



Joint UK/Japan Automotive Technology Forum
on Low Carbon Vehicles

**Future Automotive Technology & Motor Fuel
for Advanced Low-emission Vehicles**

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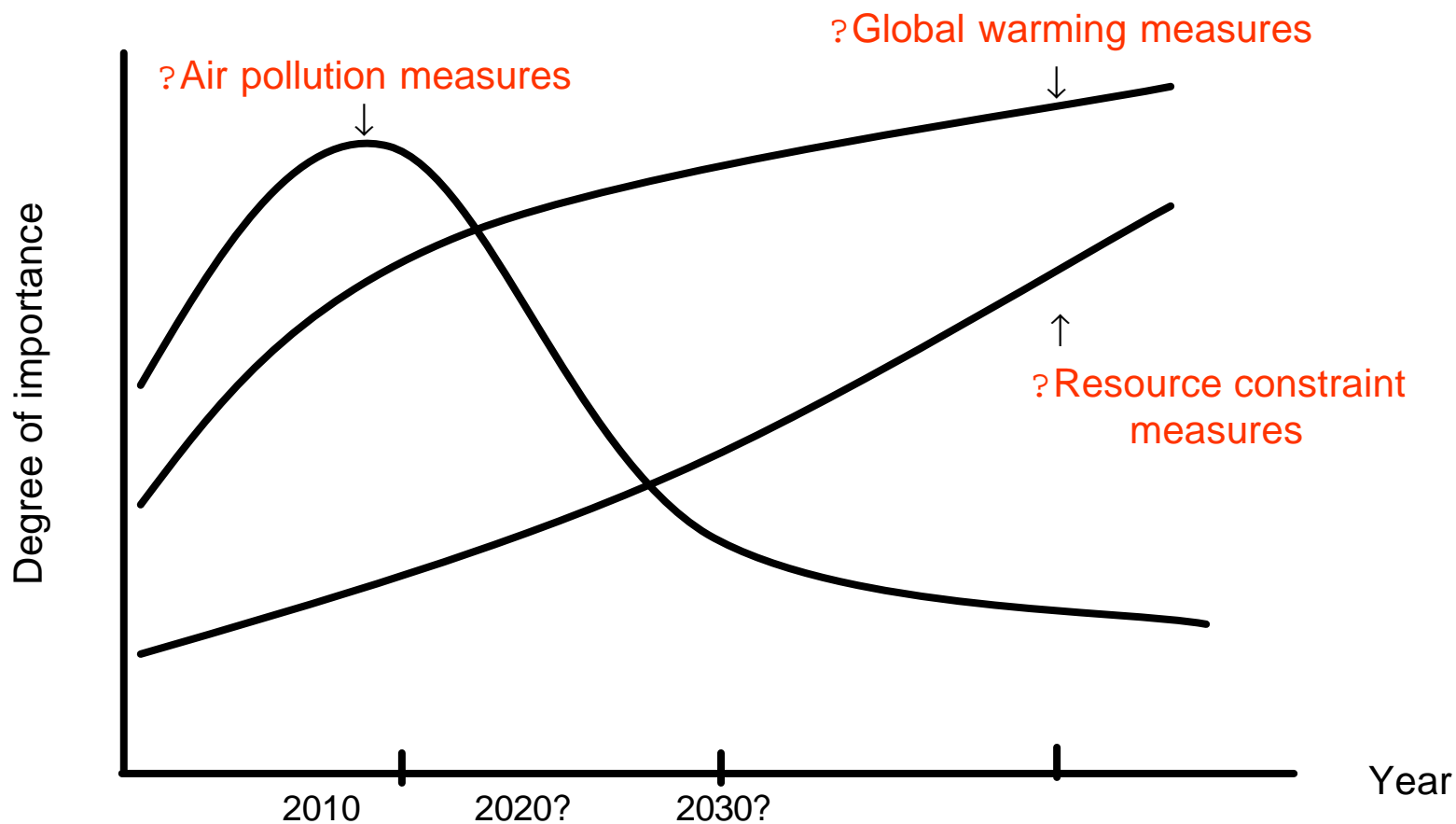
- ? .Background**
- ? .Low-emission Vehicles**
- ? .Air Pollution Problem**
- ? .Global Warming Problem**
- ? .Natural Resource and
Energy Problem**

