



# **“Concepts of Next Generation Environmentally Friendly Vehicles”**

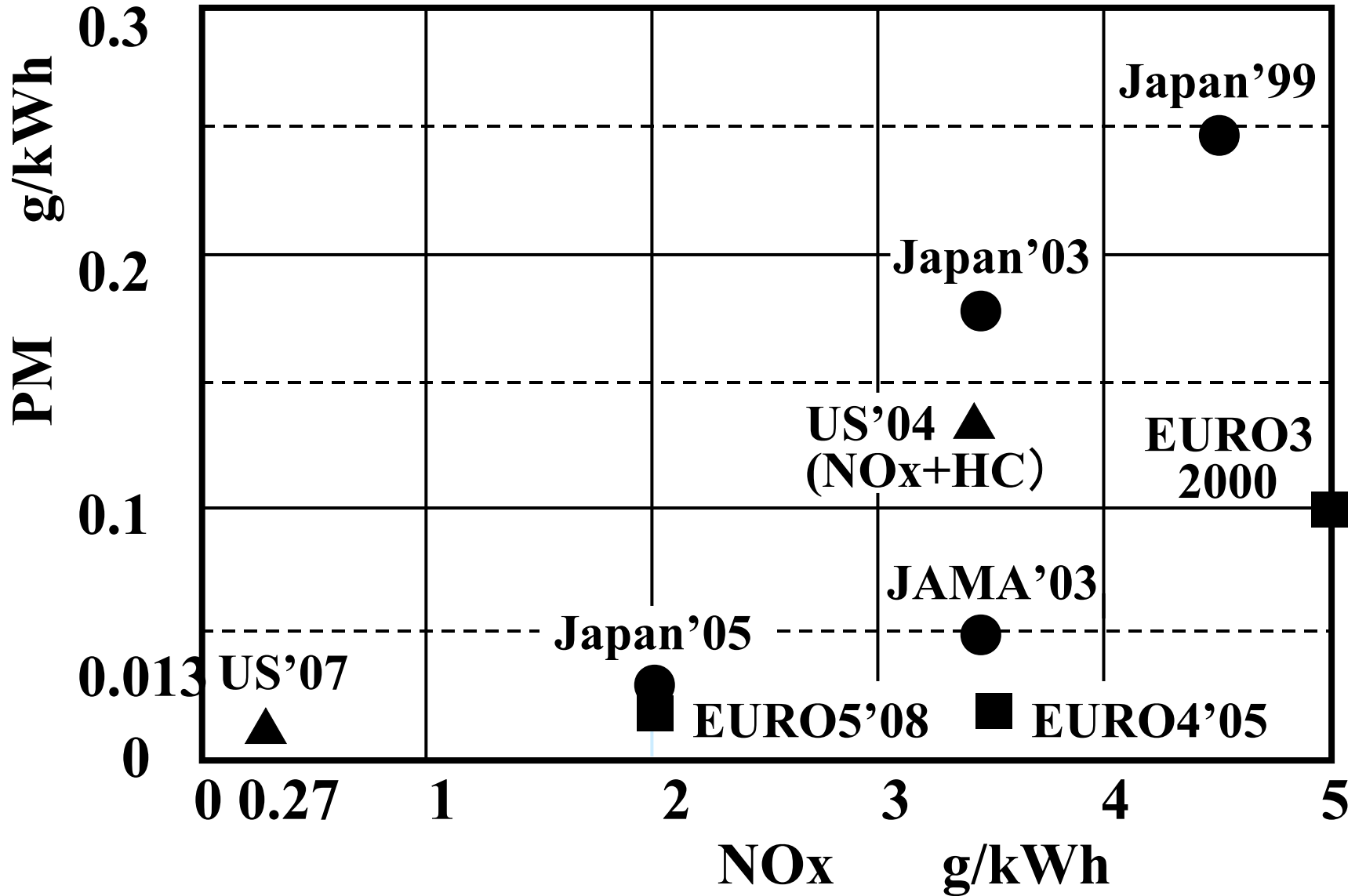
**Yasuhiro Daisho**

**Dept. of Mech. Eng., Waseda University**

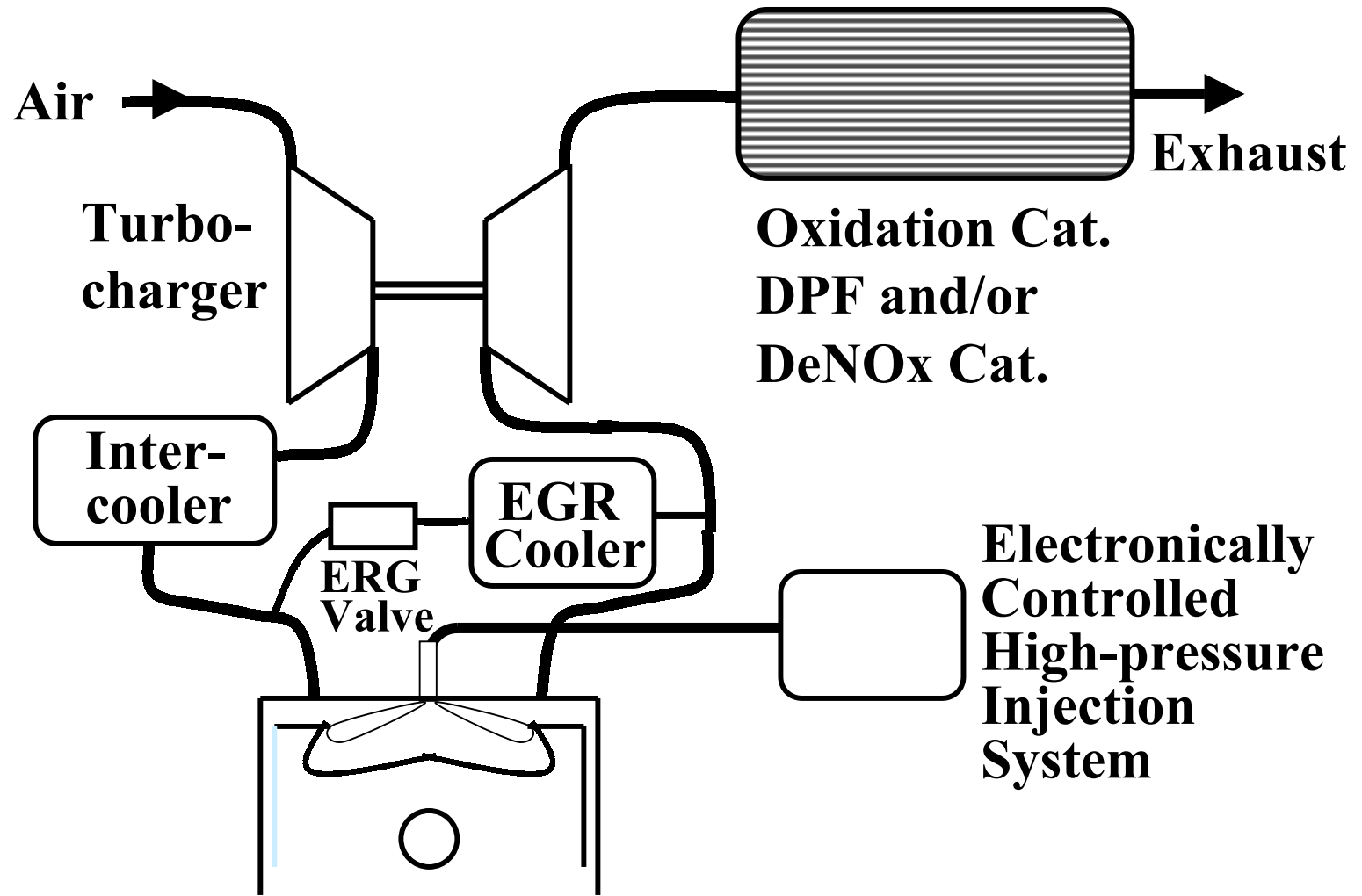
**Email: [daisho@waseda.jp](mailto:daisho@waseda.jp)**

# Requirements for EFVs

- ★ **Ultra-Low or Zero Emissions**
- ★ **High Fuel-Efficiency/  
Low CO2 Emission**
- ★ **Availability/Affordability**
- ★ **Energy Diversity/  
Use of Renewable Fuels**
- ★ **High Recyclability**
- ★ **High Competitiveness**
- ★ **Symbolic**



