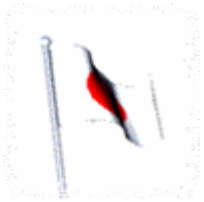
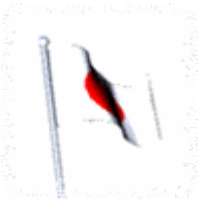
International Partnership *for the* Hydrogen Economy

IPHE Steering Committee Meeting in Brazil





Country Update

Japan's Approach to the Commercialization of Fuel Cell/Hydrogen Technology

April 2007

Hydrogen & Fuel Cell Promotion Office

Agency for Natural Resources and Energy

Ministry of Economy, Trade and Industry

Government of Japan

New Policy Initiatives on Hydrogen and Fuel Cell in Japan

New National Energy Strategy

The government is to actively engage in specific programs shown below for the various national challenges based on these, and manifest initiative so that the positive cycle of government-private sector efforts can be established at all levels of society.

(1) Establishing a state-of-the-art energy supply-demand structure

Energy Conservation Frontrunner Plan
Evolvement Plan of Transport Energy
New Energy Innovation Plan
Nuclear Power Nation Plan

(2) Strengthening diplomatic efforts and comprehensive measures to address energy and environmental issues

Energy and Natural Resources Securing Strategy
Asia Energy Environment Cooperation Strategy

(3) Improving emergency measures

Strengthening the Emergency Response

(4) Other common issue

Establishing the Energy Technology Strategy

New energy innovation program

Engage in the reinforcement of promotion measures according to the attributes and dissemination stages of each energy source

① Introduction support measures according to the attributes and growth stages of each energy source
→ Expand the supply and demand

② To promote regional businesses based on the local-production and local-consumption of solar, wind-power and biomass.
→ Form a substantial industrial structure for the new energy industry

③Promotion of the development and dissemination of innovative technologies
→ promote the intensive use of new energy

④ Expand the support for new energy ventures
→ explore innovative technologies

Next-Generation Vehicle Fuel Initiative:
～Simultaneous Achievement of Goals in Energy Security, Environmental Conservation and Increased Competitiveness～

1. Biofuel | 2. Clean diesel | 3. Next-generation batteries | 4. Fuel cells/hydrogen-fueled society

1. Biofuel

Two types of biofuel → Bioethanol blended with gasoline, and biodiesel blended with diesel oil

<Bioethanol>
•-Ethanol made by fermenting sugar content of sugarcane or corn
•Cost problems and supply instability arising from securing raw materials that can also be consumed as food
•-Medium and long-term need to develop cellulose-derived bioethanol made from scrap wood or straw
•<Biodiesel>
•-Fuel made by synthesizing vegetable oil such as rapeseed and palm oil
•-Need to develop hydrogenation technology for commercial use to prevent oxidization (decomposition)

Cellulose-derived biofuel

Promotion of the development of cellulose-derived biofuel made from raw materials not consumed as food


Ethanol fuel

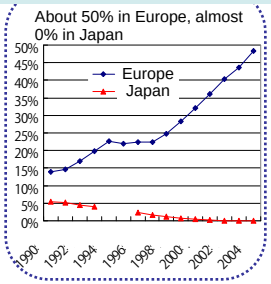
Waste wood → • Conversion into sugar using enzymes • Fermentation using yeast

2. Clean diesel

- Clean diesel-powered vehicles are about two times more fuel-efficient than gasoline-powered vehicles, making use of Japan's diesel oil, which is the cleanest in the world.
- Various other types of fuel, such as GTL fuel, can be used for clean diesel vehicles.

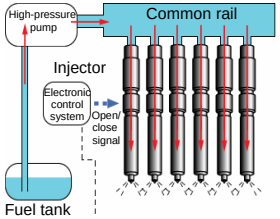
Share of diesel vehicles

About 50% in Europe, almost 0% in Japan



Common rail system

Electronic control of fuel injection systems has made possible cleaner gas exhaust



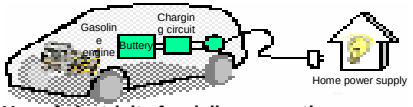
* GTL: Gas-to-liquid, fuel made from natural gas

3. Next-generation batteries

● Development of next-generation batteries will expand the potential of vehicles.

Next-Generation Vehicle Battery Development Project
Budget requested for FY2006: 5 billion yen

～ What is a plug-in hybrids vehicle?～



Use of electricity for daily commuting
(Significant cut of oil consumption)
Use of gasoline for long weekend drives

	Improved battery (2010)	Advanced battery (2015)		Innovative battery (2030)
	Compact electric vehicles for business use	Compact electric vehicles for family use	Plug-in hybrids vehicle	Standard-sized electric vehicle
				
Targeted battery performance	1	1.5		7
Targeted battery cost	1/2	1/7		1/40

Development of next-generation batteries (improvement in battery performance)

4. Fuel cells/hydrogen-fueled society

Sound promotion of the development of fuel cells, which will be the key for the creation of a hydrogen-fueled society through the transition from "carbon cycle" to "water cycle"


Hydrogen station

Hydrogen supply


Fuel cell vehicle

Hydrogen vehicles will play an important role in spreading the use of fuel cells and creating a hydrogen-fueled society.

