# Overview of Scenario, Roadmap and R&D projects of Hydrogen and FCV in Japan

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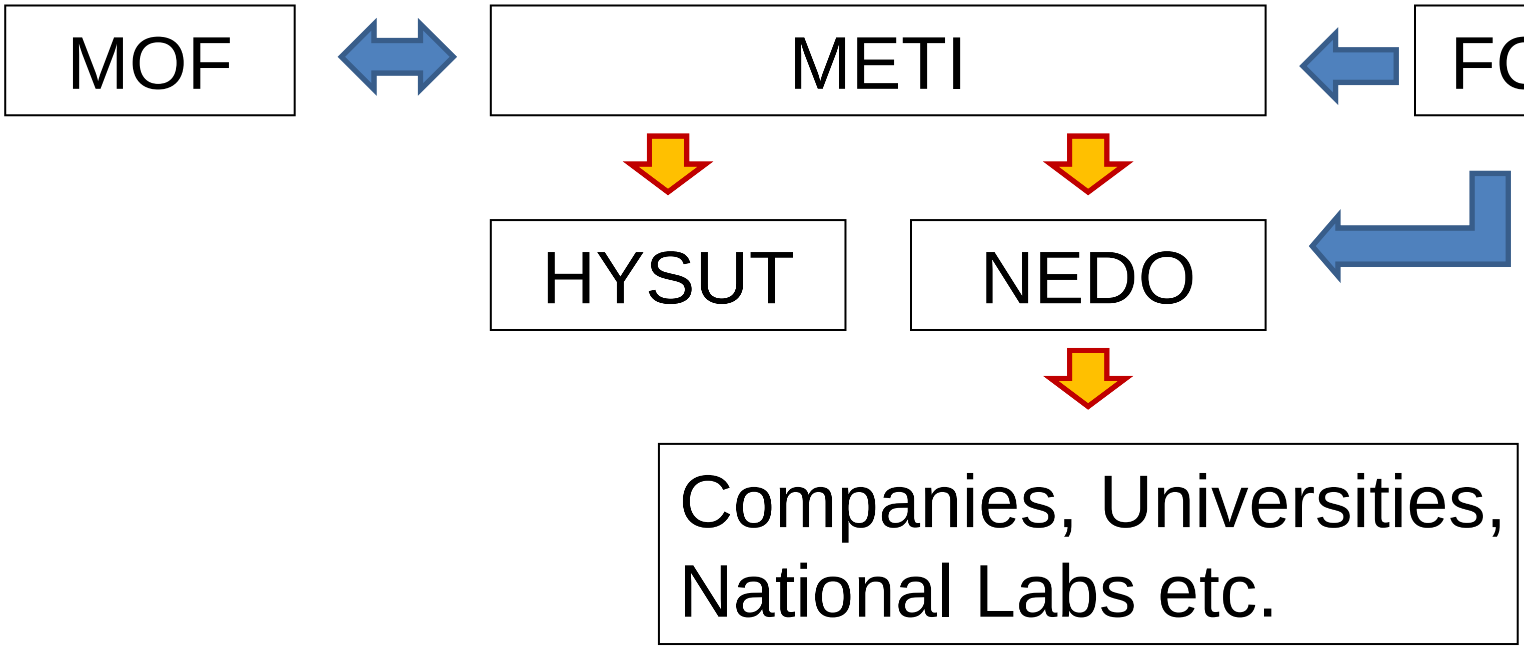
# Framework for R&D of Hydrogen and Fuel Cells under METI & NEDO in Japan

**Policy planning**
Hydrogen and Fuel Cell Promotion Office
METI (Ministry of Economy, Trade and Industry)

**R&D program planning, funding and managing**
Fuel Cell and Hydrogen Tech. Devel. Depart.
NEDO

**R&D Project**
Companies, Universities, National Labs etc.




FCCJ : Fuel Cell Commercialization Conference of Japan
FCCJ was established on March 19, 2001 as a conference to study and discuss at a nongovernmental level the commercialization and commercialization of fuel cells. FCCJ’s major activities include making proposals regarding verification tests for fuel cell vehicles, hydrogen infrastructure and stationary fuel cells; identifying technological development issues for fuel cells and creating and proposing roadmaps; discussing fuel cell introduction scenarios and making proposals to the ministries concerned regarding standardization and review of regulations.

