Research, Development, and Deployment of Fuel Cells and Hydrogen in Japan

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Hirohisa Aki, *Ph.D.*

Deputy Director, Technology Development
New and Renewable Energy Policy Division
Agency for Natural Resources and Energy (ANRE)
Ministry of Economy, Trade and Industry (METI)

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Outline

1. Introduction
2. RD&D on Hydrogen & Fuel Cell in Japan
3. Commercialization of Residential Fuel Cell Systems
4. FC Vehicle R&D and Hydrogen Infrastructure
5. R&D for Further Breakthrough
6. Concluding Remarks

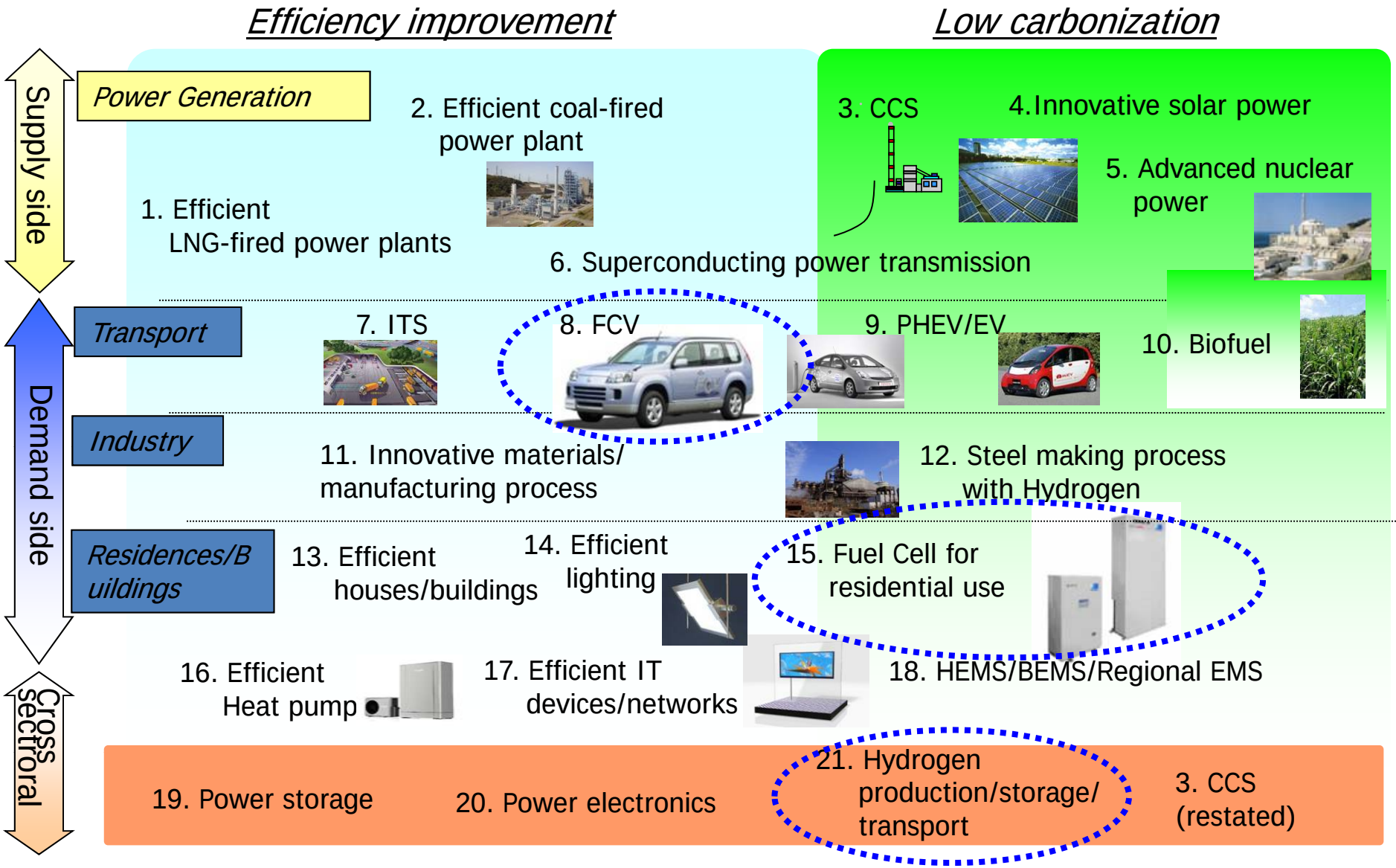
Fuel Cell/Hydrogen Technology in Government Policies

- Science and Technology Basic Plan (Mar. 2006)
- New National Energy Strategy (May 2006)
- Basic Energy Plan (Mar. 2007)
- Next-Generation Automobile Fuel Initiative (May 2007)
- Cool Earth – Innovative Energy Technology (Mar. 2008)
  Selection of 21 technologies as innovative technologies that should be given higher priority