Hydrogen vehicles

- Powered by way of the combustion of hydrogen instead of fossil fuel (e.g. gasoline)
- Producing very clean exhaust that contains almost nothing but water

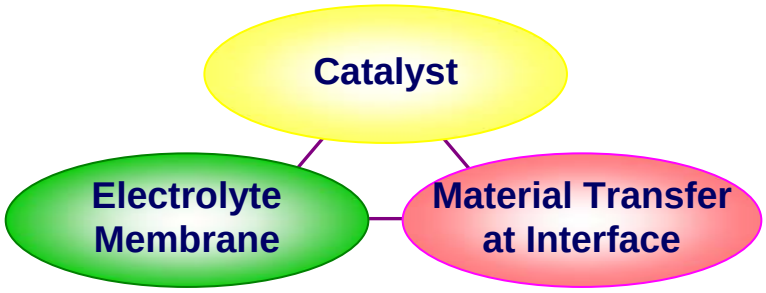
Country Update

Hydrogen and Fuel Cell R&D, Demonstration Project
Events & Solicitation &
Government Hydrogen and Fuel Cell R,D&D Funding

A National Lab. for Basic FC R&D

Polymer Electrolyte Fuel Cell Cutting-Edge Research Center (FC³ = FC-cubic)

- *Established on April 1, 2005*
- *Director of FC-cubic: Dr. Hiroshi HASEGAWA*
- *Budget: 1.0 billion yen for FY2007(1.2 billion yen for FY2006)*



AIST Depts.

METI

Close collaboration

Industry, Public, Academia

Basic Scientific Knowledge
↓
Innovation in R&D

A New National Lab. for Hydrogen Material R&D

In order to realize a hydrogen energy society, a new laboratory "HYDROGENIUS" was founded last June, which aims to establish basic technologies to use hydrogen more safely and conveniently.

Budget: 1.7 billion yen for FY2006

HYDROGENIUS was established on June 1, 2006.

Focus on a unique research base for hydrogen material

Director of HYDROGENIUS: Prof. Yukitaka Murakami

Organization of HYDROGENIUS

Director
Dr. Murakami, Y.

Deputy Director
Dr. Sasaki, K. (Research)
Mr. Ogata, T (General Affairs)
Dr. Yotsumoto, H. (Planning)

Research teams

Leader
Dr. Fukuyama

Hydrogen Dynamics in Metal Research Team

Leader
Dr. Matsuoka

Leader
Dr. Fujii

Hydrogen Fatigue and Fracture Team

Hydrogen Thermophysical Properties Team

Hydrogen Simulation Team

Hydrogen Tribology Team

Leader
Dr. Murakami

Leader
Dr. Sugimura

Prof. R.O. Ritchie
University of California, USA
(2007～)

Dr. Jean-Marc Olive
University of Bordeaux I, FRANCE
(2006.8.16～)

Dr. Veronique Doquet
Ecole Polytechnique, FRANCE (2007～)

Prof. Dan Eliezer
Ben Gurion University of The Negev, ISRAEL
(2006.10.5～10.15)

Prof. Petros Sofronis
University of Illinois at Urbana-Champaign, USA
(2006.6, 2007.1～2)

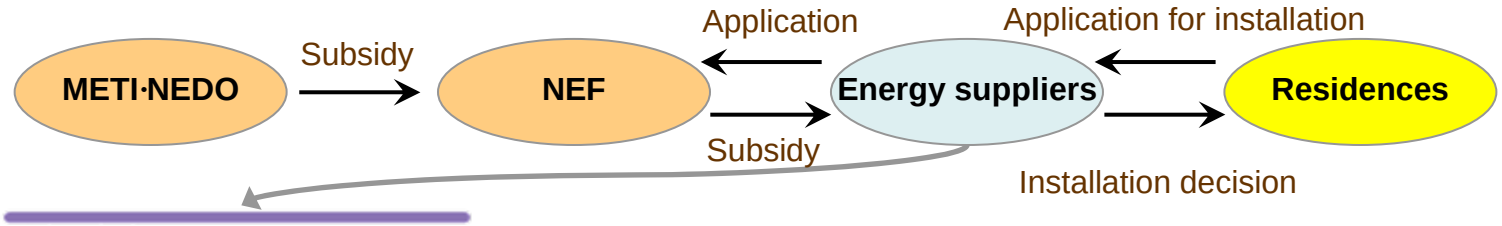
Prof. Richard P. Gangloff
University of Virginia, USA
(2007.1～2)

Dr. Sergiy M. Stepanyuk
Paton Electric Welding Institute of National Academy of Sciences UKRAINE
(2007.2.1～)

Dr. Brian P. Somerday
Sandia National Laboratories, USA
(2007.1～2)

Large-Scale Stationary Fuel Cell Demonstration Project

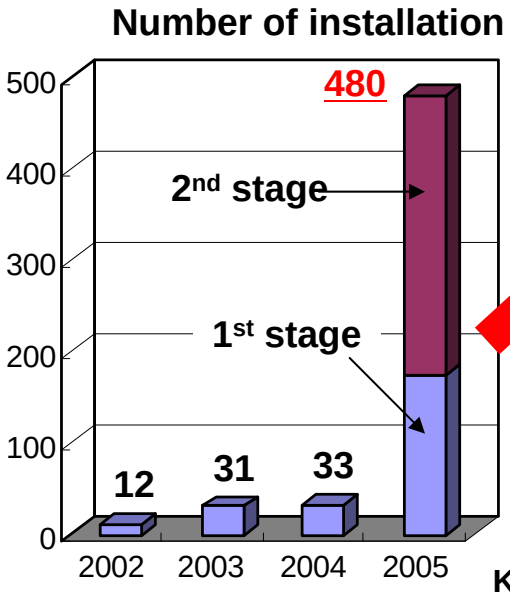
Provide feedback on various demonstration data, for research and development
Step up to mass production and inspection of learning curve
Price target: 1.2 million yen/system (in 2008)