? . Background

Environmental and Energy Restrictions That Must Be Overcome

- **Air pollution problems**
 - Drastic reduction of toxic substances in exhaust gases (NO_x, PM, etc.)
- **Global warming problems**
 - Drastic reduction of CO₂ exhausted into the atmosphere
- **Natural resource and energy problems**
 - Energy resource for the transportation sector's overdependence on petroleum (use of alternative fuels, etc.)

Conceptual Diagram of Order of Priority of Environmental and Energy Issues Surrounding Motor Vehicles



* Excerpt from document issued by Professor Yasuhiro Daisho at the METI's Special Committee; revised in part by METI.

* This is only a conceptual diagram; some leeway should therefore be given to the scale and the degree of importance values.

.. Low- emission Vehicles

Definition of Low-emission Vehicle

(1) Low-emission vehicles at the practical use stage

- Natural gas vehicles (CNG vehicles)
- Electric vehicles
- Hybrid vehicles
- Methanol vehicles
- Vehicles approved as high-fuel-efficiency and low-emission vehicles (meeting top-runner standard and more than 25% low emission vehicle)

(2) Fuel cell vehicles and other next-generation low-emission vehicles

- Fuel cell vehicles
- Vehicles with reduced environmental impact because of a new fuel or new technology produced by a technical breakthrough

Source: "Action Plan for the Development and diffusion of Low-emission Vehicles"; July 2001; Ministry of Economy, Trade and Industry; Ministry of Land, Infrastructure and Transport; Ministry of the Environment.

Measures for the Development and Diffusion of Low-emission Vehicles

“Action Plan for the Development and Diffusion of Low-emission Vehicles”

contains the following measures to support the diffusion of low-emission vehicles, aiming to have 10 million units in use by 2010.

(1) Subsidies, tax provisions, and other measures

Subsidies worth up to one-half the price differential with existing vehicles; infrastructure construction aid; green tax system

(2) Government-led introduction of low-emission vehicles

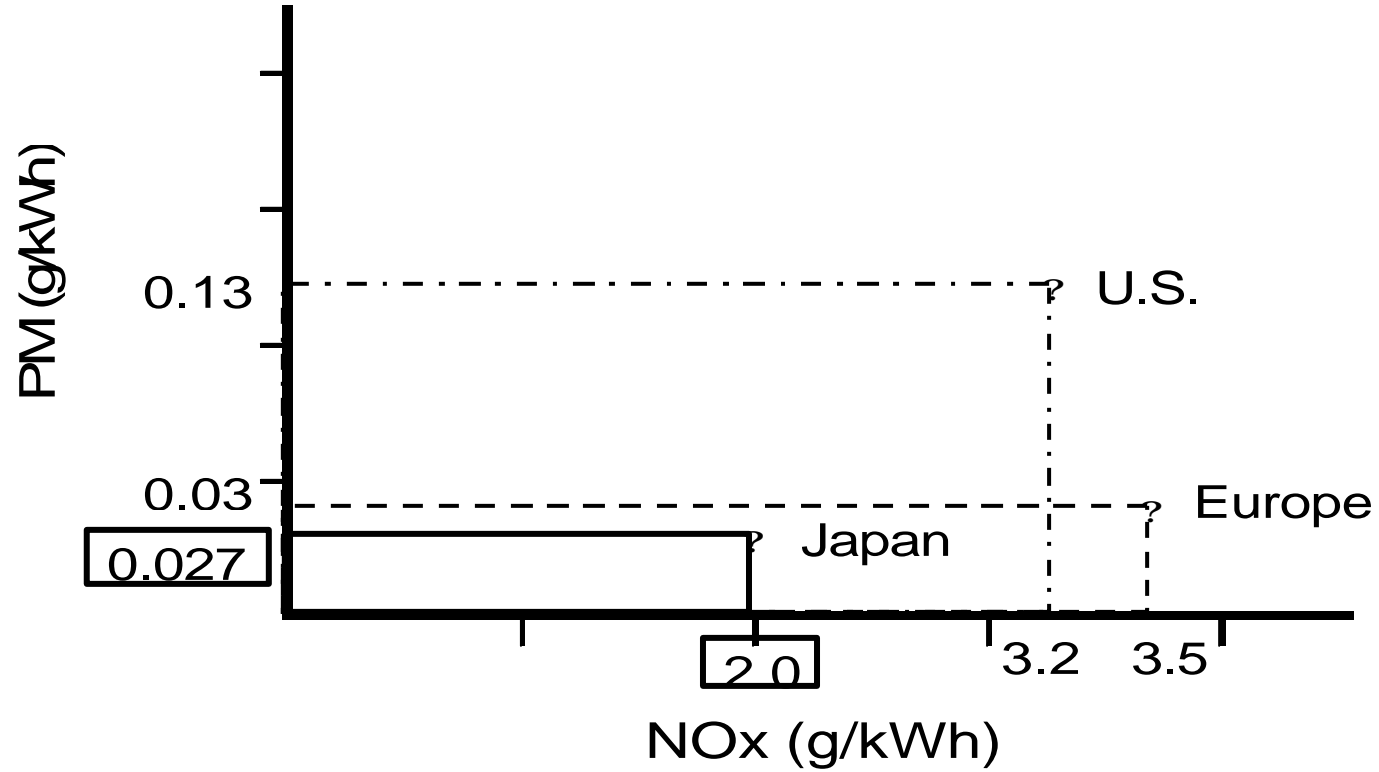
All public vehicles to be low-emission vehicles by 2004.