**HD Diesel NO<sub>x</sub> and PM Emissions Regulations**

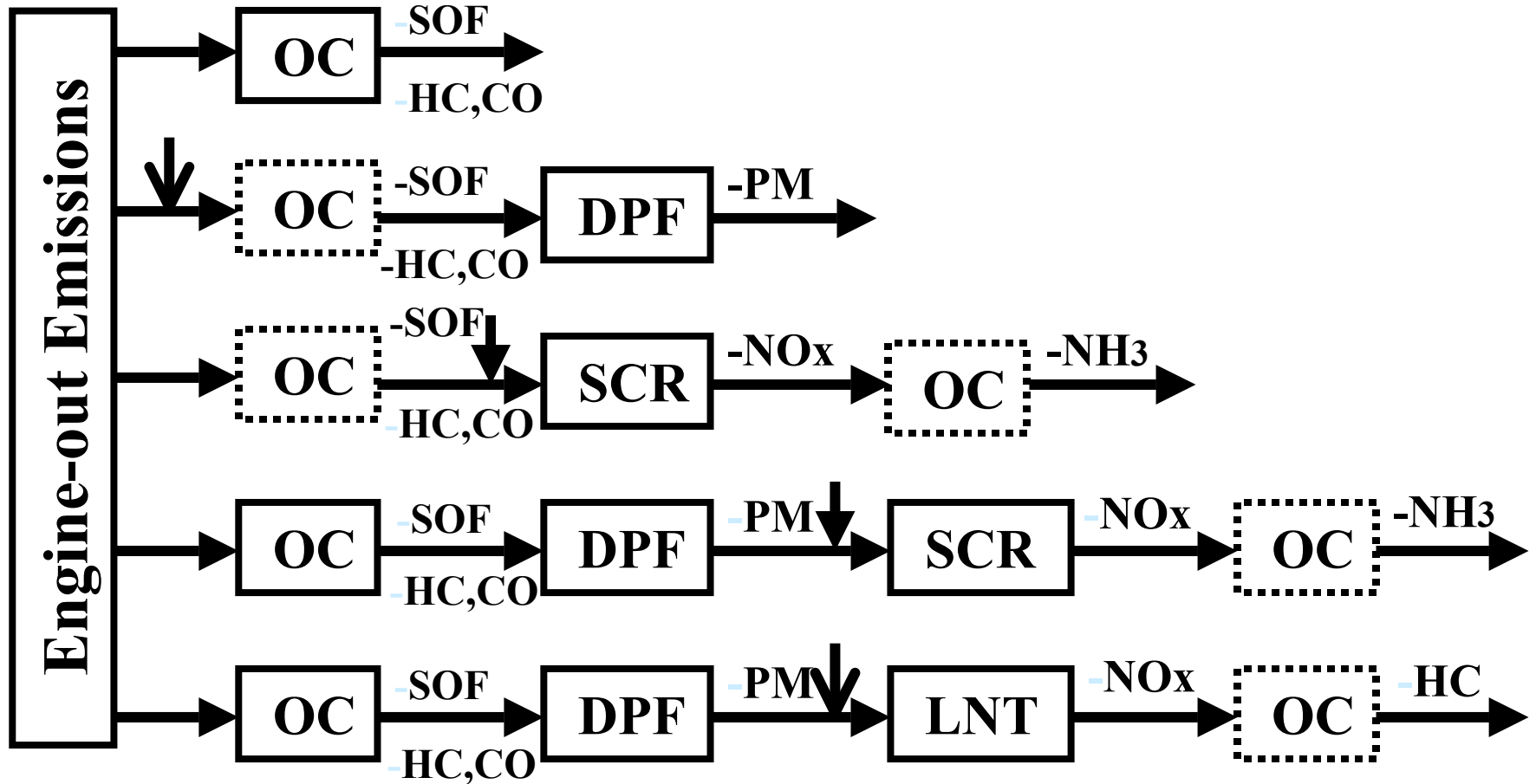


**A Typical Diesel Emission Control System**

**OC: oxidation catalyst**

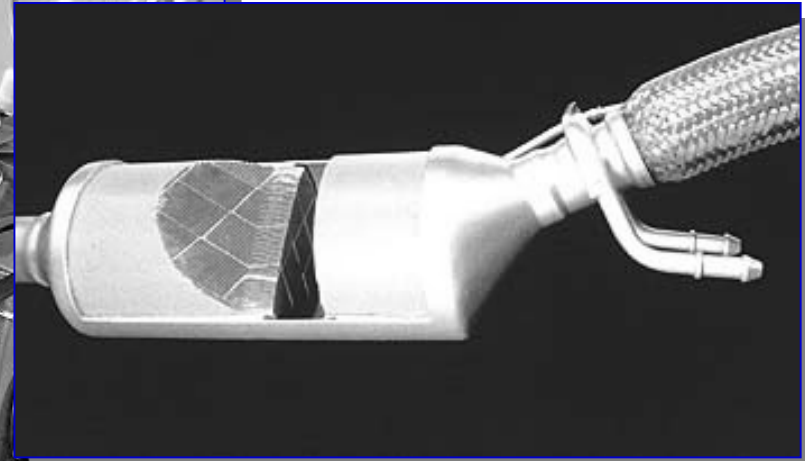
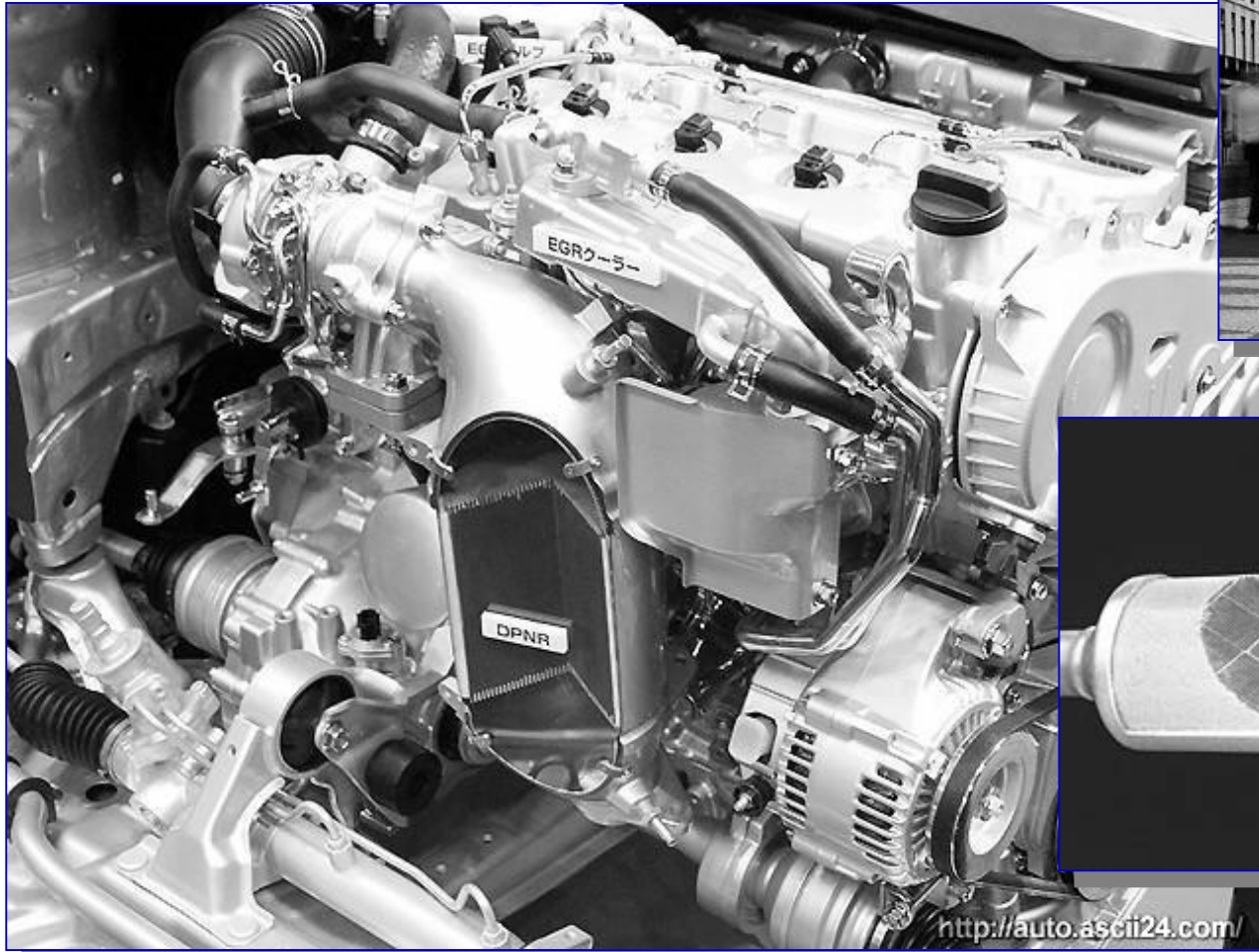
**SCR: selective catalytic reduction** ..... ↓ : Urea