Breakdown of installation (FY2005)

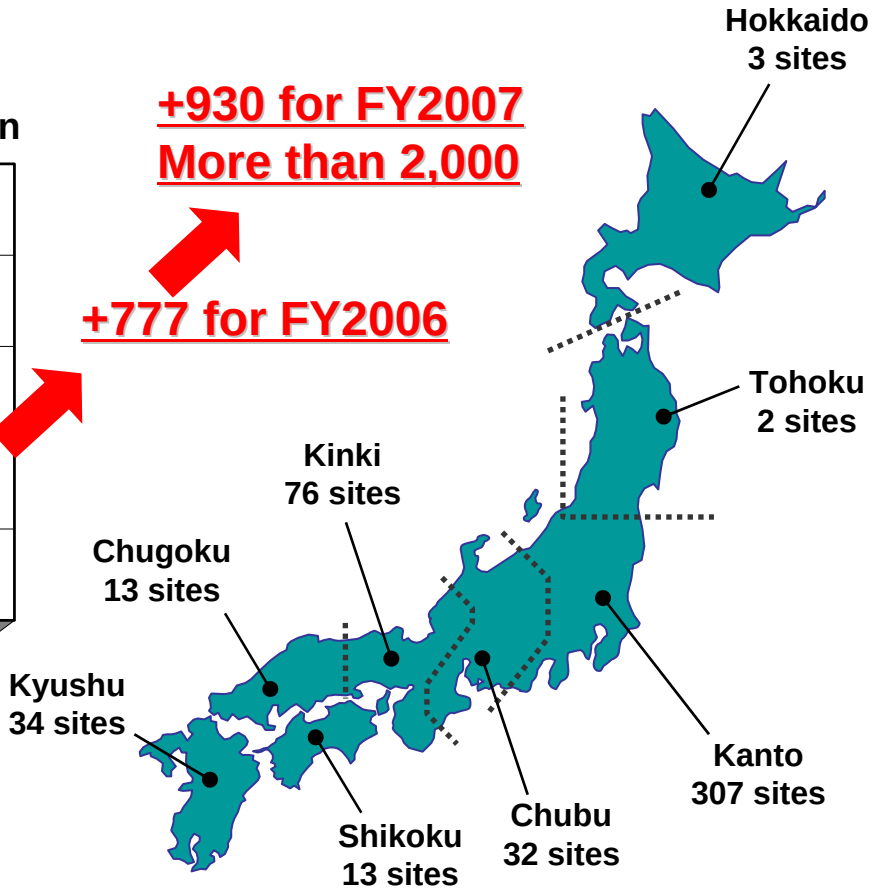
Energy supplier	1st stage	2nd stage
Tokyo Gas	67	83
Osaka Gas	28	35
Nippon Oil	44	90
Japan Energy	12	18
Idemitsu	8	25
Kyushu Oil	8	–
Taiyo Oil	8	–
Toho Gas	–	12
Saibu Gas	–	10
Iwatani	–	10
Cosmo Oil	–	10
Kamata (LemonGas)	–	6
Showa Shell Sekiyu	–	6
Total	175	305

In FY2005, up to 6 million yen per stationary FC for household is subsidized to the energy supplier.



