

PATH HYDROGEN WORKSHOP IN MEXICO.

**HYDROGEN AND FUEL CELL
ACTIVITIES IN JAPAN**

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HYDROGEN ENERGY SYSTEMS SOCIETY OF JAPAN

PRESENTATION. OVERVIEW

- **Japan's strategy for hydrogen infrastructure and fuel cell development**
- **Status of FCVs and fuel cell development**
- **Development of hydrogen technologies in the national WE-NET program**
- **Development of hydrogen refueling stations**
- **Perspective on fuel cells and hydrogen infrastructure**

**JAPAN. S STRATEGY FOR HYDROGEN
INFRASTRUCTURE AND FUEL CELL
DEVELOPMENT**

STRATEGY FOR HYDROGEN & FC DEVELOPMENT

METI. s strategy: Focus on commercialization of fuel cells, fuel cell vehicles and hydrogen infrastructure, and set the targets in 2001.

- **Targets for market introduction**

Year	FC vehicles	Stationary FC
2010	50,000	2,100 MW
2020	5 million	10,000 MW

- **Targets for the development of practical FC technologies (Cell performance, system efficiency, life time etc)**
- **Issues to be solved for H2 and FC commercialization (Cost reduction, fuel infrastructure, deregulation etc)**
- **Partnership of the government, industry and academia**

TECHNICAL AND COST TARGETS FOR FUEL CELLS

Efficiency	<ul style="list-style-type: none">- FC stack: >55% HHV (direct hydrogen)- FC system: >40% HHV (reformate gas)
Life time	<ul style="list-style-type: none">- Stationary FC: >40,000h- Vehicular FC: >5,000h
Cost	<ul style="list-style-type: none">- Residential FC: \ 300,000/unit (1kW system) (\$ 2,500/unit)- On-site FC: \ 150,000/kW (\$ 1,250/kW)- Vehicular FC: \ 5,000/kW (\$ 41.6/kW)

ISSUES TO BE SOLVED FOR COMMERCIALIZATION

1. High performance and low cost system

- High efficiency, compact, light weight
- Low cost
- Long life

2. Fuel infrastructure

- Hydrogen refueling stations

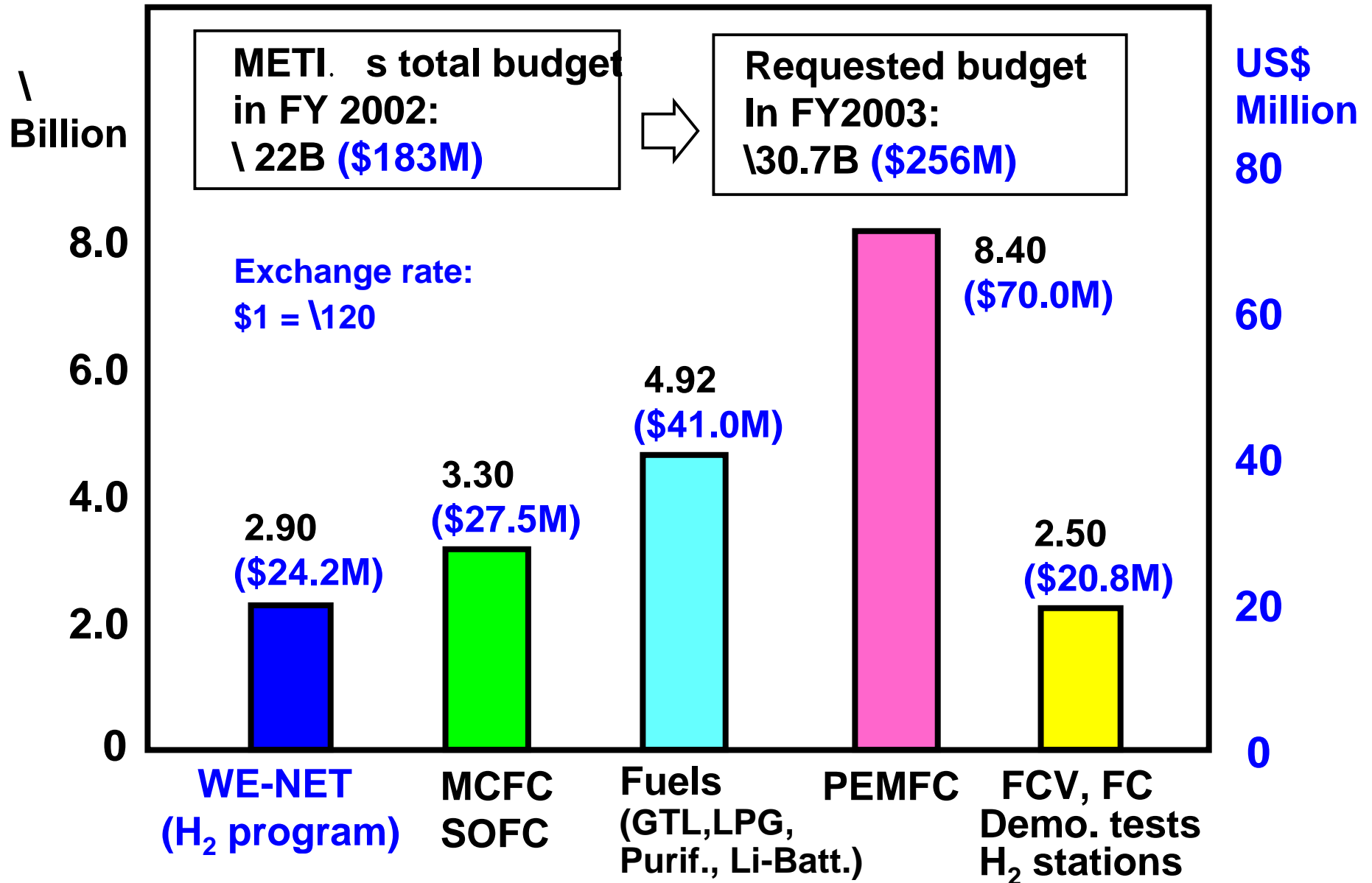
3. Codes and standards to be made till 2005