**LNT: lean NO<sub>x</sub> trap** ..... ↓ : Fuel



**Various Combined Diesel Aftertreatment Systems**

**(Toyota Motor Corp.)**



**“DPNR” Tested in Diesel Passenger Cars**

# Cleaner Fuels for EFVs

## **\* Gasoline:**

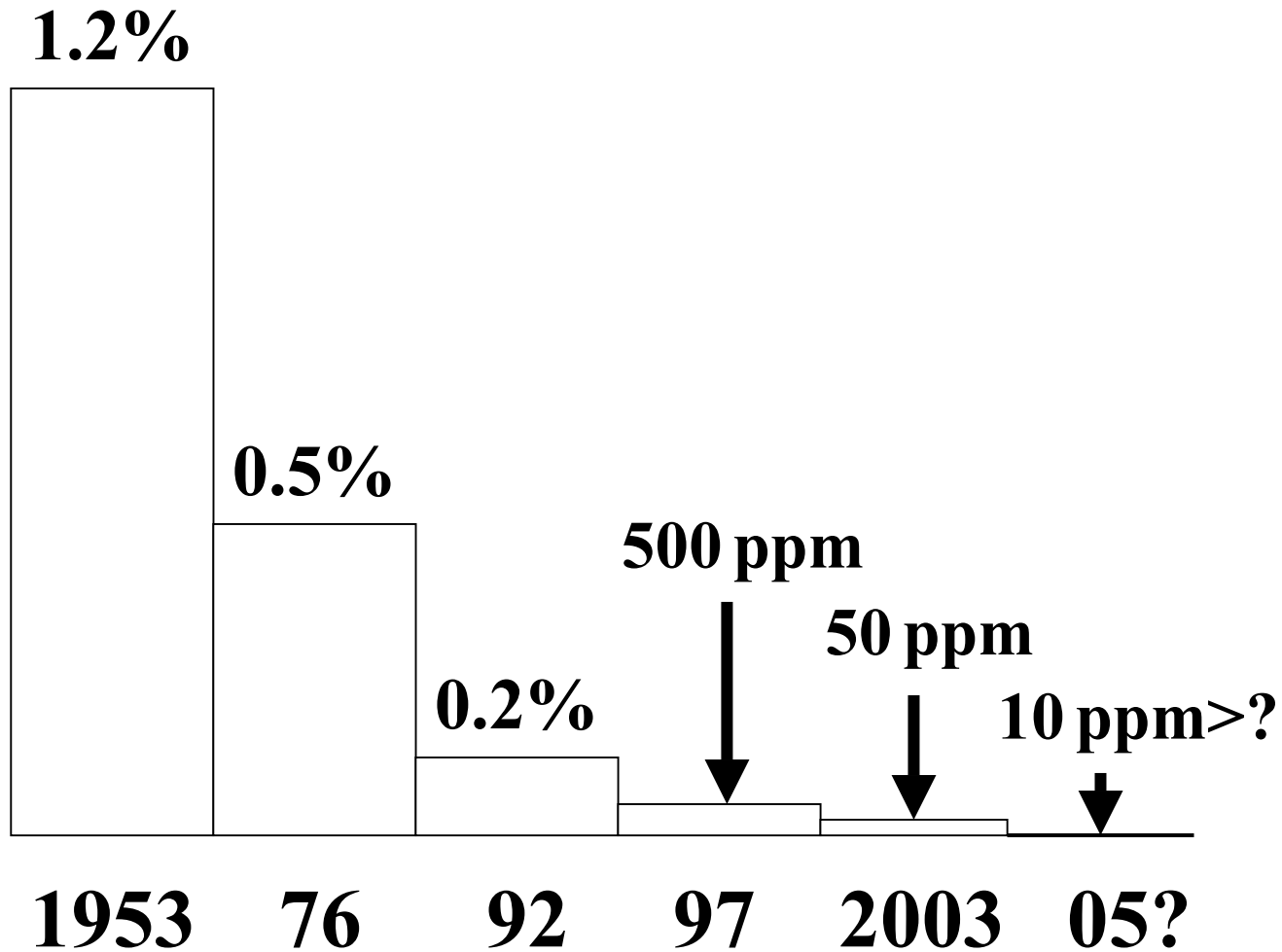
- **Lower sulfur (<50 ppm) for LNTs**
- **Higher octane number for higher efficiency**