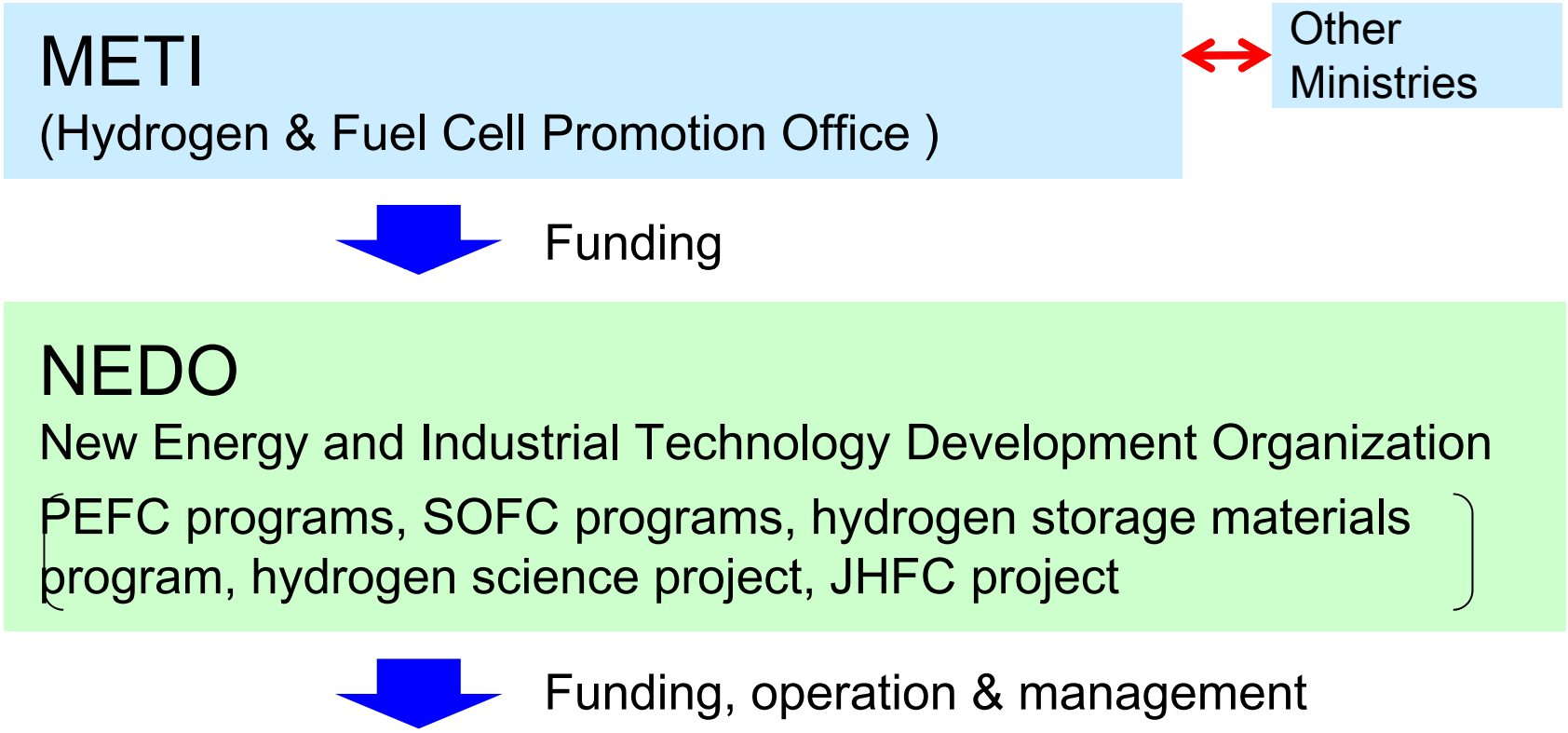
- "Hatoyama Initiative" (22 Sep. 2009)
  "Japan will aim to reduce its emissions by 25% by 2020, if compared to the 1990 level." Statement by Prime Minister Yukio Hatoyama at UN Summit on Climate Change

  "Needless to say, solar panels, fuel cells and various other types of green technology need to be mobilized. Hydrogen energy is also likely to become available in the future." Press Conference by PM Yukio Hatoyama following his attendance at meetings at the UN and the Pittsburgh G20 Summit