- Safety standards
- Test procedures
- Deregulation

4. Others

- Limitation of Pt resources
- Public acceptance

R&D FUNDING IN FY2002 ON FCS AND FUELS

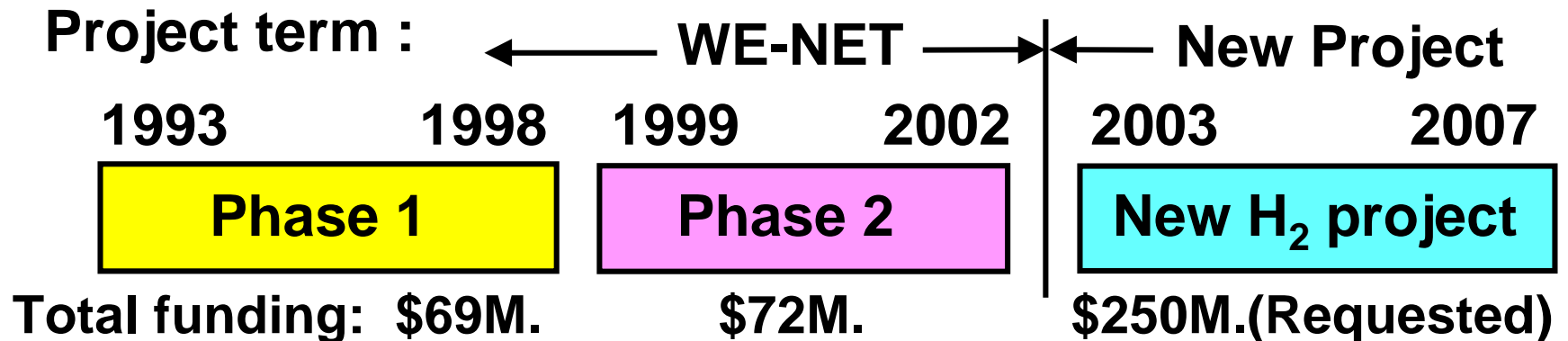


NATIONAL HYDROGEN PROGRAM (WE-NET)

MITI-NEDO initiated national hydrogen program
WE-NET. (World Energy Network) in FY1993
and it will be finished in FY2002 (March, 2003).

Mission :

To conduct research and development in the area of hydrogen production, transportation, storage, materials safety and utilization, for the purpose of establishment of the hydrogen infrastructure in short-term, mid-term and long-term.



METI' S NEW HYDROGEN PROJECT (PLAN)

The new hydrogen project will be started on April, 2003.

1.Objectives:

- To support market introduction of hydrogen fueled fuel cell vehicles from 2005**
- To establish hydrogen infrastructure for vehicles**
- To contribute global environment and to secure energy sources**

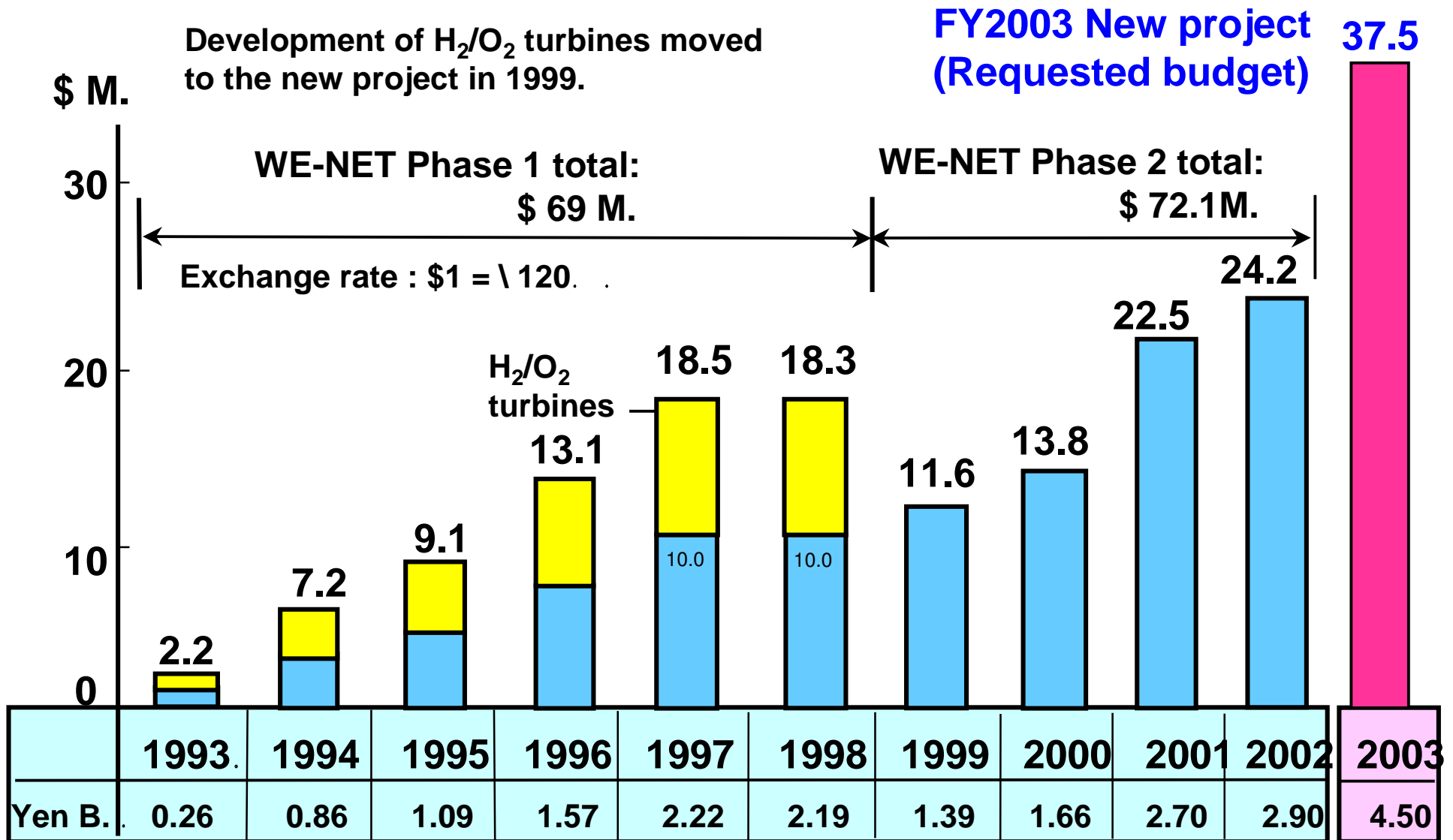
2. Project term: FY2003-FY2007 (5 years)