(3) Implementation of R&D on next-generation low-emission vehicles (fuel cell vehicles, etc.)

? 4.6 million units in use now (at the end of 2002FY)

.. Air Pollution Problem

Regulatory Values of Japanese, U.S., and European Exhaust Gas Regulations (Heavy-Duty Diesel Vehicles, by 2005)



Diesel Engine's Disadvantages:

- Emits PM.
- Produces large quantities of NOx.
- Exhaust gas after-treatment is difficult

Direction of Automotive Technology < Diesel Vehicles >

- The development of [higher pressure and electronic control fuel injection systems](#) (common rail system, etc) will continue.
- The feasibility of using [Urea SCR](#) in long-range trucks is being studied as a next-generation exhaust gas after-treatment system. For trucks and buses that operate in urban areas, [De-NOx catalysts and catalysts that simultaneously reduce PM and NOx](#) are expected to be introduced.
- Introduction of [HCCI engines](#) starting from a technically feasible range. The introducible range is expected to expand.
- The introductory range of [hybrid systems](#) for urban traffic applications (trucks and buses) is expected to expand.

Direction of Fuel Selection

Fuels for Diesel : CNG, LNG,

- [Low-sulfur diesel oil](#) (less than 10ppm) will be used and [comprehensive exhaust gas treatment](#) measures will be based on the latest emission-reducing technologies.
- In light of medium- and long-term resource limits, [GTL](#) will be promoted between now and 2010, because it can be blended with diesel oil.
- The prerequisites for introducing [diesel oil blended with biomass fuel](#) must be evaluated.
- In the urban traffic (trucks and buses) field, [CNG vehicles](#) will be promoted. In areas that have no CNG infrastructure, the diffusion of LPG or gasoline will be encouraged.