+930 for FY2007
More than 2,000

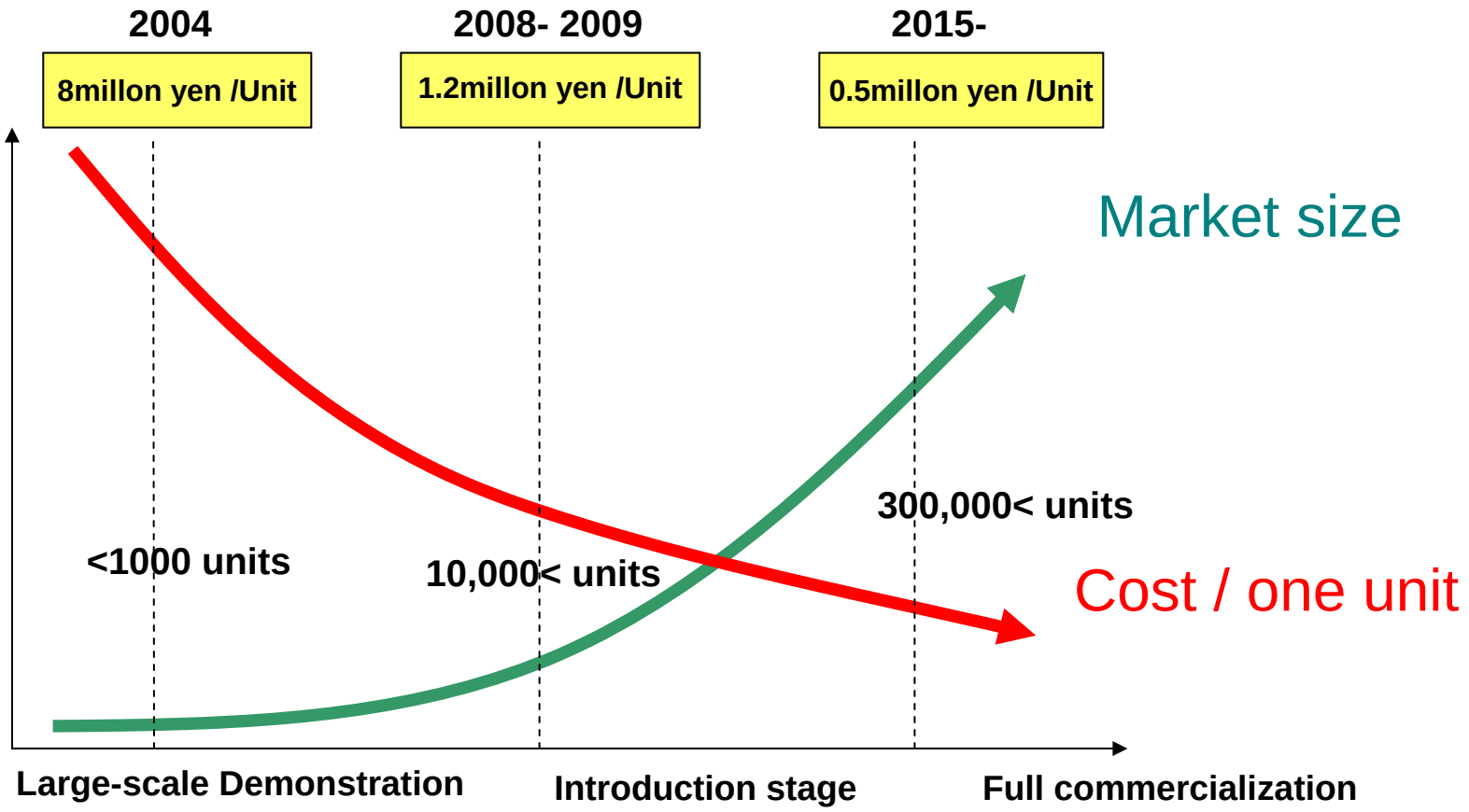
+777 for FY2006



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

Scenario of Market Creation for Residential Fuel Cell

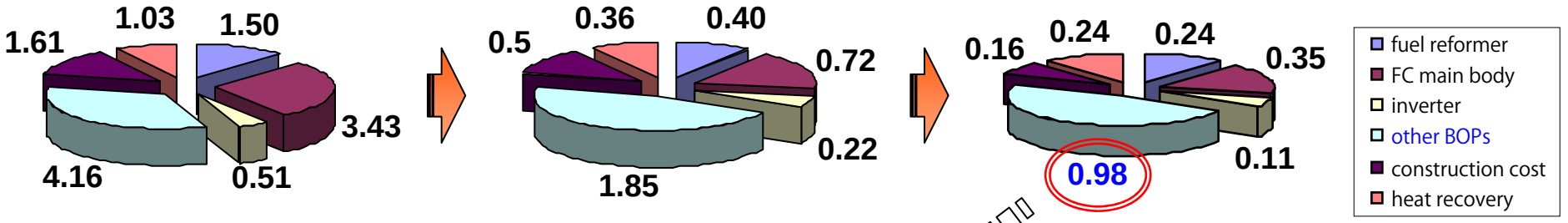
Large-scale Demonstration Project → Market creation by government support → Full commercialization Self sustained and growing market



Note: * means annual production rate

Strategy for Further Cost Reduction of BOP

Forecast of cost of 1kW PEFC system based on mass production (by major system makers)

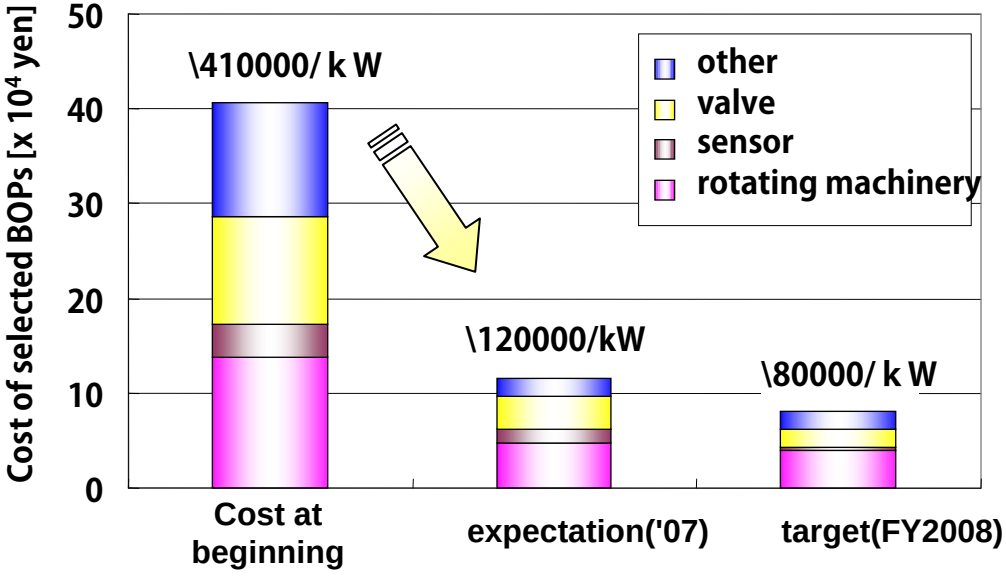


12.24 million yen (present)

4.04 million yen (1,000systems/year)

2.08 million yen (10,000 systems/year)

- 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 consequence of the effort in this R&D (’06～’07), drastic cost reduction has been achieved:**
￥410,000/kw ⇒ ￥120,000/kw

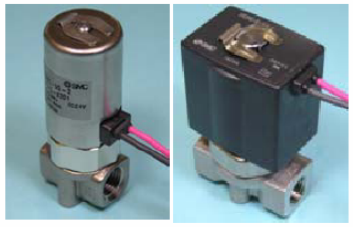
○ **By concentrated and continuous R&D, improvement of BOPs as well as the further cost reduction will be achieved**
\80,000/kw by FY2008