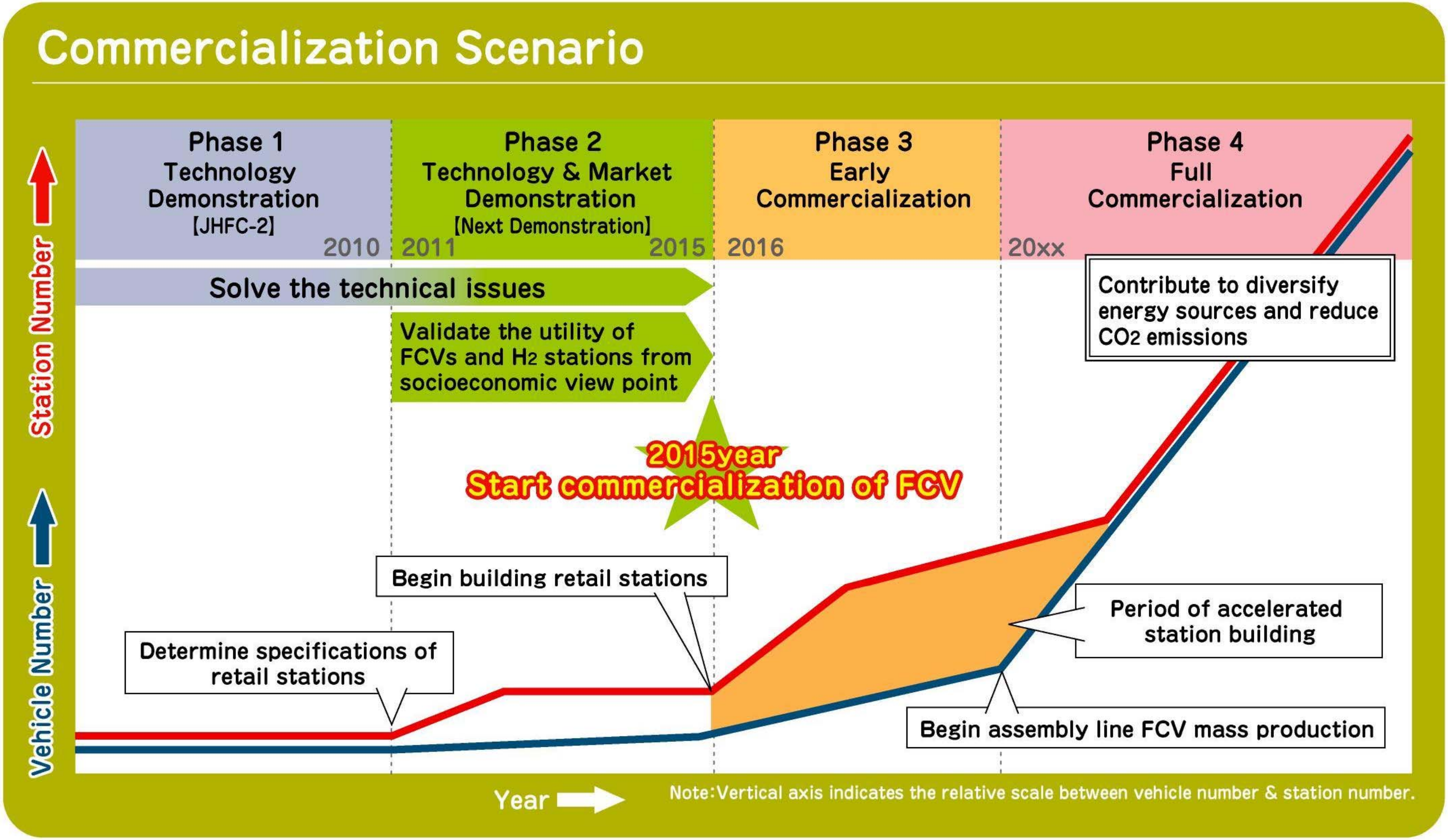
FCCJ press release on July 4, 2008

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.

They have also identified the challengers facing future energy diversification and post-Kyoto Protocol talks.

Under METI (Ministry of Economy, Trade and Industry), activities for overcoming the challenges are being accelerated through the Japan Hydrogen & Fuel Cell Demonstration Project, through promotion of technology development programs led by NEDO (New Energy and Industrial Technology Development Organization), through investigations into a large scale pilot project, and through other unique initiatives by individual energy automobile companies.