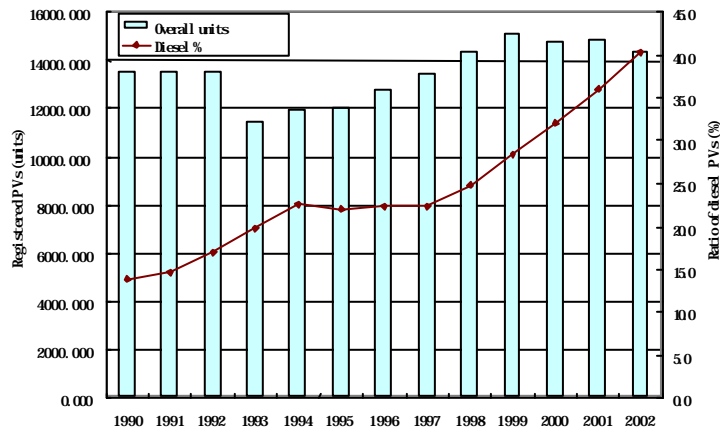
.. Global Warming Problem

Direction of Measures Dealing with Global Warming Problems

- Continuing improvement of the fuel consumption efficiency by more advanced engines ,etc.
- The introduction of [hybrid technologies](#) will be promoted.
- Attention will be re-focused on the [high fuel efficiency of diesel-powered passenger cars](#), and the preconditions for the diffusion of such vehicles in Japan will be prepared. The environmental performance of diesel passenger cars is expected to improve.
- A preliminary evaluation must be pursued regarding the introduction of [gasoline blended with biomass ethanol](#).

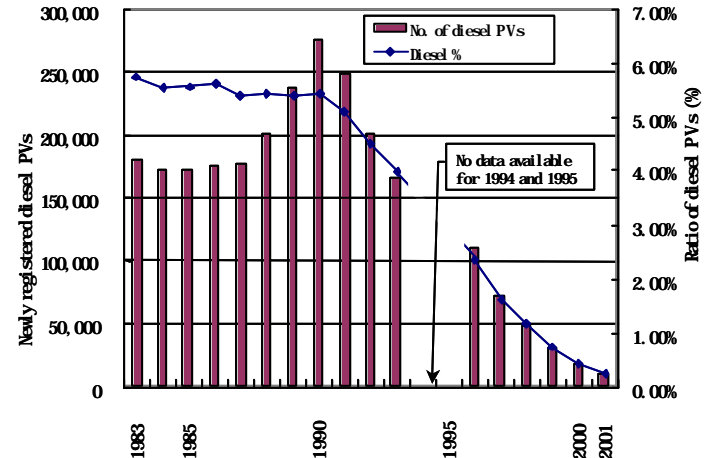
Diesel passenger cars

Newly registered PVs in Europe: overall vs. diesel



Source: European Automobile Manufacturers Association (ACEA)

Newly registered diesel PVs in Japan



Source: Created by MRI based on the Major Country Automobile Data and the World Automobile Data Annual Report published by the Japan Automobile Manufacturers Association

Why diesel passenger cars are popular in Europe:

- . High-performance diesel engines now available
- . Less costly for users
- . CO2 problem

Why diesel passenger cars are less popular in Japan:

- . No models meeting stringent urban environmental regulations are available
- . No cost advantage over gasoline vehicles

When further R&D has reduced CO2 emissions to a level comparable to those of gasoline vehicles and the cost advantages become apparent, diesel passenger cars are also expected to become more popular in Japan. Further, it is possible to promote the use of passenger cars incorporating the latest diesel technologies in provincial areas before urban centers, as driving distances are comparable to those in Europe.

Overall Energy Efficiency

.To prevent global warming from reaching critical levels, it is necessary to consider not only vehicle energy efficiency but also the energy efficiency of the whole process from fuel extraction to vehicle supply.

$$\text{Overall efficiency (\%)} = \text{Fuel efficiency (\% Well to vehicle tank energy efficiency)} \times \text{Vehicle efficiency (\% Tank to wheel energy efficiency)}$$

	Fuel efficiency (well-to-tank) (%)	Vehicle efficiency (tank-to-wheel) (%)	Overall efficiency (%) (well-to-wheel)			
			0	10	20	30
Recent gasoline car	88	16	14%			
Prius (before improvement)		28	25%			
Prius (after improvement)	88	32	28%			
Prius with THS II		37	32% <i>Energy efficiency*</i>			
Toyota FCHV	58 Natural gas-H2	50	29%			
FCHV (target)	70	60	42%			

.The overall energy efficiency of diesel hybrid vehicles is currently better than that of fuel cell vehicles.