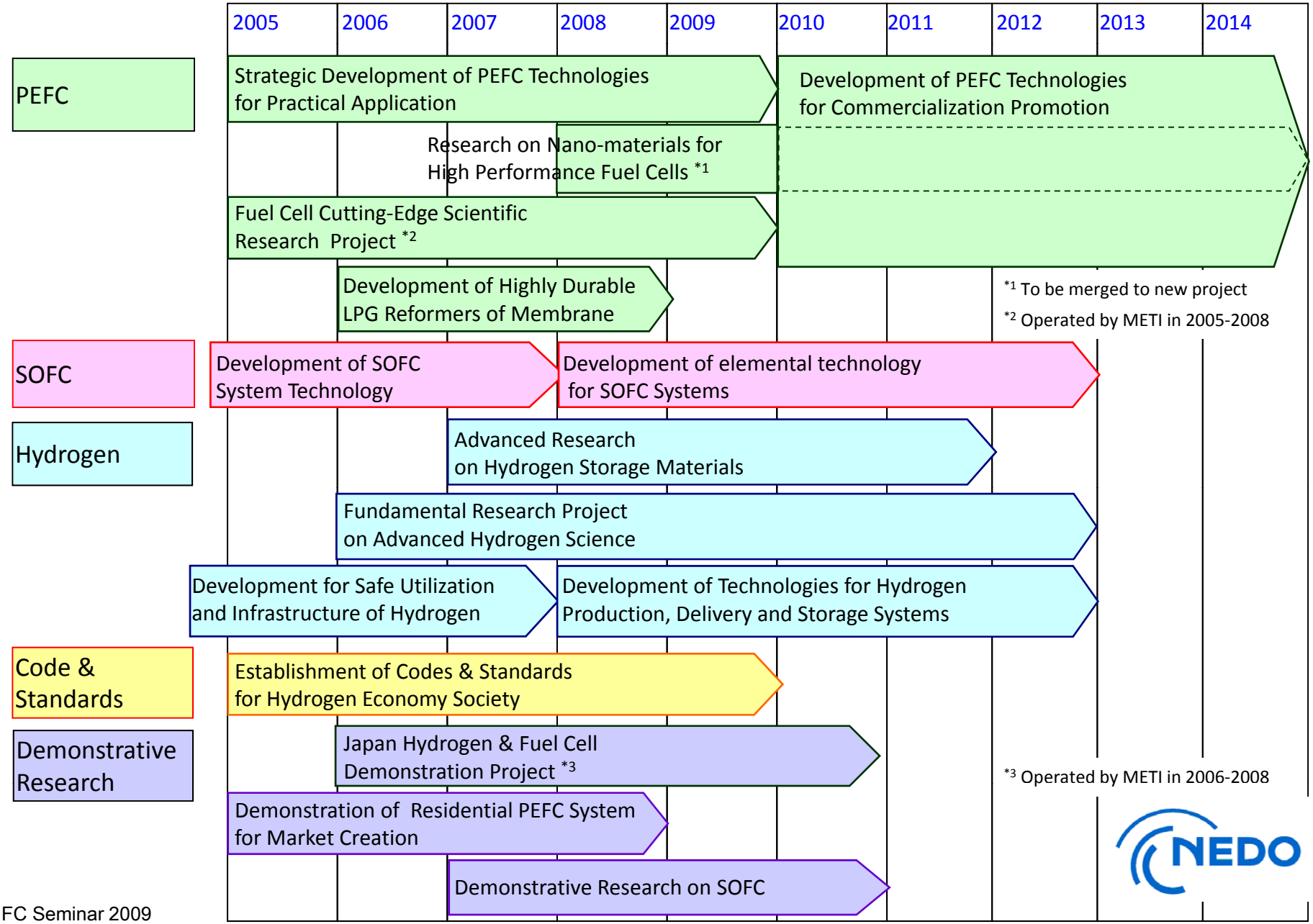
21 Key Innovative Energy Technologies



Framework for R&D of Hydrogen and Fuel Cells under METI in Japan

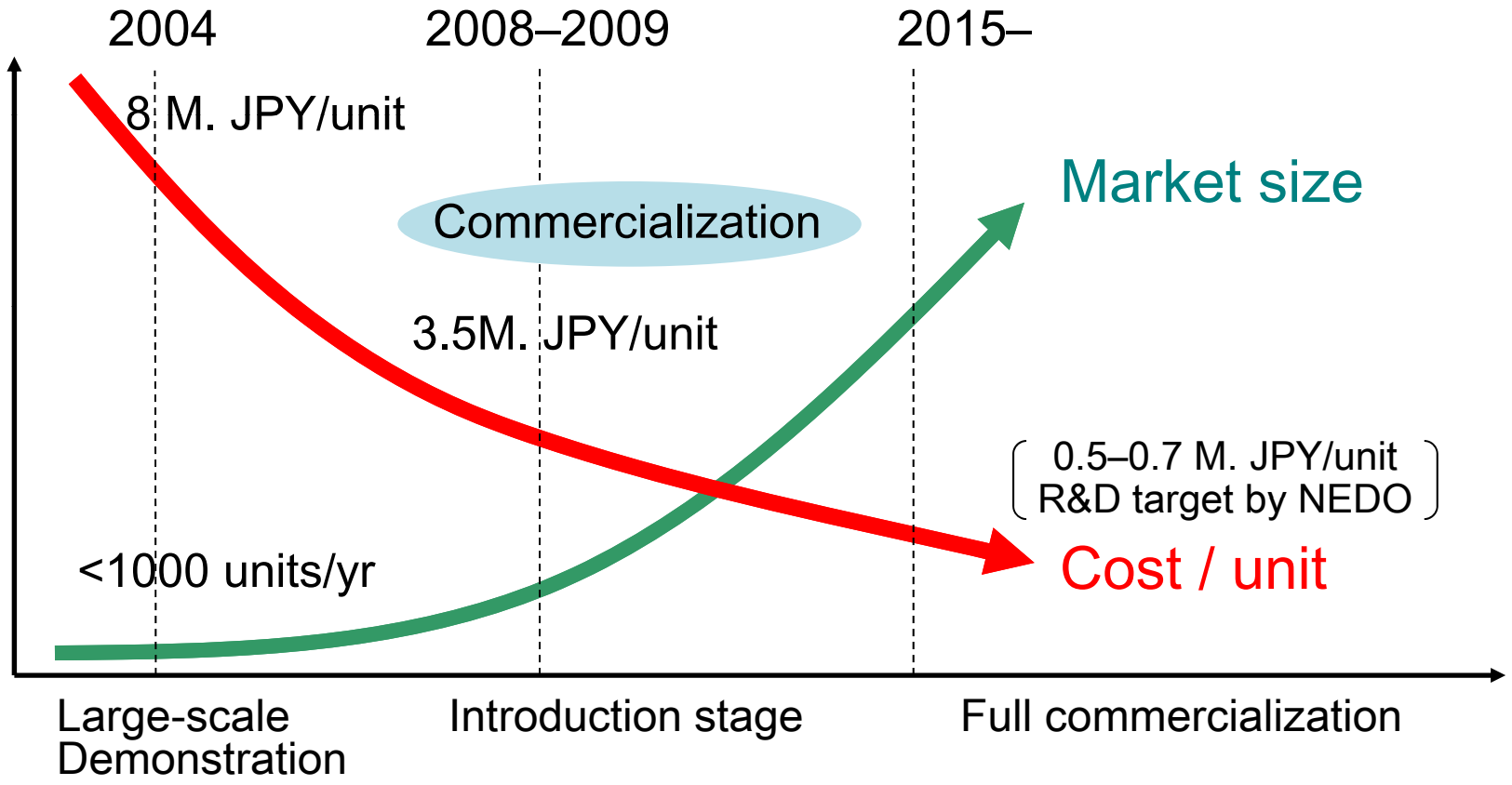


R&D on Fuel Cell and Hydrogen Technologies by NEDO