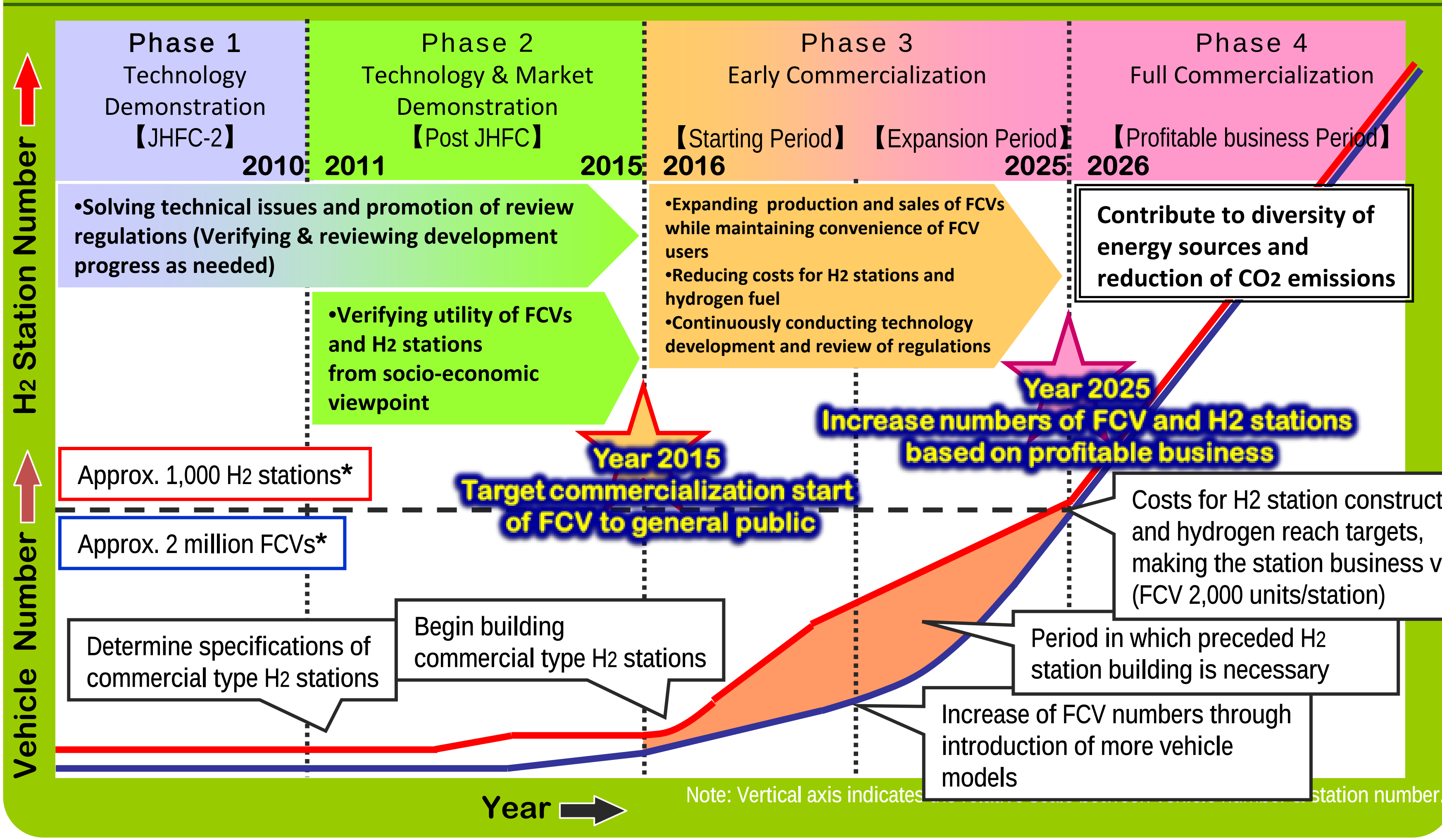
Commercialization of fuel cell vehicles and hydrogen stations to commence in 2015




Major member companies of the FCCJ board

Toyota Motor, Honda Motor, Nissan Motor, General Motors Asia Pacific (Japan), Mercedes-Benz Japan, Nippon Oil, Tokyo Gas, Osaka Gas, Idemitsu Kosan, Cosmo Oil, Japan Energy, Showa Shell Sekiyu

# Commercialization Scenario for FCVs and $H_2$ Stations




* **Precondition: Benefit for FCV users (price/convenience etc.) are secured, and FCVs are widely and smoothly deployed**

# NEDO's Mission and Approach

## Mission

As Japan's largest funding agency promoting research and development as well as the diffusion of energy, environmental, and industrial technologies, NEDO has a crucial mission to carry out.