Wanted!!: New Entries in R&D Competition ！ for BOP ｓ of Stationary FC Cogeneration System

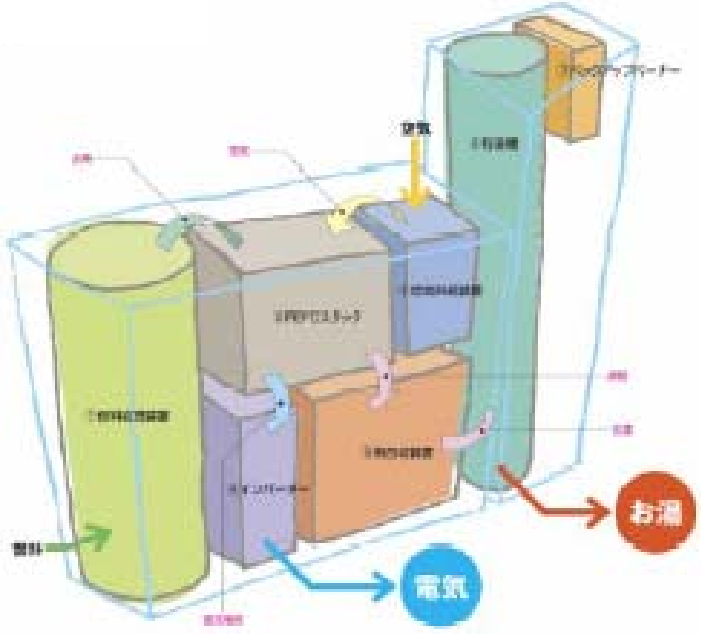
Specifications of BOPs required for stationary FC system can be seen at the website (http://meti.go.jp/press/20051227004/20051227/004.html)