3. Total budget: Yen 30 billion (\$ 250 million)

4. R&D priorities:

- Validation and evaluation for safety of hydrogen to enact regulation, code and standards**
- Establish hydrogen infrastructure and develop related technologies (Compressors, 70MPa hydrogen cylinders)**
- Micro fuel cell systems for electronic devices**

WE-NET PROGRAM FUNDING



STATUS OF FCVS AND FUEL CELLS DEVELOPMENT IN JAPAN

FUEL CELL VEHICLES IN JAPAN

Japanese FCVs running on the public road



TOYOTA



HONDA



NISSAN



Compact FCV. Daihatsu Move



TOYOTA/HINO FC BUS2.

FUEL CELL VEHICLES DELIVERED TO THE JAPANESE GOVERNMENT

Five fuel cell vehicles were delivered to the Government on December 3, 2002.

TOYOTA: Four FC vehicles

- Cabinet office
- Ministry of Eco.Trade.Ind.
- Ministry of Environment
- Ministry of Transportation

HONDA: One FC vehicle

- Cabinet office.

Lease fee for FC vehicles

TOYOTA. s FCV. \$ 10,000/Month

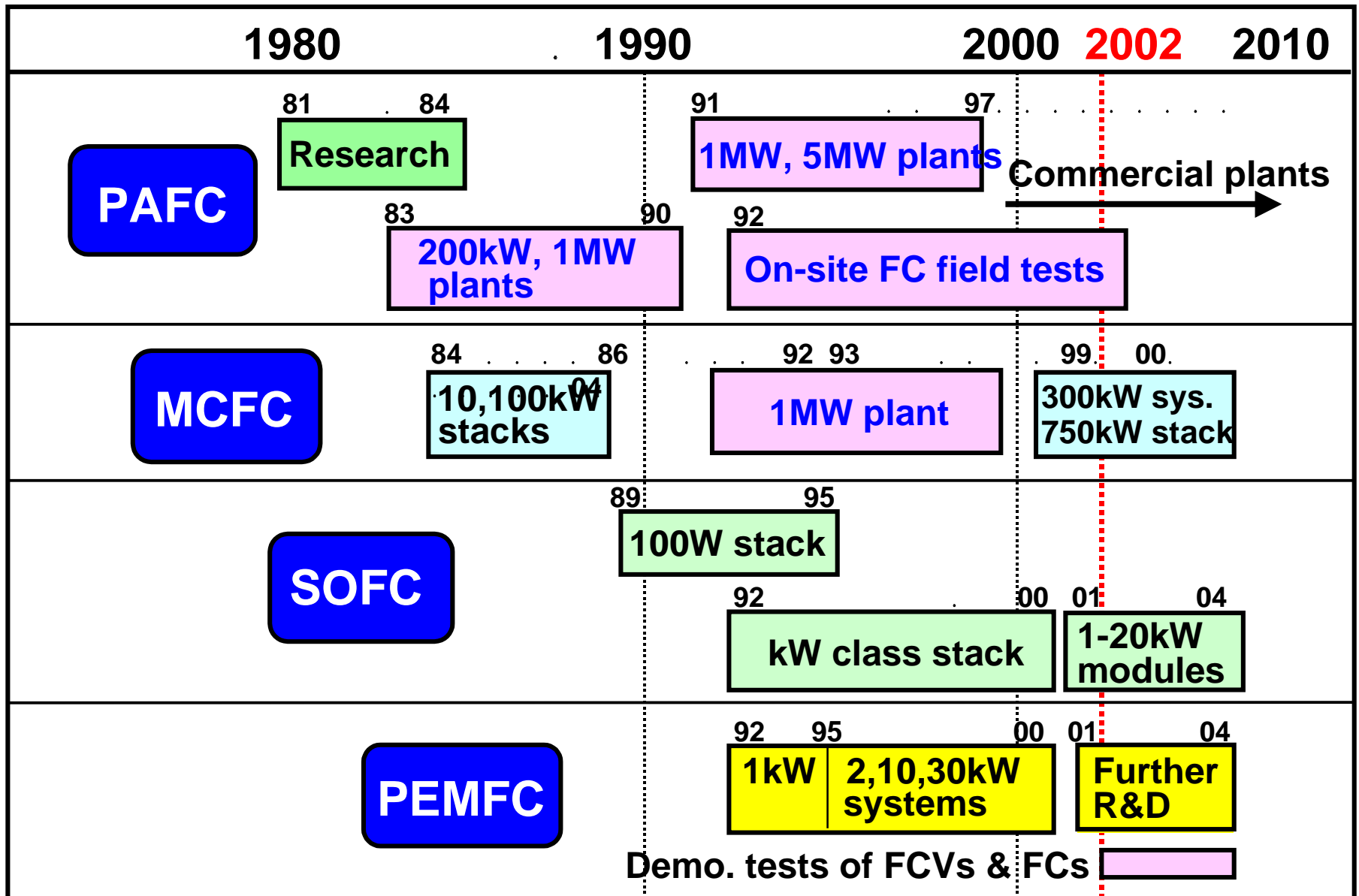
HONDA. s FCV: \$ 6,700/Month



Transportable hydrogen refueling station in the parking lot of METI.



NATIONAL FC PROJECTS IN JAPAN



RESIDENTIAL FUEL CELLS IN JAPAN

Capacity : 0.7-1kW PEMFC

Fuel : Natural gas



Sanyo Electric Co.