- Addressing energy and global environmental challenges
- Enhancement of industrial competitiveness

## Approach

Based on the goals of outcome oriented and user friendly operation, NEDO, a professional research and development management organization, employs a Plan-Do-See (PDS) approach.

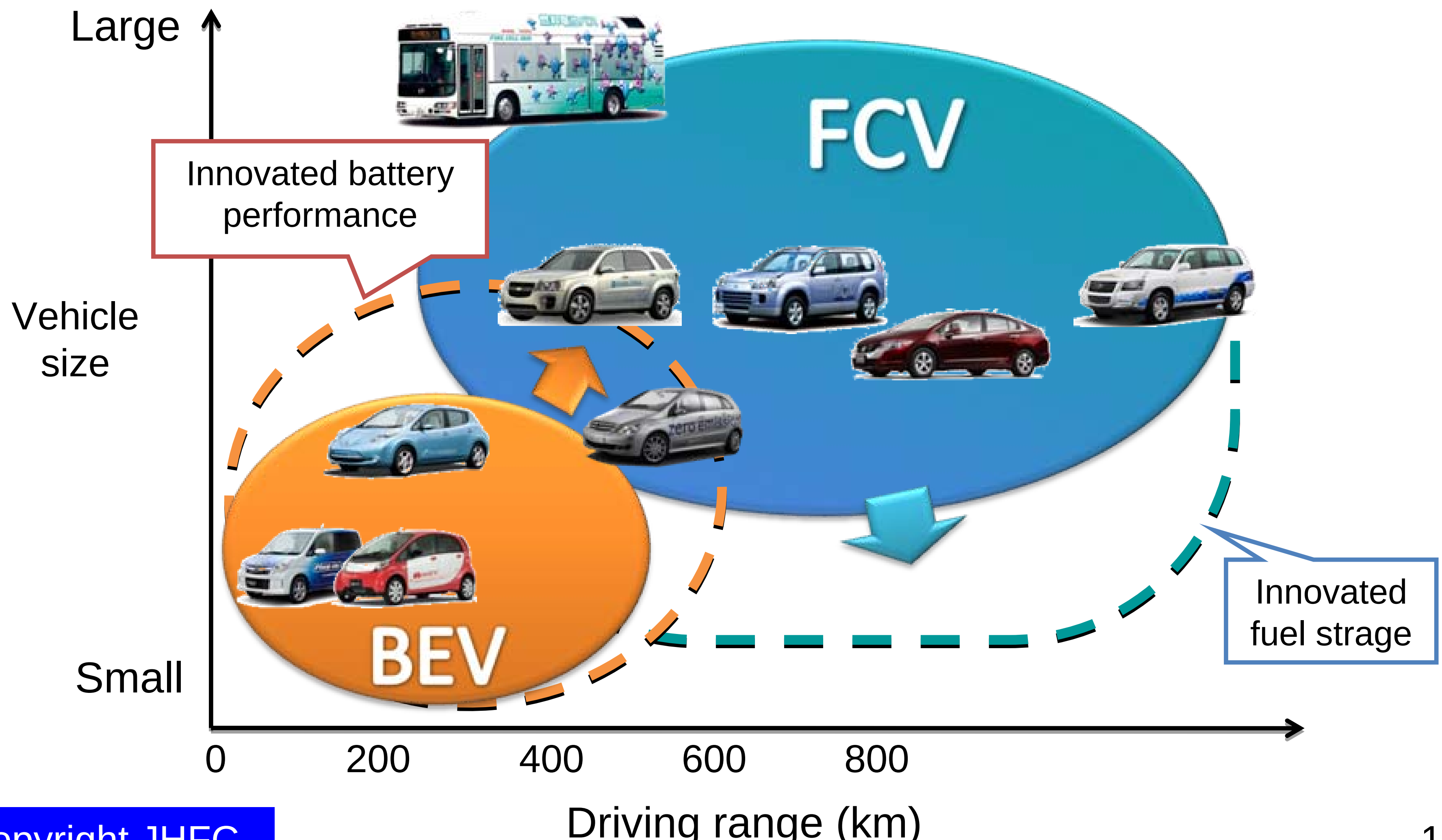
- Promotion of R&D through "Selecting and Focusing"
- Flexible and agile project management through rigorous evaluations