Solenoid valves

電磁弁（SMC）



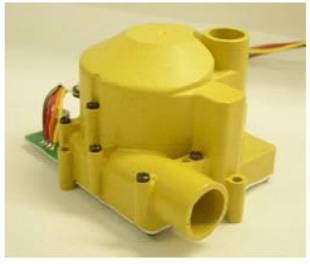
リリーフ弁（アイビーエスジャパン）



Precise pumps

Blowers

バーナ空気ブロワ（日本電産コパル電子）



燃料昇圧ブロワ（イワキ）

Pressure transducers

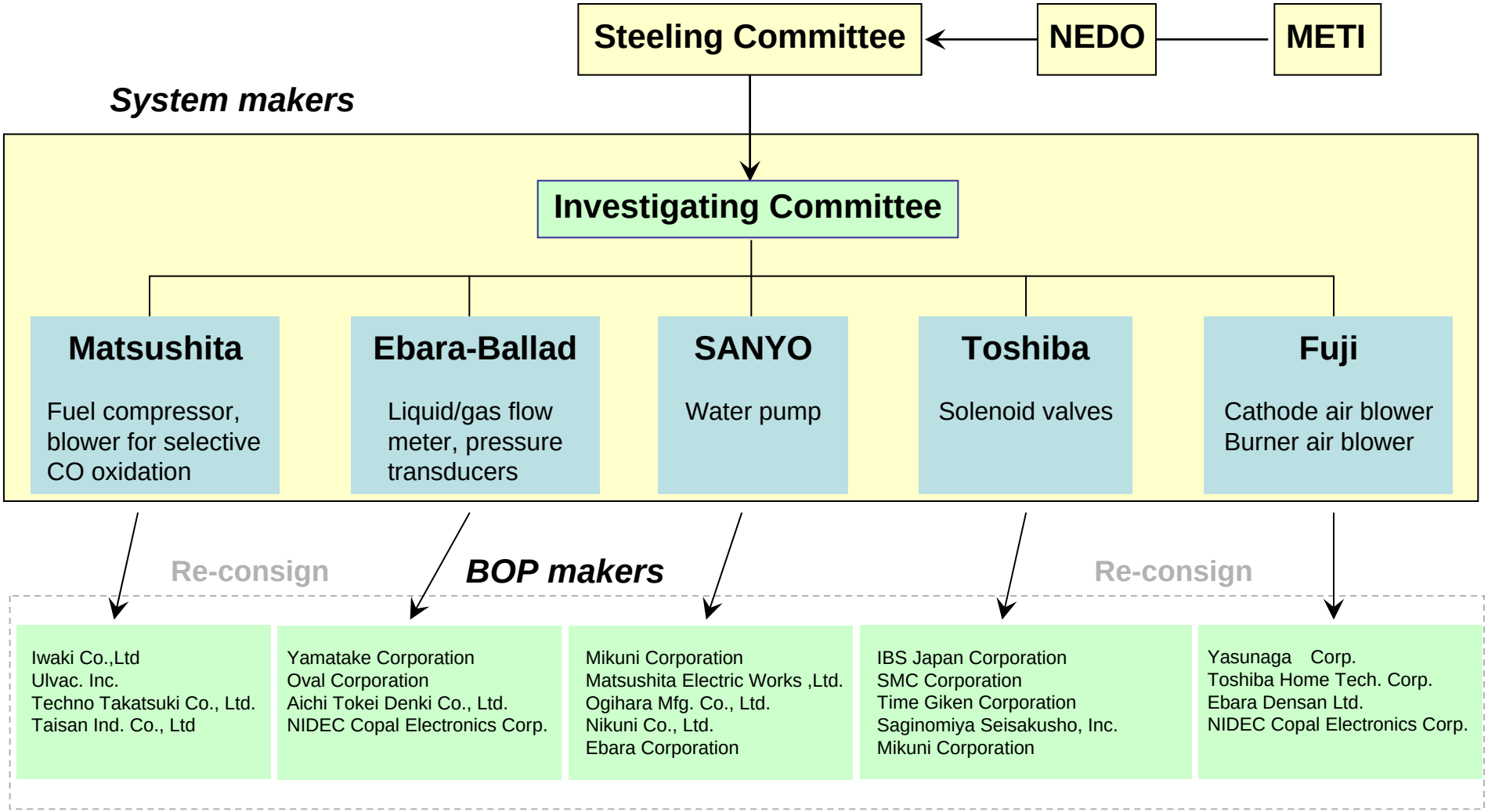
圧力センサー（日本電産コパル電子）

Flow meters

ガス・空気流量計（山武）

水流量計（愛知時計電機）

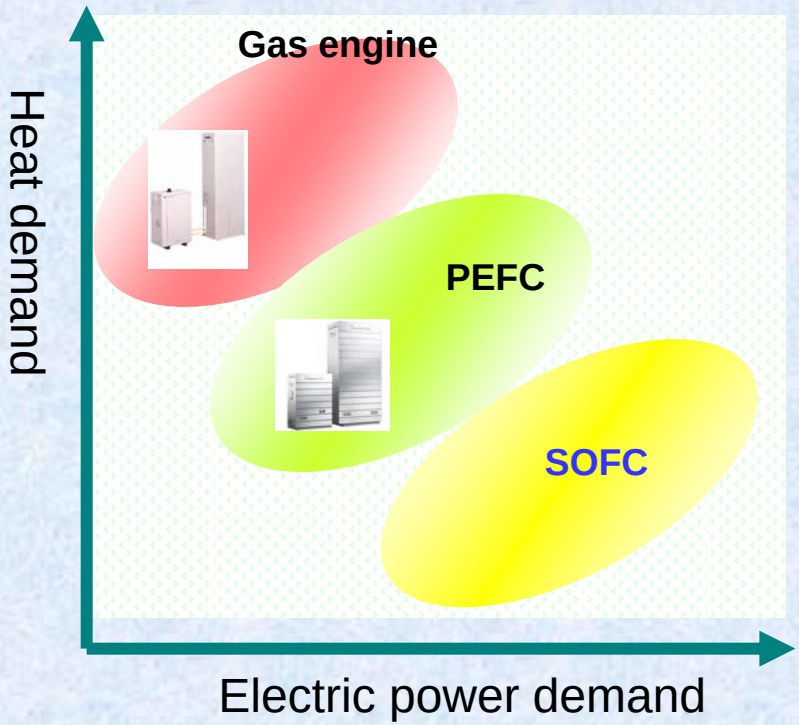
R&D organization for harmonization of BOP of stationary FC cogeneration system



Solid Oxide Fuel Cell (SOFC) Demonstration Project

Aiming at commercialization of residential SOFC co-generation system, demonstration project is started from FY2007 to accumulate our experience of practical operation of SOFC and extract technical subjects to be undertaken for further development of SOFC.

Characteristic of co-generation system for household



- **Budget: 0.77 billion yen for FY 2007**

Objectives

- **clarification of degradation of stack caused by high temperature operation**

(ca. 90 ℃ for PEFC, ca. 1000 ℃ for SOFC)

- **Accumulation of experience of practical operation of residential SOFC system**

Characteristic of SOFC

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

Demonstration of FCVs and H_2 Station (JHFC-2)

Identifying Issues and Improving Public Acceptance for Hydrogen Society

Hydrogen Infrastructure

H_2

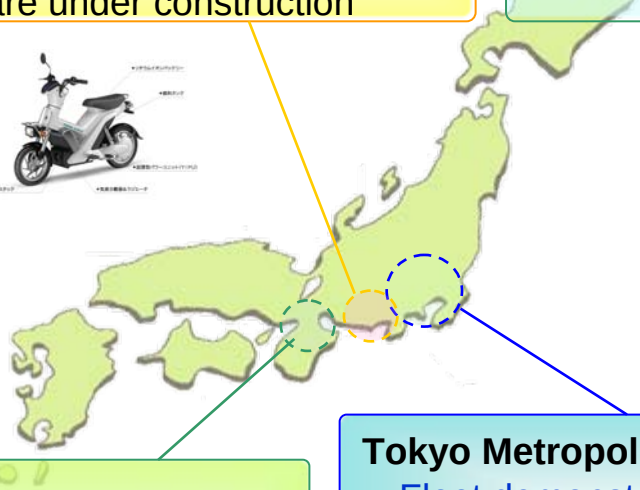
FCEV Demonstration Project

Kansai Area

- New applications and hydrogen station demonstration (Wheelchairs, FC motor-cycles)
- Emergency power source applications
- Hydrogen station suitable for cities
- Conventional hydrogen supply (Satellite stations)
- H_2 stations are under construction

Common

- PR・Educational activities
  Initiate and join events
  JHFC park event
- PR・Long-term strategy
  Proposal for educational curriculums in school and social education

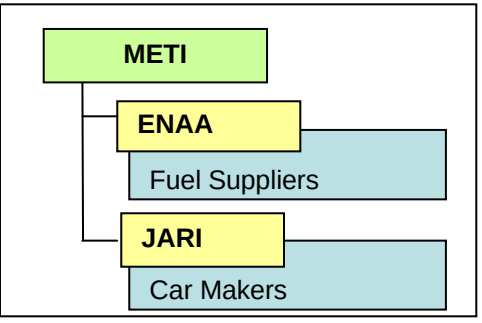


Chubu Area

- Fuel cell bus demonstration
- Hydrogen station test
- Natural gas reforming and off-site hybrid hydrogen station
- Two H_2 stations and three FCV