Toyota MotorCo.



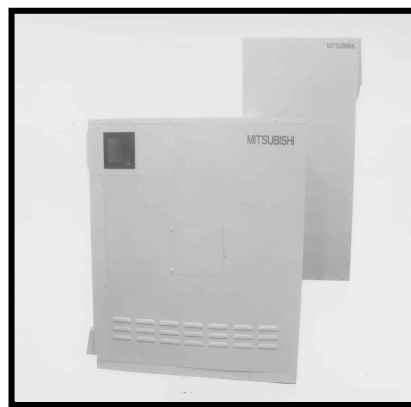
Matsushita Electric Works Co.



Ebara-Ballard Co.



Toshiba Int. Fuel Cells



Mitsubishi Electric



Fuji Electric Co.



Matsushita Electric Industrial Co.

JHFC METI'S FUEL CELL VALIDATION PROJECT

- Project term: 2002-2004. 3 years project
- Validation of 12 residential fuel cells at various operating conditions..
- Participants: Ebara Corp., Sanyo Electric, Shin-Nisseki, Toshiba Int. Fuel Cells, Toyota Motor, Matsushita Electric.

Area	Site location	Output	Fuel	Place
Residential area	Tokyo, Nagoya Yokohama	1kW	Natural gas	House
	Tokyo, Osaka			Apartment house
	Tsuchiura		LPG	House
Cold area	Sapporo	1kW	Natural gas	House
Sea shore area	Fukuoka	1kW	Natural gas	House
	Kawasaki		LPG	Apartment house
Heavy traffic area	Osaka	1kW	Natural gas	Apartment house
	Tokyo			House
	Shimizu	5kW	Naphtha	Shop

BIOGAS FUEL CELL POWER PLANTS

1. Biogas system from sewerage sludge



190kW plant in Tomakomai (2001)
Ebara-Ballard Co.



100kWx2 plants in Yamagata (2002)
FujiElectric Co.

2. Biogas system from garbage.



100kW test plant (2001)
Kajima and Fuji Electric Co.