# FY2010 Budget for R&Ds of Hydrogen and Fuel Cells managed by NEDO (in million Yen)

| | | |
|---|---|---|
| R&D program of PEFC | FY2010-FY2014 | 5,100 |
| R&D program of hydrogen production, delivery, storage and refueling system | FY2008-FY2012 | 1,350 |
| R&D of hydrogen storage material (HYDROSTAR project, Leader : Dr. Akiba) | FY2007-FY2011 | 900 |
| R&D of hydrogen embrittlement and tribology (HYDROGENIUS project, Leader : Prof. Murakami) | FY2006-FY2012 | 1,000 |
| D of FCV and refueling station (JHFC project, Chair of Steering Comm.: Dr. Ishitani) | FY2006-FY2010 | 870 |
| R&D program of SOFC | FY2008-FY2012 | 800 |
| D of residential SOFC | FY2007-FY2010 | 662 |
| Total | | 10,682 |

# Segmentation of FCV and BEV

- FCV can replace existing gasoline vehicle in aspects of vehicle size and driving range.
- For small and short-distance applications, BEV and FCV can coexist to spread more widely.



# Objectives of JHFC Phase 2

1. To clarify remaining issues under the actual using conditions.
2. To collect data to develop regulations, codes and standards.
3. To formulate and implement public relations and educations for dissemination and promotion.
4. To verify the energy savings (fuel economy) and environmental impact
5. To identify technology and policy trends of FCV's, fuel cell powered small vehicles and hydrogen ICV's as well as hydrogen infrastructures

# Features of JHFC Phase 2

Fleet tests by third parties

Increase of hydrogen users ( not limited to FCV's but small FC carriers and hydrogen ICV's )

Area extension ( metropolitan Tokyo, Nagoya and Osaka )

Operation of FC buses and hydrogen station in Centrair Airport region

Operation of FC wheel chairs, FC carts and FC-assisted bicycles and operation of hydrogen stations for them in Osaka region

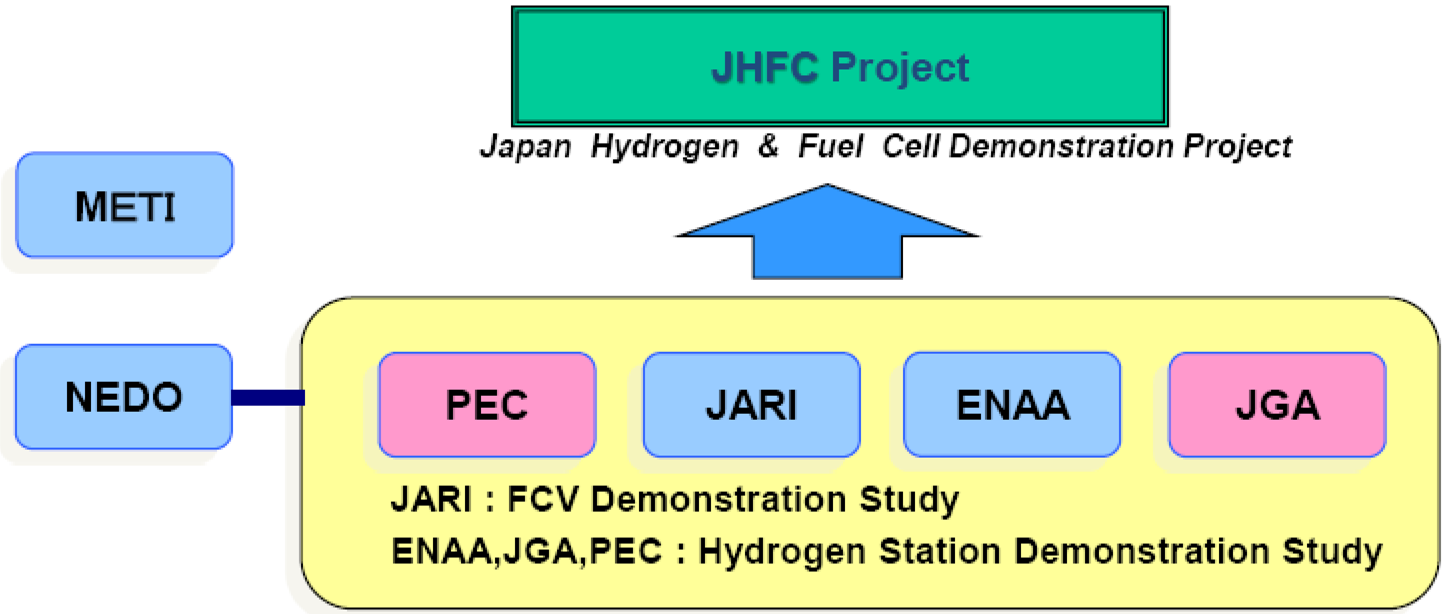
# Important points

- Progress
  - 8-year operation without serious accidents
  - Various outreach activities
  - Demonstrating technical advances
- Challenges
  - 70 MPa infrastructure technologies
  - Cost reduction ( vehicles and stations )
  - Codes and standards

# Organizational Framework of JHFC

JHFC consists of demonstrations of FCVs and hydrogen stations financially supported by NEDO & METI.