Scenario of Market Creation for Residential Full Cell

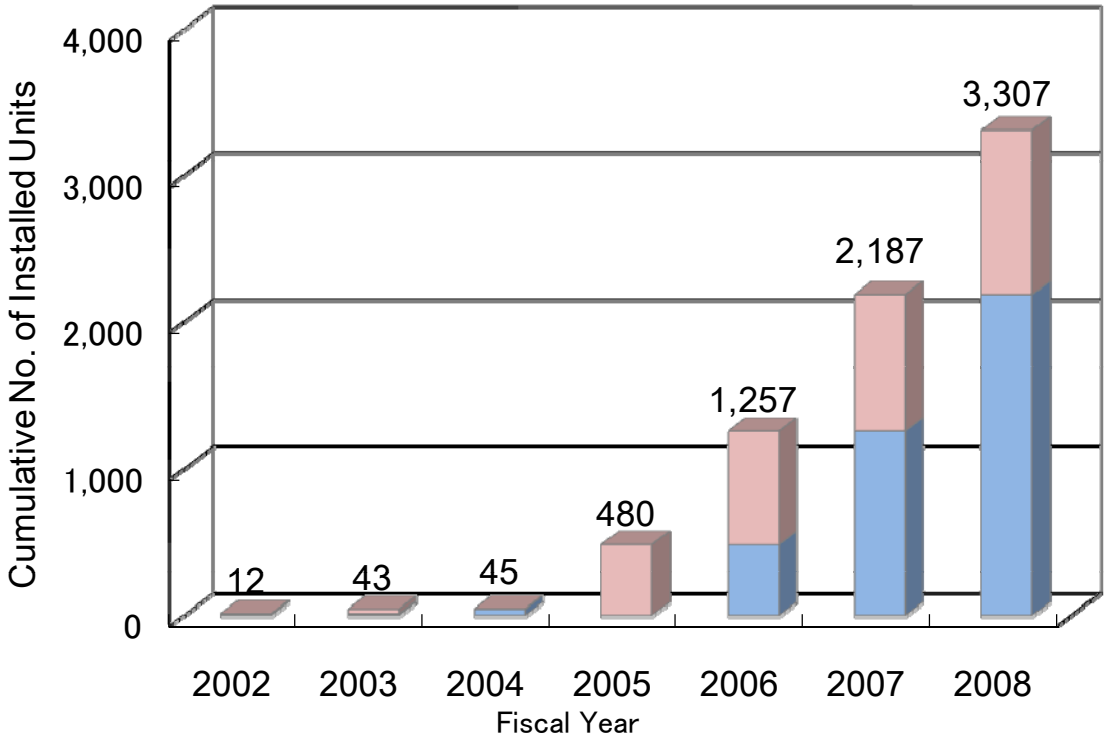
Large-scale Demonstration project → Market creation by government support (subsidization) → Full commercialization self sustained and growing market