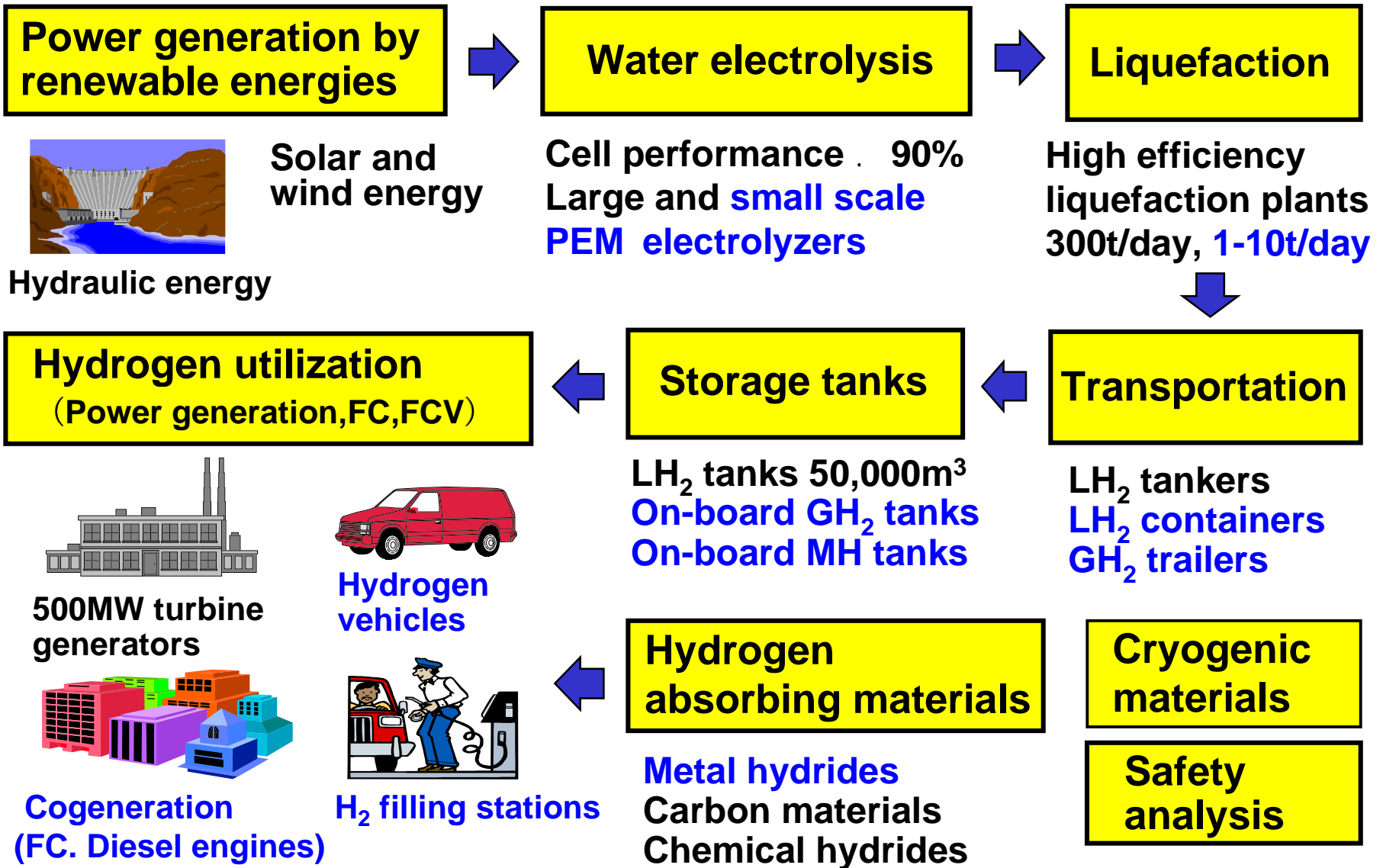
3. Biogas from beer breweries



Sapporo Beer Co. Chiba (1999)
200kW PAFC by Toshiba/ONSI

**DEVELOPMENT OF HYDROGEN
TECHNOLOGIES IN THE WE-NET**

HYDROGEN ENERGY SYSTEM AND TECHNOLOGIES TO BE DEVELOPED IN THE WE-NET

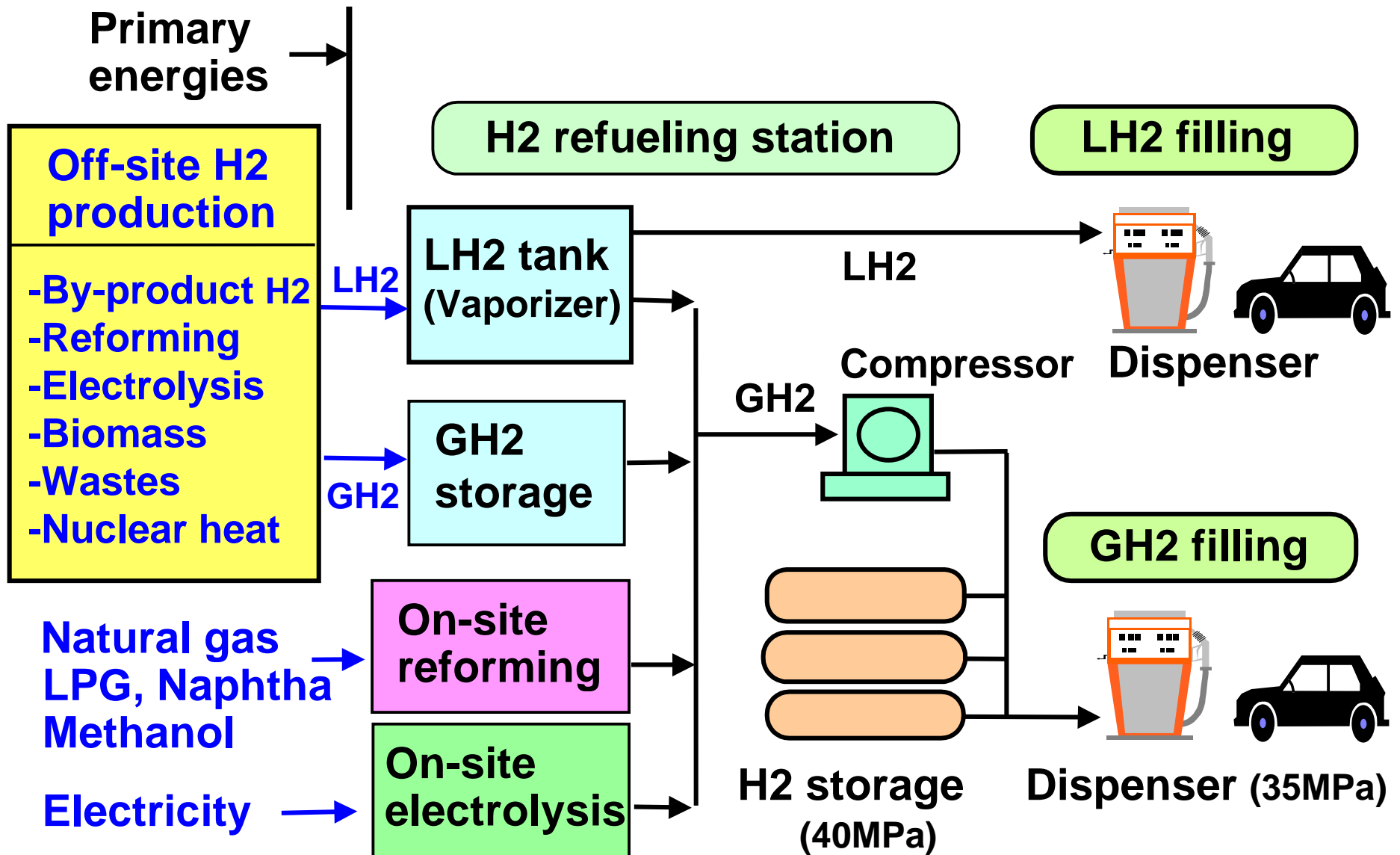


ACOMPLISHMENTS OF THE WE-NET PROGRAM

R&D items	Acomplishments
Hydrogen production	Developed a PEM electrolyzer, Eff.>90% and high performance cell technologies
Transportation and storage	Obtained data of Heat conductivity for thermal insulation panels. LH ₂ pumps
Metal hydride.	Developed 2.6 wt% at <100 deg.C.
Cryogenic materials	Made data base for mecha. properties of weld and base metals in LH ₂
Hydrogen diesel engine	Tested 100kW single cylinder engine
Hydrogen fuel cells	Developed a 30kW PEM FC power plant
FC vehicles fuel tank systems	Conducted safety test of MH fuel tanks and quick refueling test for MH tanks
Hydrogen filling station	Developed three H ₂ filling stations (PEM electrolysis, natural gas reforming and by-product hydrogen system)

DEVELOPMENT OF HYDROGEN REFUELING STATIONS IN JAPAN

HYDROGEN SUPPLY OPTIONS FOR FCVS



HYDROGEN DEMAND FOR VEHICLES

- Hydrogen demand for 5 million FC vehicles in 2020:
6.2 billion Nm³/Year
(For light and heavy duty vehicles)
- Hydrogen filling stations in 2020:
4,000 stations
(Gasoline stations in Japan in 2003: 53,000).