From FY2009 on, PEC and JGA, representing oil industries and city gas industries respectively, have been involved in JHFC.




| | |
|---|---|
| METI : | Ministry of Economy, Trade and Industry |
| NEDO : | New Energy and Industrial Technology Development Organization |
| PEC : | Japan Petroleum Energy Center |
| JARI : | Japan Automotive Research Institute |
| ENAA : | Engineering Advancement Association of Japan |
| JGA : | The Japan Gas Association |

# Steering of Current JHFC Phase 2

**Planning and Promotion Committee**
Chairperson : Prof. Hisashi Ishitani
Vice Chairperson : Prof. Ken Okazaki

- **WG1 : Hydrogen Supply Infrastructure**
  Chairperson : Prof. Takeshi Okazaki
  Vice Chairperson : Prof. Masanori Monde
- **WG2 : Fuel Cell Vehicle**
  Chairperson : Prof. Youichi Hori
- **WG3 : Interface Area between Vehicle and Infrastructure**
  Chairperson : Prof. Yasuo Takagi
  Vice Chairperson : Prof. Masanori Monde
- **WG4 : Promotion of Awareness**
  Co-Leader : Mr. Noriaki Osao
  Co-Leader : Mr. Katsumi Yoshida
- **WG5 : International Collaboration**
  Advisor : Prof. Hisashi Ishitani
  Leader : Dr. Shogo Saegusa
- **WG6 : Demonstration in Local Areas**
  Leader : Mr. Jin-ichi Tomuro

# JHFC Participating Companies

**Auto manufacturers: 8** | **Energy & Infra. Related companies : 16**

| Auto manufacturers | Energy & Infra. | Energy & Infra. |
|---|---|---|
| TOYOTA | | SINANEN |
| NISSAN | ENEOS | ITOCHU ENEX CO.,LTD. |
| HONDA | | TOHO GAS |
| Mercedes-Benz | TOKYO GAS | OSAKA GAS |
| GM | Iwatani | KANSAI |
| HINO | JAPAN AIR GASES | JOMO |
| SUZUKI | TAIYO NIPPON SANSO The Gas Professionals | IDEMITSU |
| mazda | Nippon Steel Corporation | KURITA |