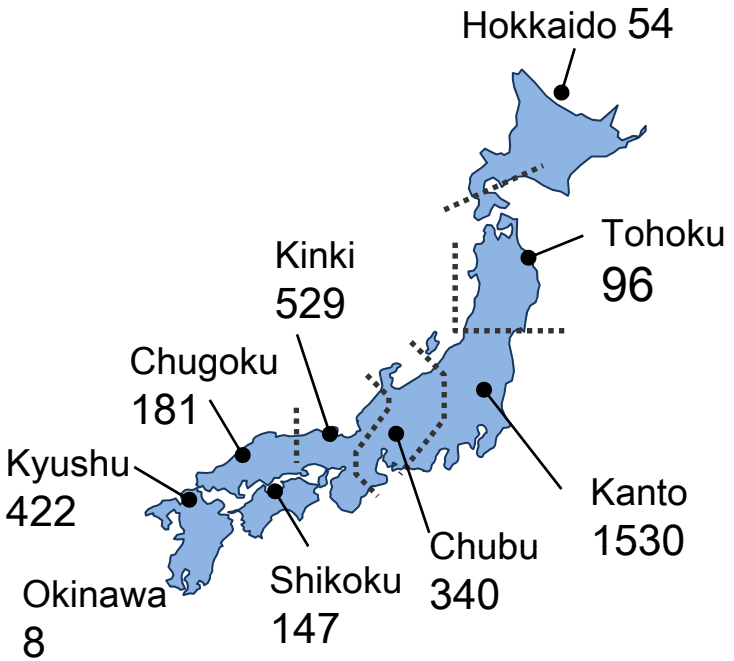


Large-Scale Stationary Fuel Cell Demonstration Project

PEFC based Residential fuel cell CHP systems
3,307 systems installed in FY 2005–2008

Primary energy conservation: 25%
CO_2 emission reduction: 39%
※ Based on data from 100 homes where top performing systems were installed in FY2007





Installation by FY2008

Commercialization of Residential Fuel Cells

Residential fuel cell systems commercialized in 2009
- 0.7–1.0 kW PEFC + heat recovery (CHP)
- Three manufactures
- Subsidization program initiated

1/2 of users' costs (system + installation) up to 1.4M JPY

1,500 units installed (as of Sep. 2009)

(+ 3,307 by demonstration project in 2004-2008)

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

ENEOS CELLTECH
Your Choice of Energy

TOSHIBA
Leading Innovation

Panasonic
ideas for life

Commercialization of Residential Fuel Cells

Production lines are working at three manufactures

“The first shipping” ceremony at Panasonic in Shiga Pref. on July 1, 2008.

“The first shipping” ceremony at ENEOS in Gunma Pref. on July 1, 2009.

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

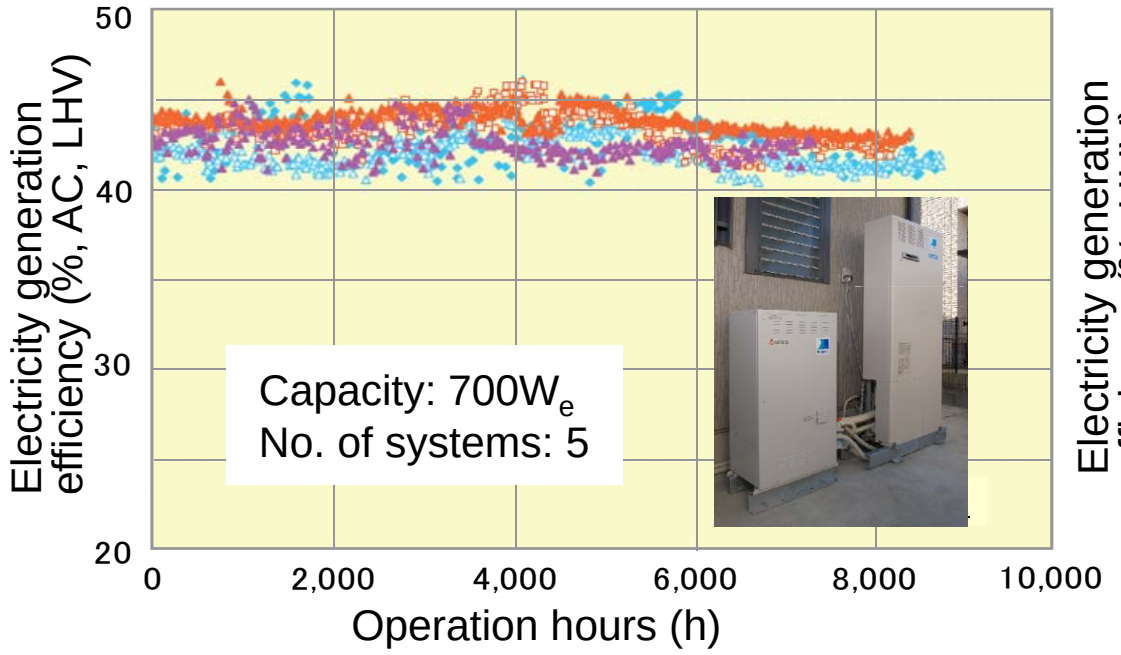
⇒ Durability improvement by modification of cell stack structure and system design