Tokyo Metropolitan Area

- Fleet demonstration by third party
- Verification of safety, reliability and performance improvements for various hydrogen sources and production methods
- Nine H_2 stations and fifty FCVs



ENAA: Engineering Advancement Association of Japan
JARI:: Japan Automobile Research Institute

Date : Feb. 7 (Wed.) - 9 (Fri.), 2007
10:00-17:00

Venue : Tokyo Big Sight, Japan

Concurrent Event : FC EXPO Technical Conference
Academic Forum

Organised by : Reed Exhibitions Japan Ltd.

Co-organised by :
Hydrogen Energy Systems Society of Japan (HESS)
Fuel Cell Development Information Center (FCDIC)

EHA EUROPEAN HYDROGEN ASSOCIATION

US Fuel Cell Council www.usfcc.com

Fuel Cell World

TFCI 台灣燃料電池資訊網

DWV Deutscher Wasserstoff- und Brennstoffzellen-Verband

Fuel Cell Europe

SCOTTISH Hydrogen & Fuel Cell ASSOCIATION

CAHE 中国氢能学会 China Association for Hydrogen Energy

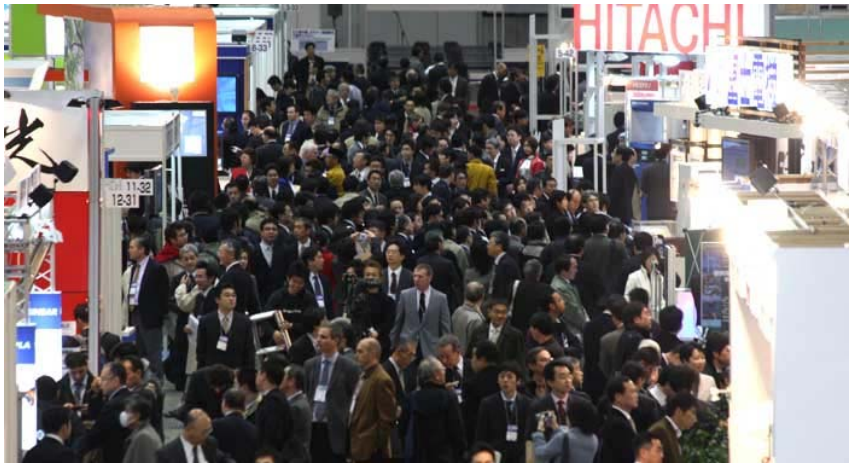
http://www.fcexpo.jp/

Numbers of visitors:

2005 : 20,037
2006 : 23,039
2007 : 24,494

Numbers of exhibitors:

2005 : 237
2006 : 404
2007 : 462



Exhibitions of leading companies from Japan and abroad

Serious business discussions and technical consultations

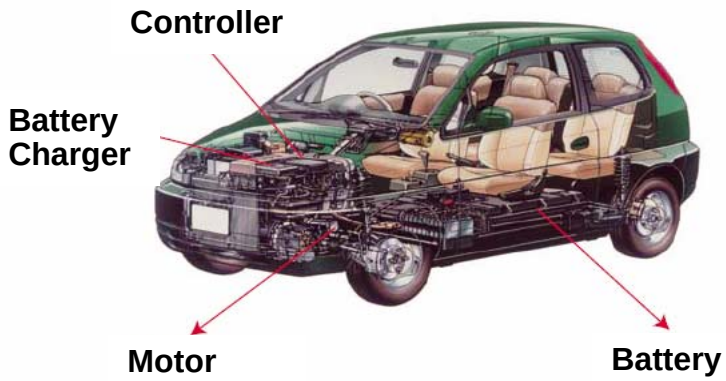
JHFC Demonstration Project (Fuel Cell Vehicle)

FC EXPO Keynote session

Strategic R&D of next generation secondary battery system for practical use

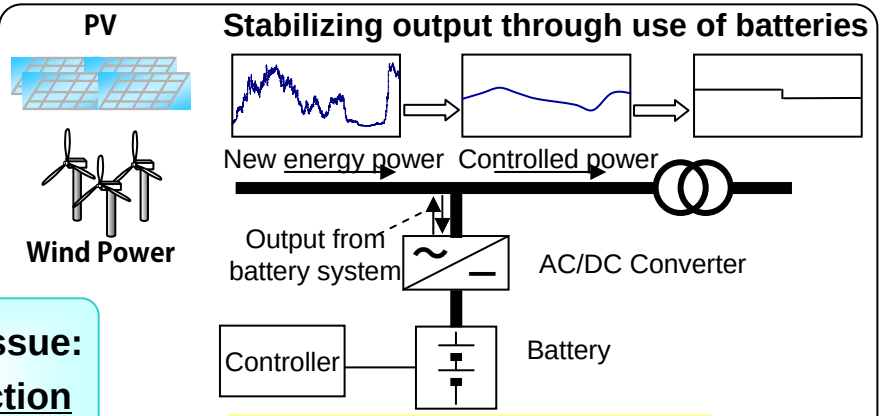
Budget: 4.9 billion yen for FY 2007
Project year: 2007- 2011

Stabilize output of new energy sources (PV, Wind power) and enhance introduction of hybrid cars, EV and FCVs by developing low cost and reliable battery systems



Issues: High energy and output density

Common issue: cost reduction



Issues: Scale-up, durability

Development Items

-**Battery system to enable grid connection**

Technical solutions for cooling, higher voltage and manufacturing processes for low-cost, long-life and maintenance-free MWh-class systems

- High-performance battery for next generation car

Development of materials for lithium battery, modules and BOPs (power controller, motor,etc.) applicable to plug-in hybrid vehicles, commuter EVs and FCVs

- Next-generation battery technology

Development of new materials or battery systems to enable breakthroughs in cost and performance

- Basic technology for battery

Establish basic technologies such as lifespan prediction, durability and safety tests, standardization, and analytical methods

- Ultra-high reliable lithium battery

New attempt: Strategic Promotion of R & D for Renewable Energy Introduction through Small Business Innovation Research Program

[What's SBIR and why?]