HYDROGEN ENERGY SOURCES IN JAPAN

- **By-product hydrogen**

Chlor-alkali plant:	1.2 (Billion Nm ³ /year)
Cokes oven plant:	5.3
Total	6.5 billion

Nm³/year

- **Potential hydrogen sources by biomass and wastes**

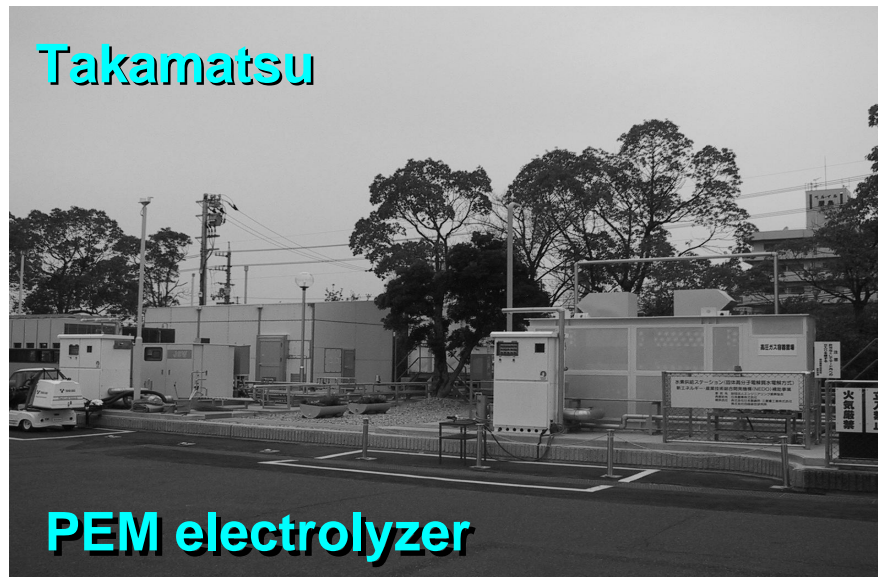
Wastes from agriculture:	0.9 (Billion Nm ³ /year)
Wastes from forestry:	1.9
Wastes from industries:	4.1
Plastics wastes:	8.0
Solid wastes (RDF):	1.4
Garbage:	0.7
Sewerage sludge:	7.7
Total	24.7 billion Nm³/year

OBJECTIVES OF WE-NET HYDROGEN REFUELING STATIONS

- **To prove reliable and safe operation**
 - Entire system
 - Refueling of hydrogen
- **To establish design instructions and standards**
Reformer, electrolyzer, metal hydride storage, compressor, high pressure storage, dispenser, control system, refueling operation, safety consideration
- **To demonstrate hydrogen fuel utilization to the general public**
- **To contribute market introduction of FCVs and hydrogen fuel**

WE-NET HYDROGEN REFUELING STATIONS

- H2 filling pressure
 - Compressed H2 FCV: 25MPa, 35MPa
 - Metal hydrides H2 FCV: 0.7MPa
- H2 production capacity
 - Natural gas reformer: 30Nm³/h
 - Electrolyzer: 30Nm³/h
 - By-prod.H2 storage: 2600m³/20MPa
- Operation: 2002 -



TOHO GAS SEMI-COMMERCIAL H₂ STATION

- Type: Natural gas reforming
- H₂ production capacity: 40Nm³/h
- H₂ supply pressure: 25/35MPa
- H₂ Purity: 99.99%
- H₂ storage: 300Nm³ at 40MPa
- Operation : October, 2002 -
- Place: Toho Gas Co. in Nagoya City

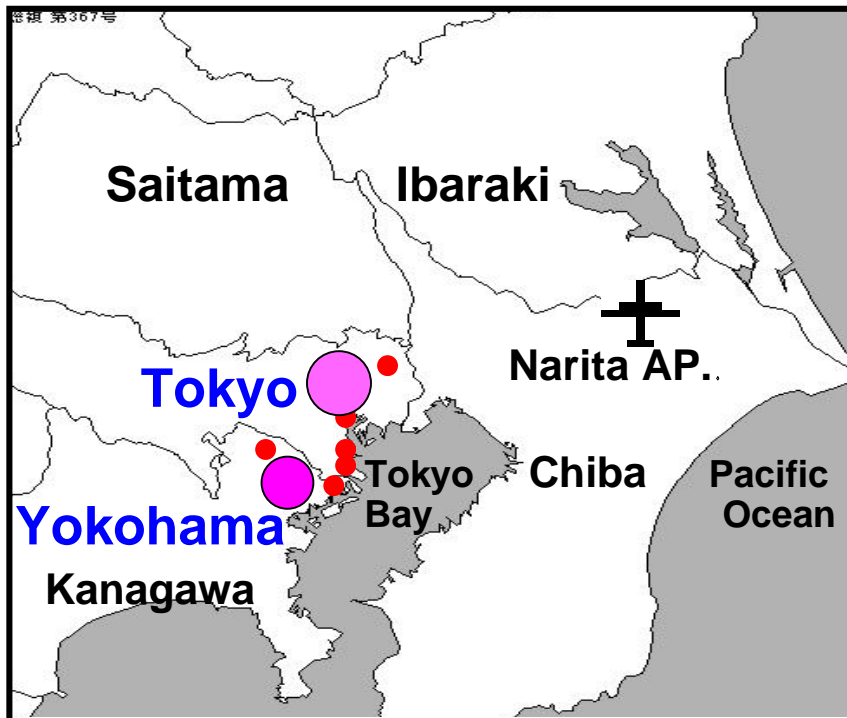
Nagoya



JHFC: JAPAN HYDROGEN & FC DEMO. PROJECT

- METI initiated JHFC project. Project term is FY2002-FY2004.
- Demonstration of FCVs will be conducted by Toyota, Honda, Nissan, GM and Daimler-Chrysler in 2003-2004.
- Five hydrogen filling stations using various fuels will be completed in 2003 (March-August).