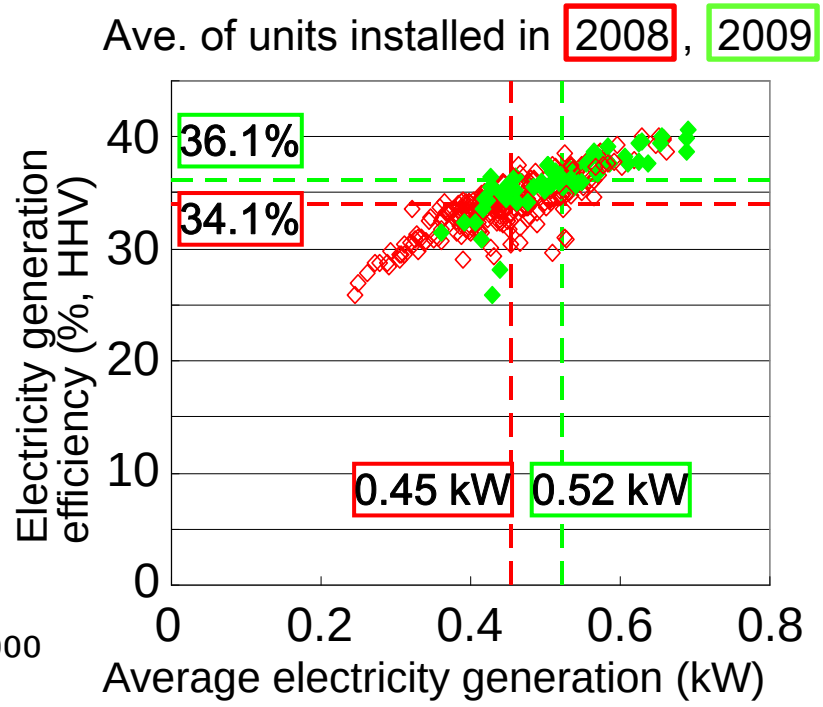
Project period: FY2007-2010

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

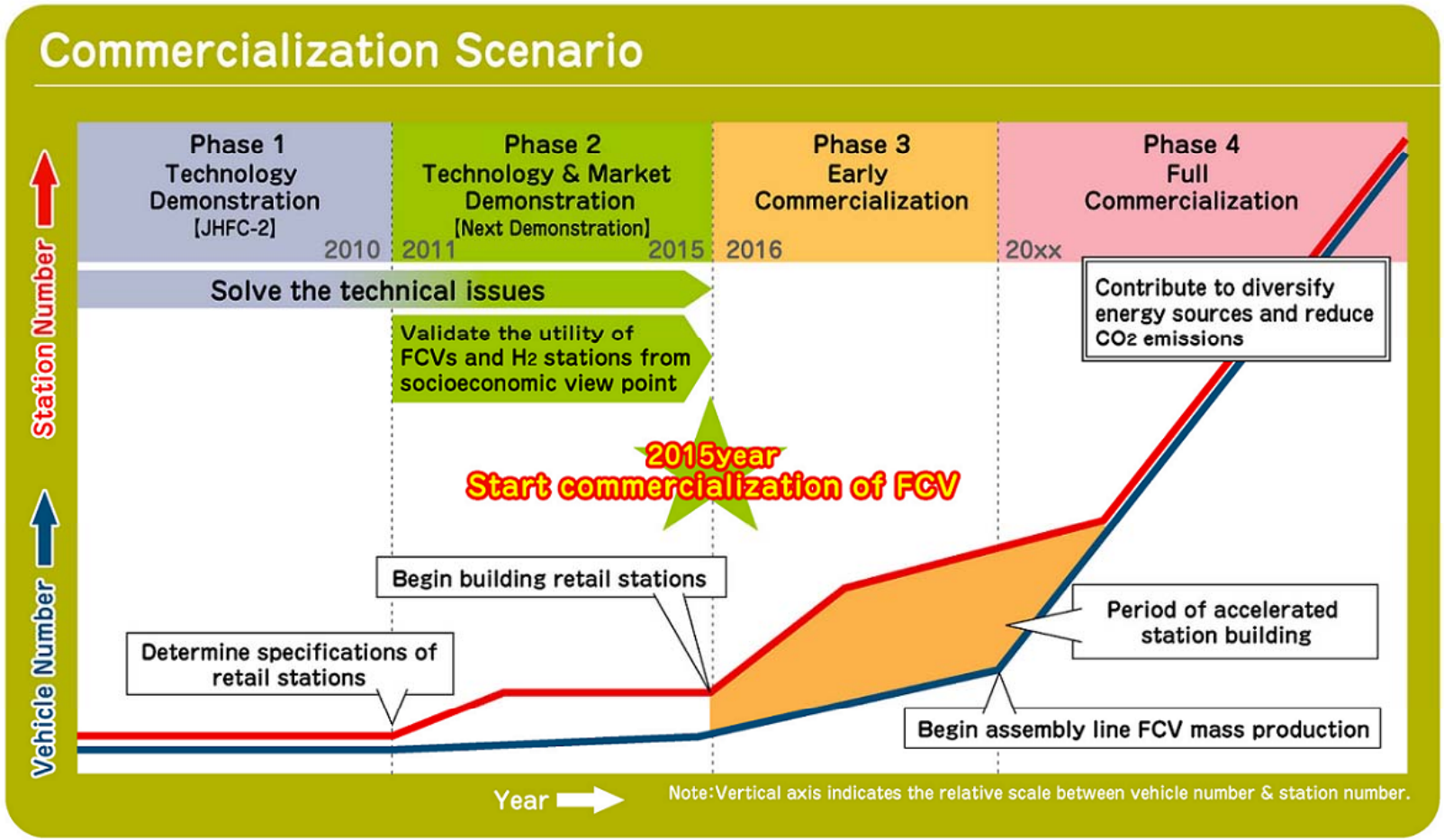
SOFC Demonstration Project

Primary energy conservation: 15–18 %
CO_2 emission reduction: 34–37 %
(average of units installed in FY2007-2008)





Commercialization of FCV and hydrogen stations



Leading automakers in and outside Japan and Japanese energy companies have agreed on a scenario which sees commercialization of fuel cell vehicles (FCVs) and hydrogen stations beginning in 2015.

Source : FCCJ, http://www.fccj.jp/pdf/20080704sks1e.pdf

Commercialization of FCV

Cruising range 300+ miles achieved.
R&D toward commercialization in 2015 is being conducted.

HONDA FCX Clarity (July 2, 2008)

Cruising range : 620 km (390 miles)
Fuel cell stack : 100 kW
Top speed : 160 km/h (100 mph)
Pressure of hydrogen tank : 35 MPa

TOYOTA FCHV-adv (June 6, 2008)

Cruising range : 830 km (520 miles)
Fuel cell stack : 90 kW
Top speed : 155 km/h (97 mph)
Pressure of hydrogen tank : 70 MPa

Japan Hydrogen & Fuel Cell Demonstration Project (JHFC Phase II)

- To clearly show energy-saving effect and environmental impact
- To collect data for codes & standards development and certification practices

- Project Year: 2006–2010
- Demonstration of FCV under actual circumstances
- Hydrogen stations: upgraded to 70 MPa
- Demonstrative operation of various means of H_2 production and supply and its verification
- Awareness & education: To raise public awareness regarding FCVs and H_2 Stations

The Research Association of Hydrogen Supply/Utilization Technology (HySUT)

Association of private companies on H_2 supply & utilization

- Verify hydrogen supply business by demonstrative research in societies
- Installations and operations of hydrogen infrastructures