Above: Toyota's diesel hybrid test model ES3, which is capable of 47 km/l due to an efficient diesel engine and hybrid technologies

MERITS?

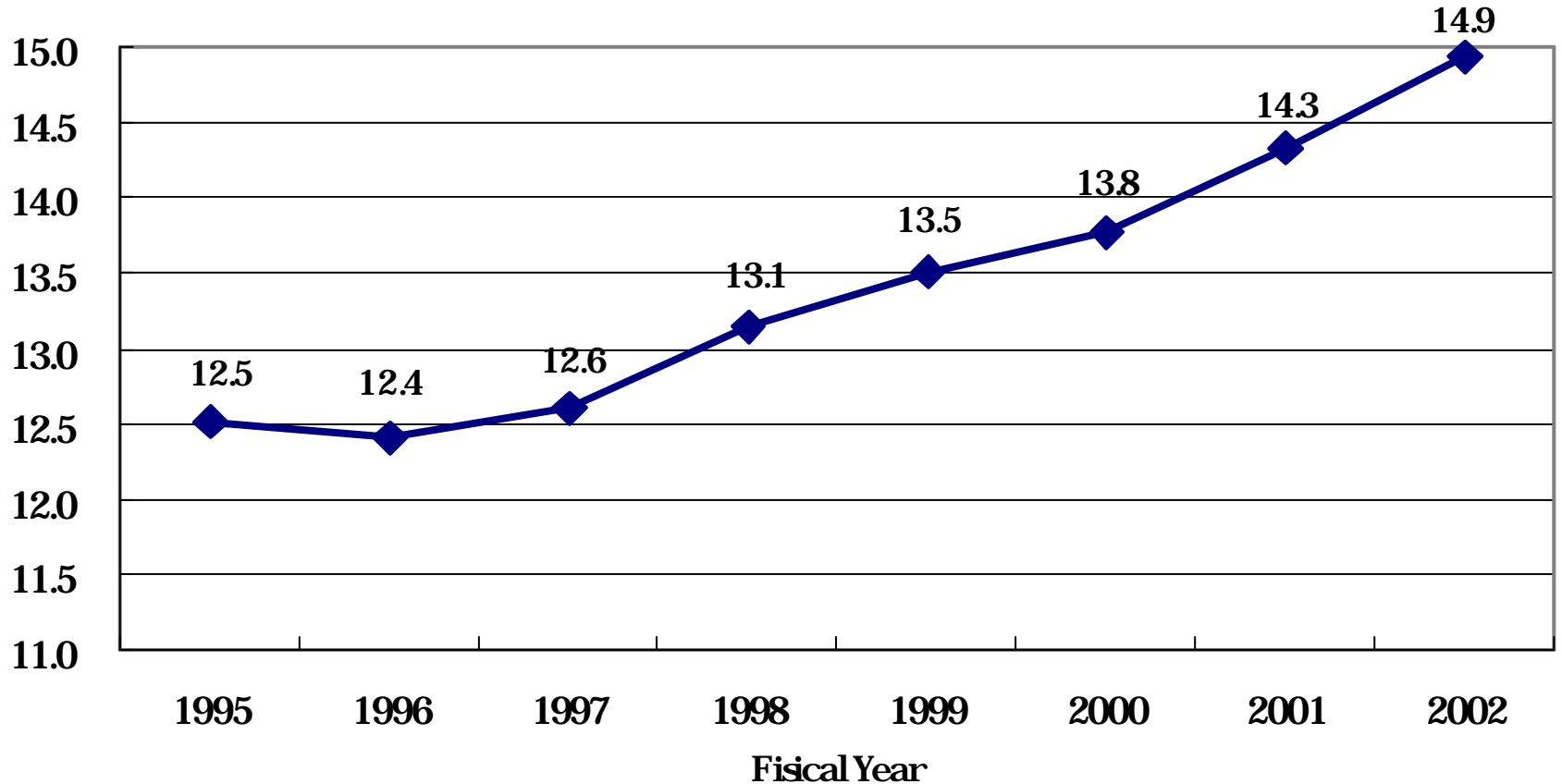
- 1) Energy-loss reduction
- 2) Energy recovery and reuse
- 3) Motor assist
- 4) High-efficiency operation control

(Quoted from the Toyota website. FCHV stands for Fuel Cell Hybrid Vehicle.)