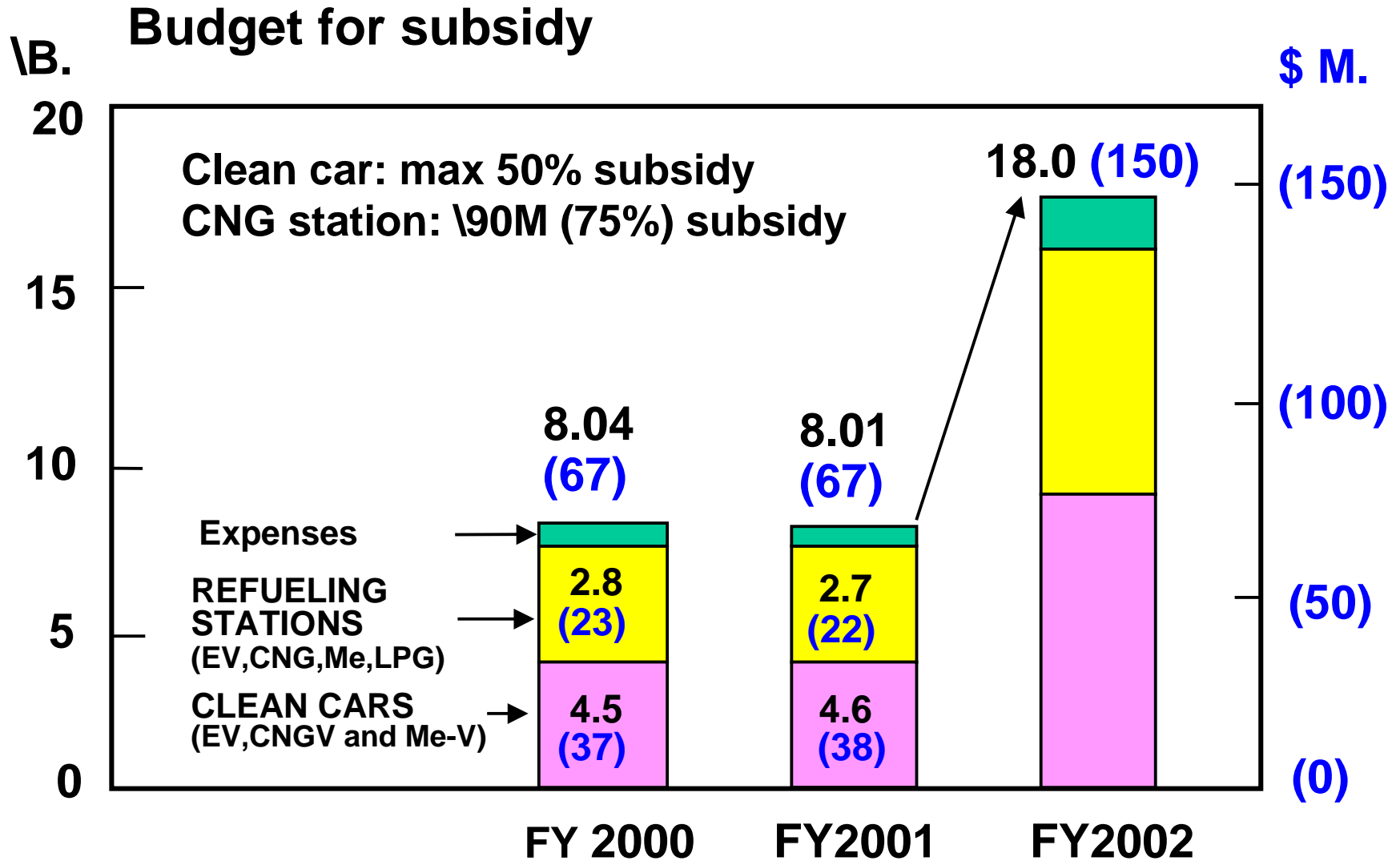
[Location for H₂ filling stations]



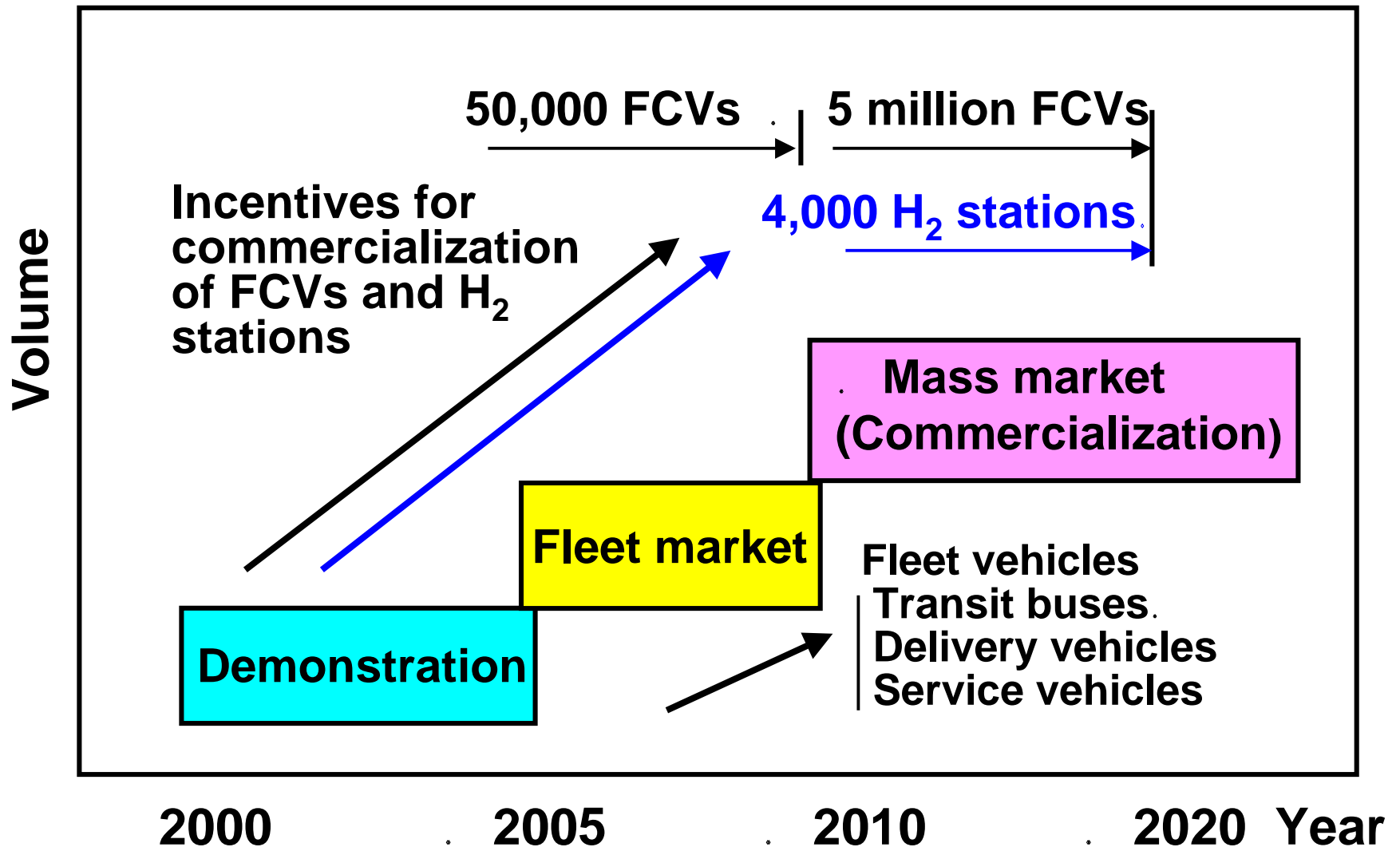
H ₂ sources	Location
1. By-Product H ₂ (WE-NET)	Yokohama
2. LPG reforming	Tokyo
3. Liquid H ₂	Tokyo
4. Methanol ref.	Kawasaki
5. Naphtha ref.	Yokohama
6. Desulfurized gasoline ref.	Yokohama