- Operations and maintenance of hydrogen utilization such as fuel cell vehicles

- Members: 13 companies

  Oil Utilities:

  Nippon Oil, Idemitsu Kosan, Cosmo Oil, Japan Energy, Showa Shell Sekiyu

  Gas Utilities:

  Tokyo Gas, Osaka Gas, Toho Gas, Saibu Gas

  Other companies (Industrial gas suppliers, hydrogen stations):

  Iwatani, Taiyo Nippon Sanso, Air Liquide Japan, Mitsubishi Kakoki Kaisha

- Established on July 31, 2009
- FY2009–2015

Demonstration Project on Hydrogen Utilization Systems in Society

Demonstrations of social models of hydrogen economy
- Community scale demos of hydrogen and fuel cell technologies
- Low carbon hydrogen

Major activities (tentative)

- Hydrogen highway
  - Fuel cell bus and fuel cell limo services between downtown Tokyo and Haneda/Narita airports.
  - Byproduct hydrogen and natural gas reformed hydrogen with carbon capture are used and dispensed at hydrogen stations.
- Hydrogen town (Fukuoka Pref.)
  - Installation of hydrogen fueled residential PEMFC CHP systems (w/o reformers) to residential houses (approx. 20 houses in a specific area).
  - Hydrogen is supplied from a hydrogen station by pipe line.

Basic Research Programs for Innovation in Science of Hydrogen & Fuel cell Technologies

Back to the basic

Basic research programs for innovation and breakthrough

Polymer Electrolyte Fuel Cell Cutting-Edge Research Center

Project period: FY2005–2009
Head: AIST (FC-Cubic)

FC-Cubic

Research Center for Hydrogen Industrial Use and Storage

Project period: FY2006–2012
Head: Kyushu Univ. and AIST Kyushu

HYDROGENIUS
Hydrogen saves the Earth

Advanced Fundamental Research on Hydrogen Storage Materials

Project period: FY2007–2011
Head: AIST

HYDRO STAR

Basic materials research for High Performance Fuel Cell

Project period: FY2008–2014
Head: Yamanashi Univ.