Improving Fuel Efficiency

Average Fuel Efficiency of Sold Cars in Japan <Japanese Manufacturer>

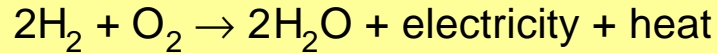
km/liter
(10·15mode)



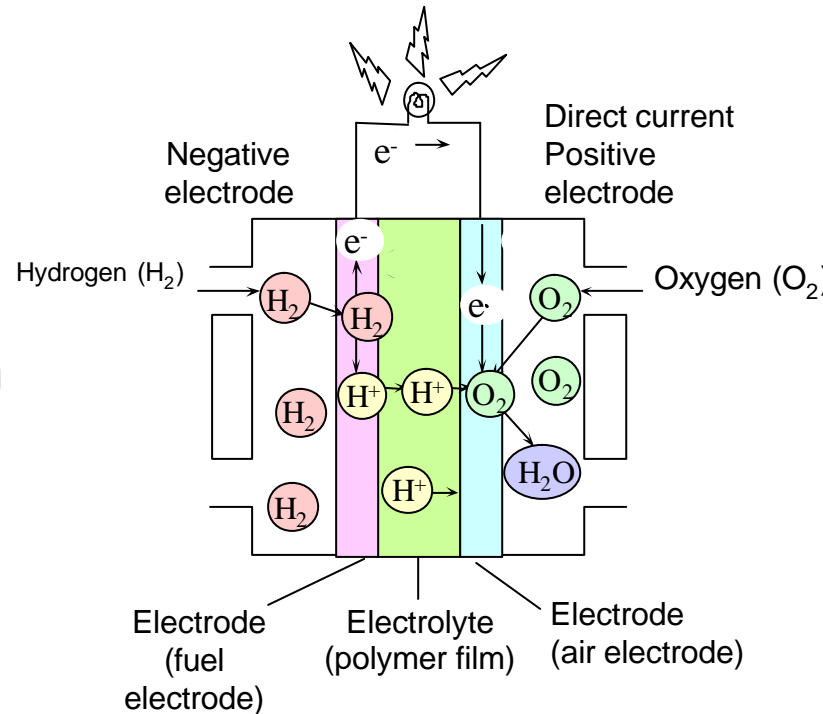
.. Natural Resource and Energy Problem (Hydrogen FCV)

Overview of Fuel Cell Vehicles

Fuel cells generate electricity by a chemical reaction between hydrogen and oxygen.



- High environmental impact-reducing effect
→ Measures for **air pollution**
- High energy efficiency
→ “Trump card” for dealing with **global warming**
- Diversification of hydrogen supply; etc.
→ **Energy security**



Hydrogen / Fuel Cell Vehicle in Future

- Hydrogen is the most expected candidate, but technical and economic hurdles are;
 - Hydrogen Production technology
 - Storage technology
 - Fuel cell technology
 - Hybrid is “key” technology in future
- Practical steps of fuel cell vehicle introduction should be established.
- Current internal combustion engine will continue to be prime for many decades.

Hydrogen & Fuel Cell Demonstration Project

- From fuel supply to actual driving, demonstrations of fuel cell vehicles conducted within an integrated framework (2002 to 2004).
- Objective data collected and necessary basic preparations made (e.g., reviews of related regulations) with a view to promoting development and popularization of fuel cells.

Hydrogen Station Locations



Participant auto makers and vehicles



Toyota, Honda, Nissan, General Motors, Daimler Chrysler, and Hino have been participating in the project with the vehicles shown above. Mitsubishi and Suzuki also joined the project in FY2003.



Thank you