**PERSPECTIVE ON FUEL CELLS
AND HYDROGEN INFRASTRUCTURE**

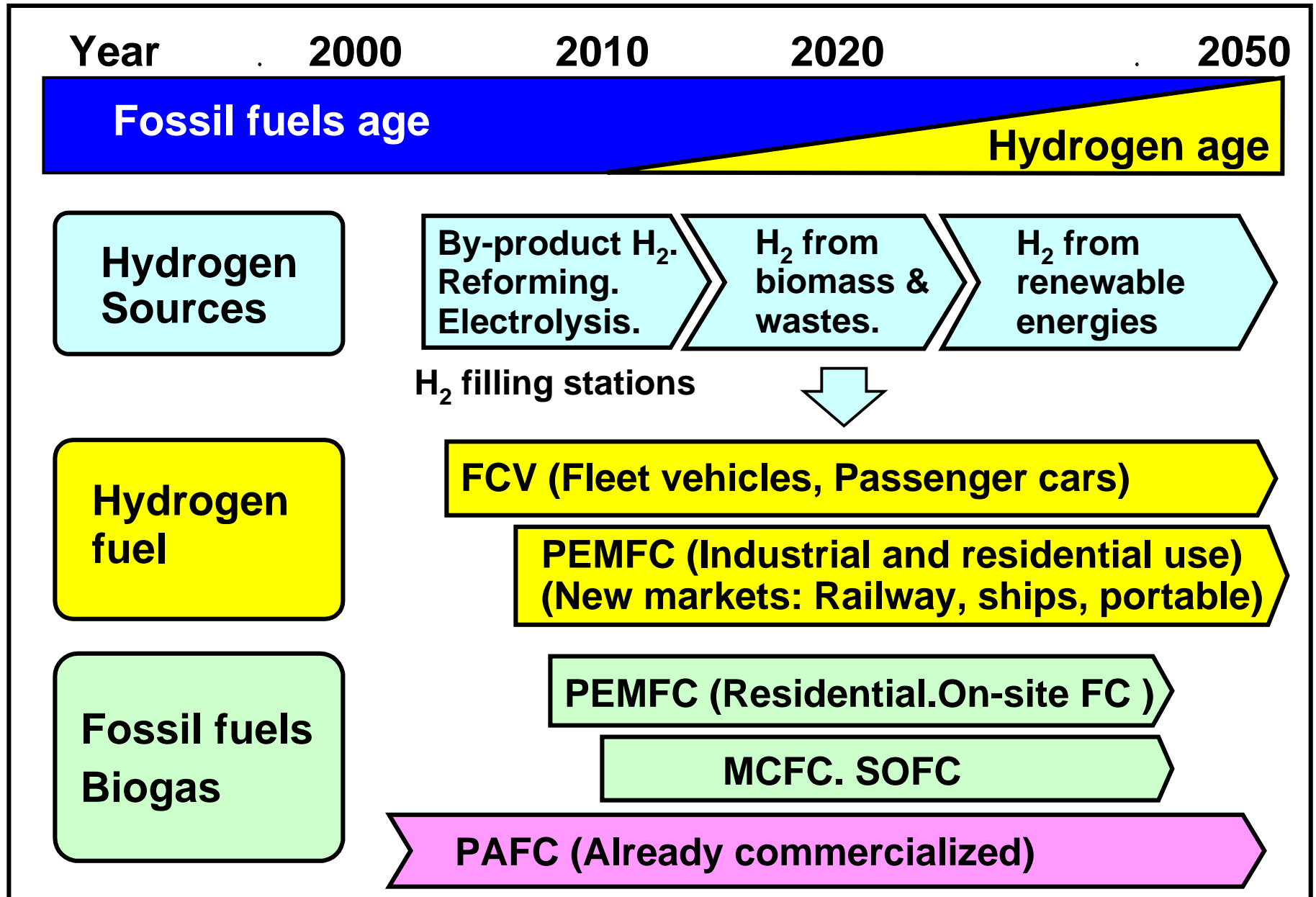
METI. S SUBSIDY FOR CLEAN CARS AND REFUELING STATIONS.



MARKET STEPS FOR H-FCV AND HYDROGEN INFRASTRUCTURE



PERSPECTIVE ON FUEL CELLS & HYDROGEN



CONCLUSION

- 1. Fuel cells still have technical and cost issues to be solved for commercialization. Key issue for fuel cells and FCVs is cost reduction.**
- 2. Many energy resources are available to produce enough hydrogen fuel for FCVs.**
- 3. Practical technologies for various hydrogen refueling stations will be established by 2004.**
- 4. Deregulation, codes and standards are very important for market introduction of hydrogen.**
- 5. Hydrogen infrastructure should be established with government support according to expansion of uptake of FCVs.**
- 6. Public acceptance for hydrogen is very important.**