HiPer-FC

Basic materials research for High Performance Fuel Cell

HiPer-FC

- Development of high performance PEMFC based on the state-of-the-art science.
- Materials researches based on the advanced analysis of reaction and degradation with nanometer scale.

Reaction and degradation mechanism
＋
Nano-technology

→

Material development

Mechanism analysis

73 researchers from 3 universities and 6 companies

Fuel Cell Nano-materials Center

- Constructed in Univ. of Yamanashi in August 2009.
- Prototype manufacturing, testing, and analysis of electrode catalysis and electrolyte membranes are possible.

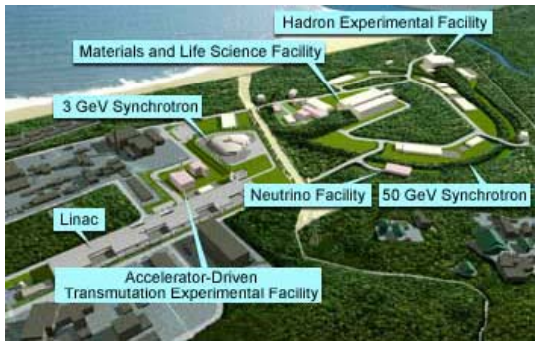
Fuel Cell Nano-materials Center

Advanced basic technology for hydrogen storage materials

Establish compact and highly-efficient hydrogen storage/delivery technology through revolutionary performance improvements of hydrogen storage materials

Key: increase of adsorption capacity in hydrogen storage material

- 5 teams under Project Leader, Dr. Akiba (AIST)
  Metal Hydrides, hydrides with light elements, materials science, computational science, neutron scattering
- Collaboration with US labs, e.g. Los Alamos National Laboratory
- J-PARC (spallation neutron source):
  in-situ measurements under hydrogen
- Spring-8 (synchrotron radiation source):
  analysis on hydrogen-Metal interaction under high-pressure



J-PARC (source: website of J-PARC)

SPring-8 (source: website of SPring-8)

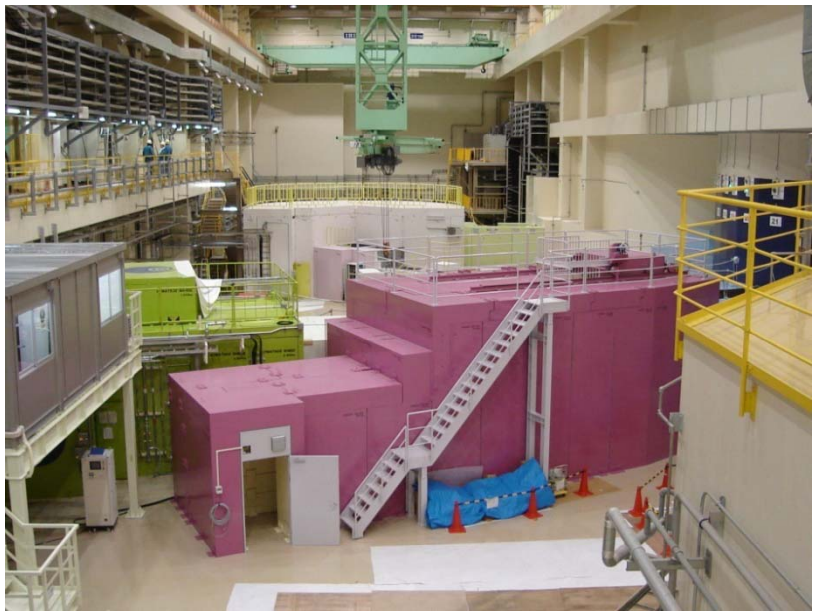
Dr. Akiba (AIST), received “Herbert C. Brown Award for Innovations in Hydrogen Research” in 2008.

Advanced basic technology for hydrogen storage materials

Total scattering spectrometer “NOVA” was constructed in Spallation Neutron source, J-PARC in 2009.

Commissioning works are underway.

In-situ measurements under H_2 environment will be available.



Research Center for Hydrogen Industrial Use and Storage

HYDROGENIUS
Hydrogen saves the Earth

Basic researches on hydrogen materials
- Embrittlement of materials
- Hydrogen tribology.

- Focus on a unique research base for hydrogen materials
- Experimentations in high pressure hydrogen environment (up to 100 MPa) is available
- 100 researchers from 9 countries
- 5 teams under Project Leader, Prof. Murakami Hydrogen dynamics in metal research, fatigue and fracture, simulation, thermophysical properties, tribology

HYDROGENIUS

Prof. Murakami, received “Nippon Keidanren Chirman’s Award” in 2009.

Concluding Remarks

- Residential fuel cell systems have been commercialized
  + Supported by subsidization by government

- Residential SOFC is under demonstration

- Basic research programs for innovation toward
  (full commercialization of residential fuel cells
  commercialization of FCV)
  + beyond