SBIR is a highly competitive program which encourages small business to explore their technological potential and provides the incentive to profit from its commercialization. By including qualified small businesses in the nation's R&D arena, high-tech innovation is stimulated and Japan gains entrepreneurial spirit as it meets its specific research and development needs.

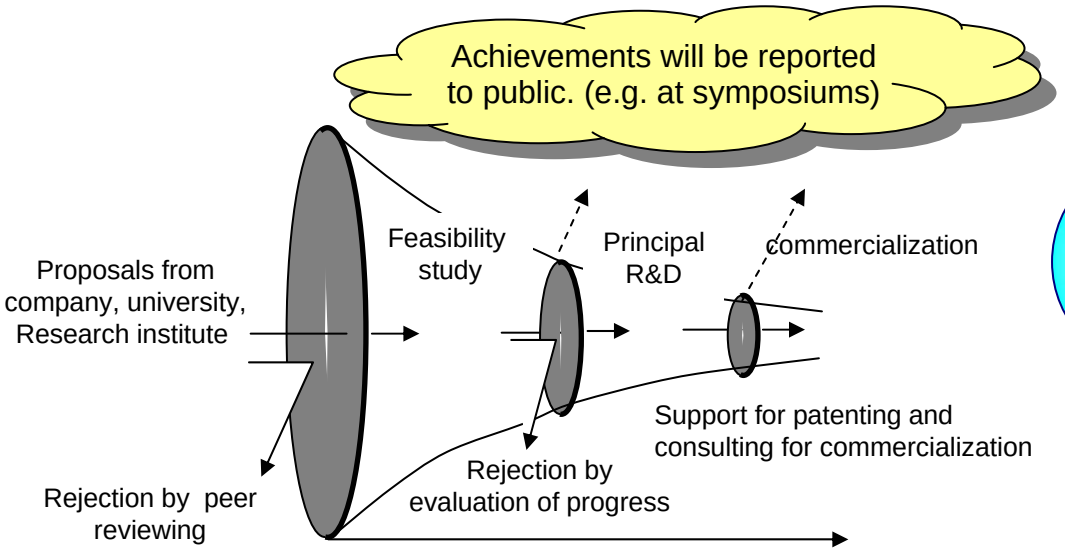
[Target and areas]

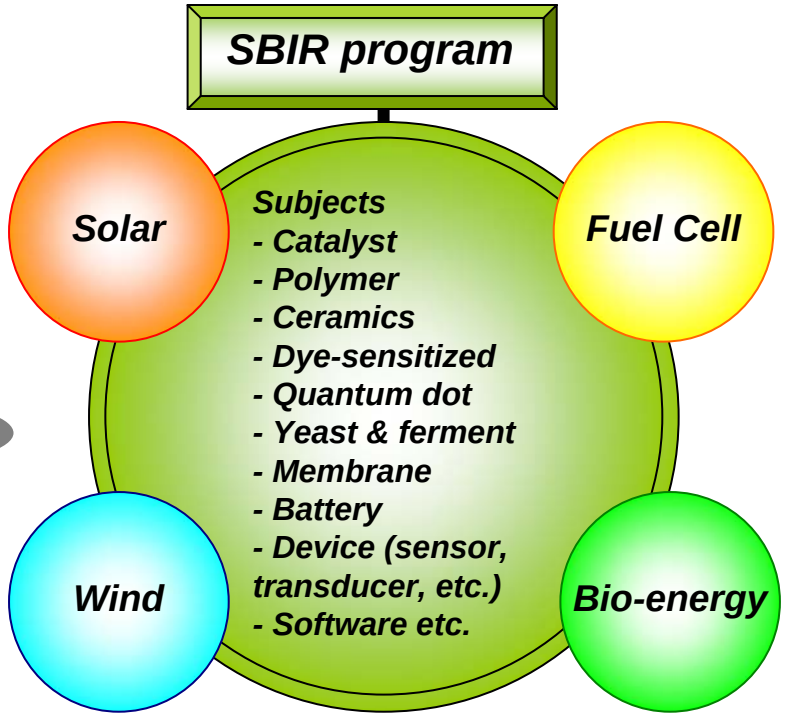
Small- and medium-companies, universities, and research group that which have a strong venture-capitalism in the new energy businesses such as solar energy, wind energy, tidal energy, geo-thermal, biomass energy as well as other related technologies for reliable and efficient utilization of new energy such as fuel cell and battery.

[Scheme]

Phase 1 (Feasibility study) [up to $90,000]
Phase 2 (Principal R&D) [up to $900,000]
Phase 3 (Commercialization)

- ○ Private sector funding
- ○ Government continue R&D as main project





These subjects are complementary to main R&D projects for new energy introduction but crucial for innovation and breakthrough for existing status of technology.