## **\* Diesel fuel:**

- **Lower or nearly zero sulfur (<10 ppm) for LNTs**
- **Lower distillation temperature (T90)  
and lower aromatics (<10%) for lower PM**

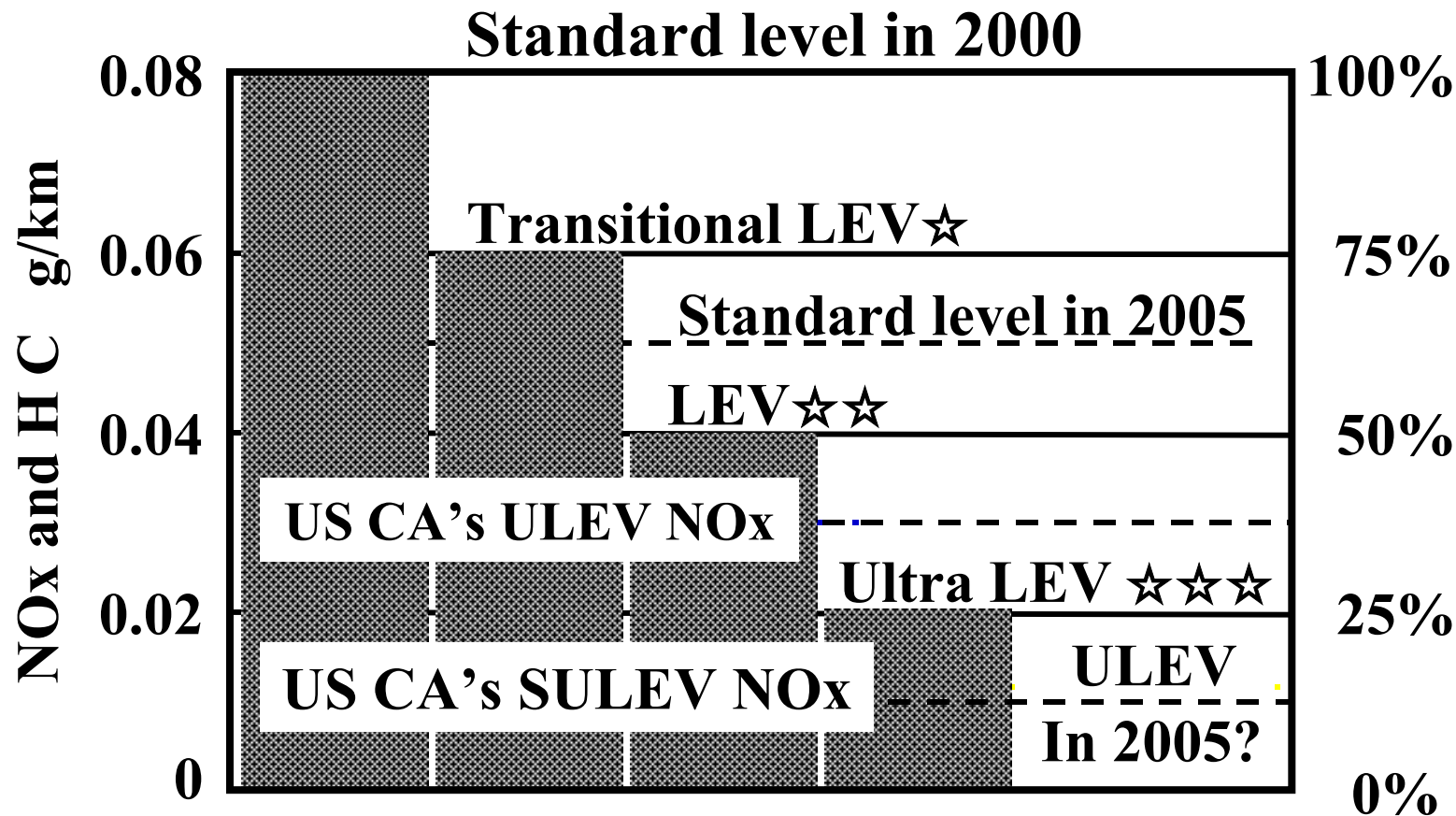
## **\* Alternative fuels:**

- **Standardized fuel properties including GTL  
and renewable blends**
- **Convenient availability and affordability**