# JHFC Participating Vehicles

**6 FCVs, FC Bus and Hydrogen ICV have been participating**

Toyota FCHV-adv

Nissan X-TRAIL FCV

Honda FCX Clarity


Mercedes Benz A-Class F-Cell


GM HydroGen3

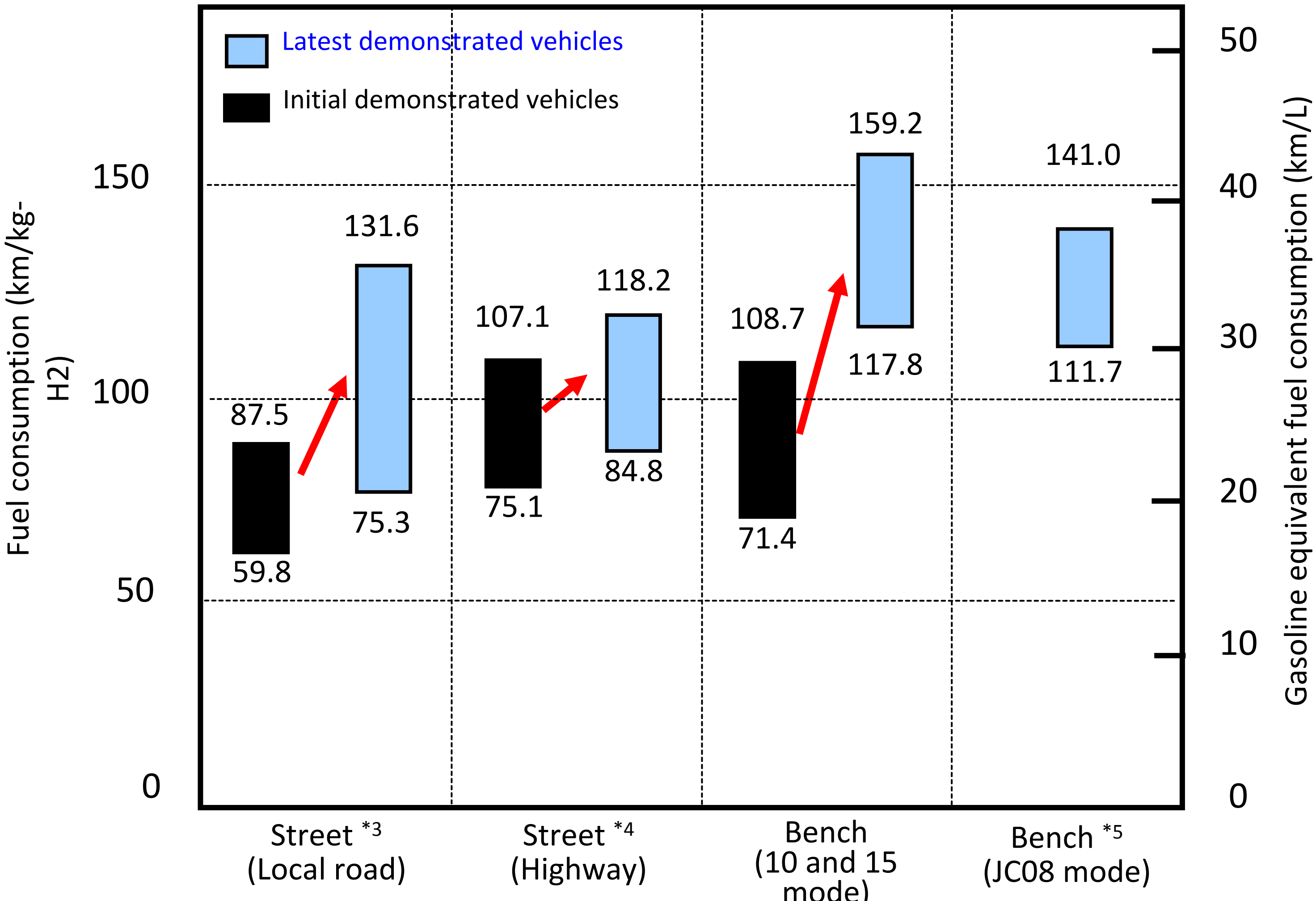

Suzuki SX4-FCV

Mazda RX-8 Hydrogen RE

Toyota/Hino FCHV-BUS

# Result of Street Fuel Economy Test

- Latest demonstrated vehicles have improved fuel economy steadily in both local road and highway.



# Current cost of Major Components

| | Current cost (million yen) | Parameter*) dependence |
|---|---|---|
| Reformer | 150 – 186 | No |
| Compressor | 50 – 110 | Yes (strong) |
| High-pressure storage cylinders | 39 - | Yes (very strong) |
| Dispenser | 15 - | Yes (fairly strong) |
| Pre-cooler | 17 - | Yes (fairly strong) |
| total | roundly 300 - | Yes (250 million yen difference between 35 MPa and 70 MPa stations) |

Construction, piping and wiring costs are extra.
*)parameter : filling pressure, filling period, filling method
Results cannot be directly compared with those previously disclosed in the JHFC product.

