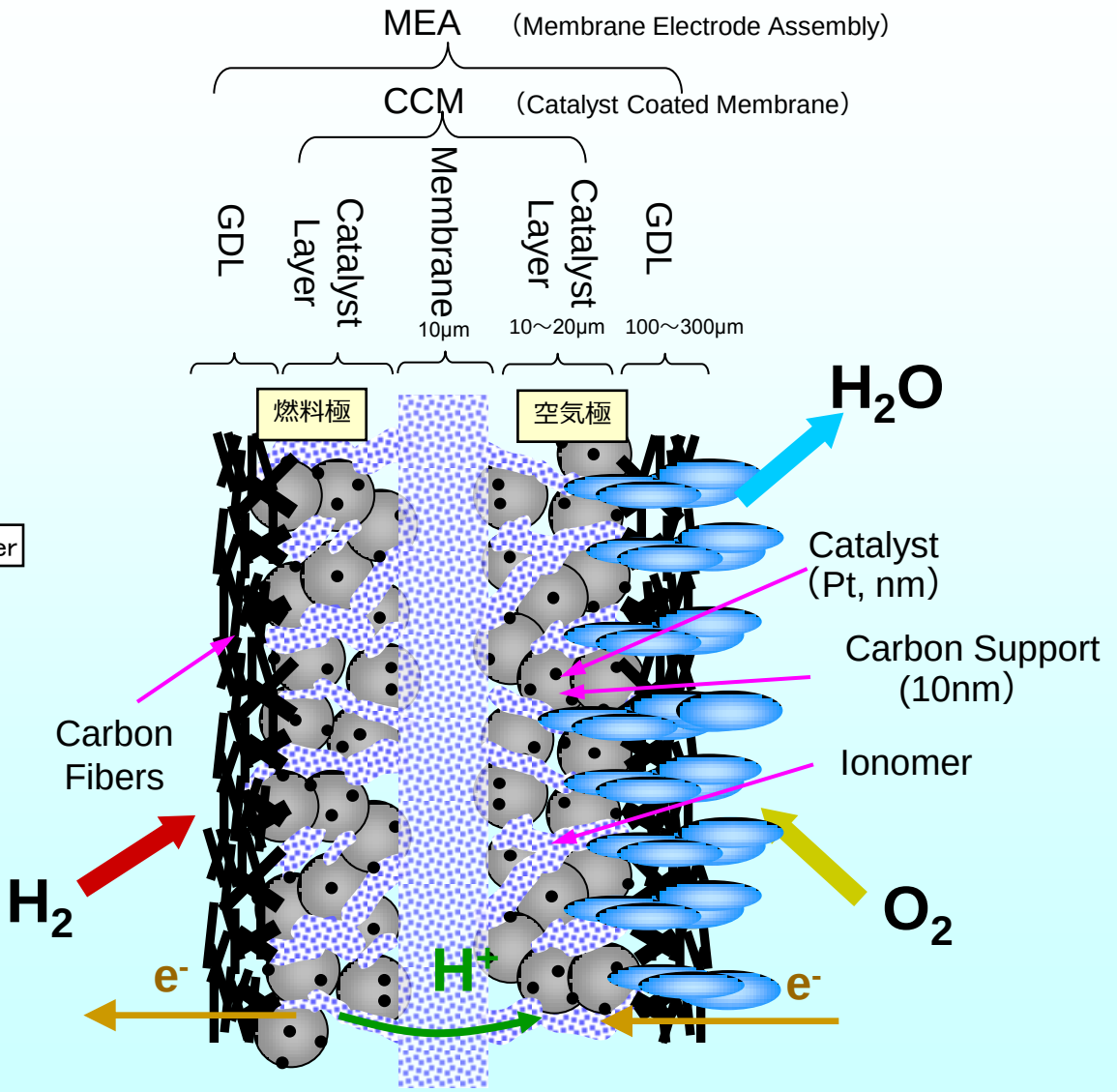
“ENE FARM” - The unified logo for Residential Fuel Cells

“The first shipping” ceremony of residential fuel cell systems at ENEOS in Gunma Pref. on July 1, 2009.

Production capacity : 10,000 units/year
40,000 units/year by 2015

PEFC Cell Structure





Scenario of Market Creation for Residential Fuel Cell

Large-scale Demonstration Project → Market creation by government support → Full commercialization Self sustained and growing market