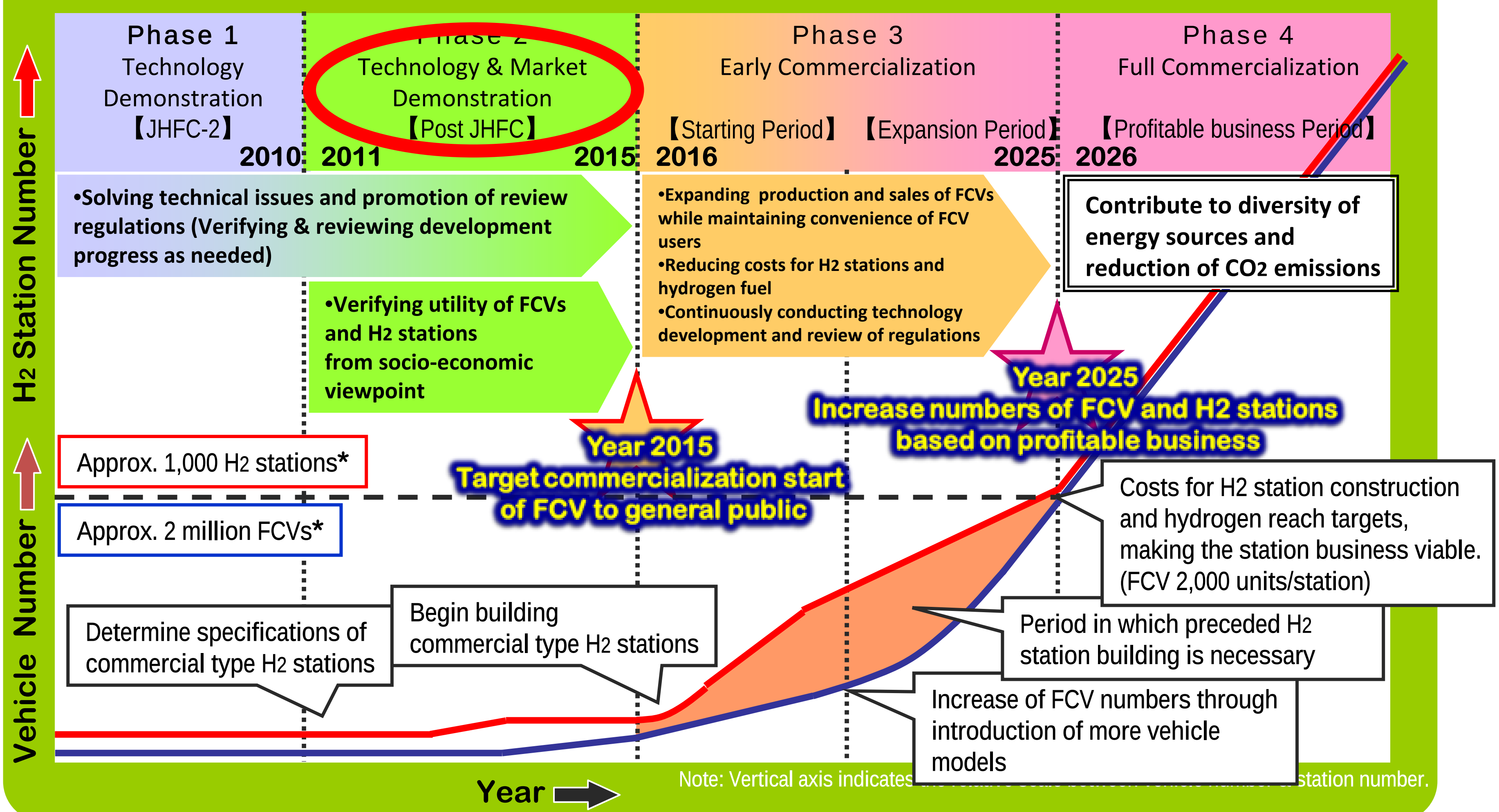
Further cost reduction is definitely necessary.

# Cost Reduction Feasibility

| | |
|---|---|
| Reformer | Simplified system, reduction of parts<br>Target is 50% of current cost. |
| Electrolizer | Key components (electrode, separator),<br>power supply, rectifier |
| Compressor | Cylinder type, oil-driven booster, &c. |
| High-pressure storage cylinders | Large-scale cylinder,<br>mass production through standardization,<br>cost reduction using material other than steel,<br>number reduction through the combination of cascade and compressor-drive filling. |
| Dispenser | Target is 50% of current cost. |
| Common (parts & equipments) | Imported parts,<br>similar equipment widely used |
| Others | Layout optimization,<br>cost reduction of general installation at the site. |

Investigation to be continued.

# Commercialization Scenario for FCVs and $H_2$ Stations




* Precondition: Benefit for FCV users (price/convenience etc.) are secured, and FCVs are widely and smoothly deployed

# Milestones in NEDO Roadmap, unfixed

## FCV

| year | 2010 | 2015 | 2020 | 2030 |
|---|---|---|---|---|
| vehicle efficiency % (HHV / LHV) | 45 / 55 | 51 / 60 | 51 / 60 | more than 51 / 60 |
| durability (hour) | 2,000 | 5,000 | 5,000 | 5,000 |
| FC system cost (million. Yen) | more than 10 | 1 | 0.8 | 0.5 |

Cost estimated on the assumption that annual production of FCV is 0.5 million.

## Hydrogen Station

| year | 2010 | 2015 | 2020 | 2030 |
|---|---|---|---|---|
| station cost (M yen) (300 $Nm^3$/h) | 1,000 (70MPa) 500 (35MPa) | 400 (70MPa) 300 (35MPa) | 200-300 | 150 |
| hydrogen cost (yen/$Nm^3$) | 120 | 90 | 70 | 60 |