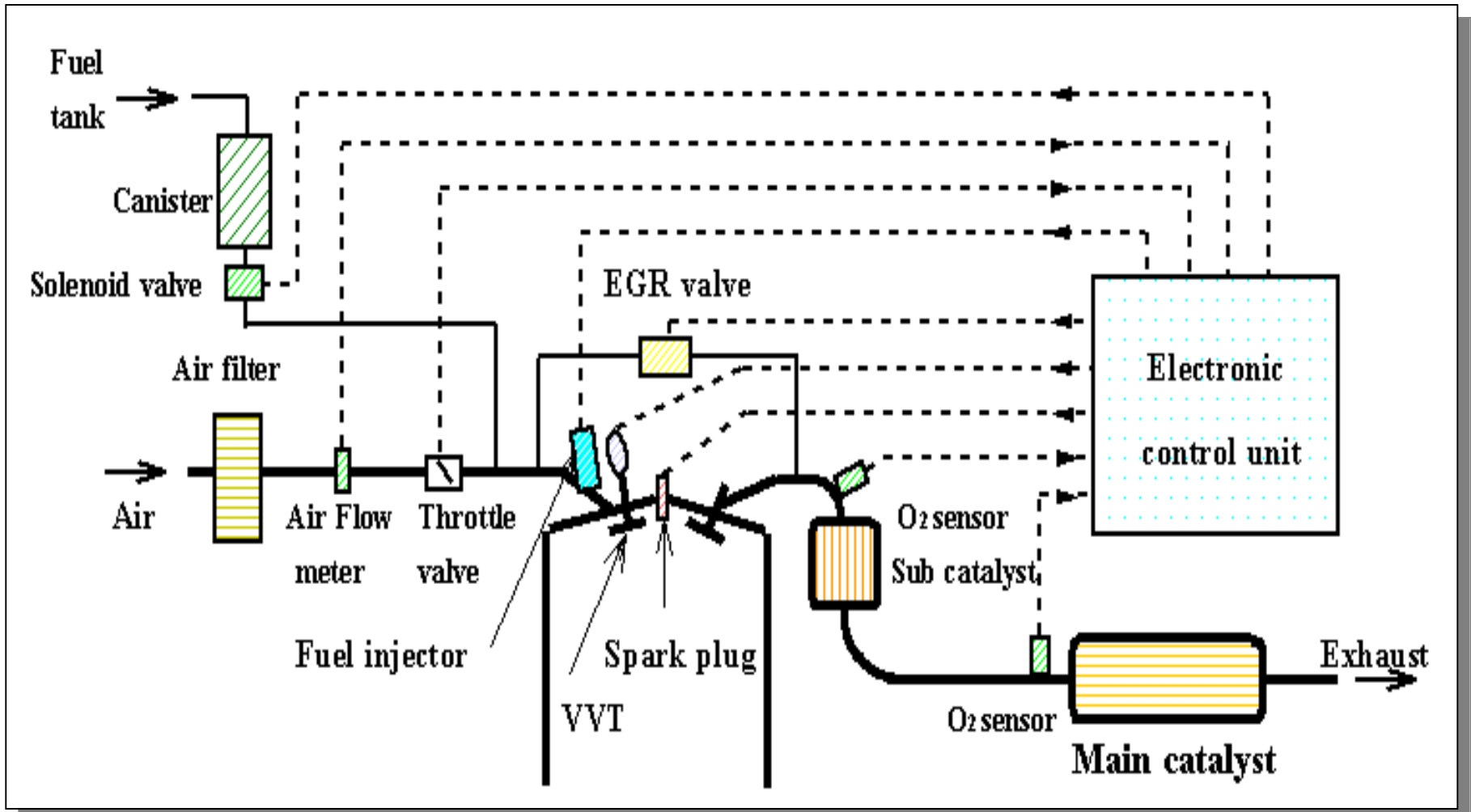


**Regulations on Sulfur Content  
in Diesel Fuel in Japan**

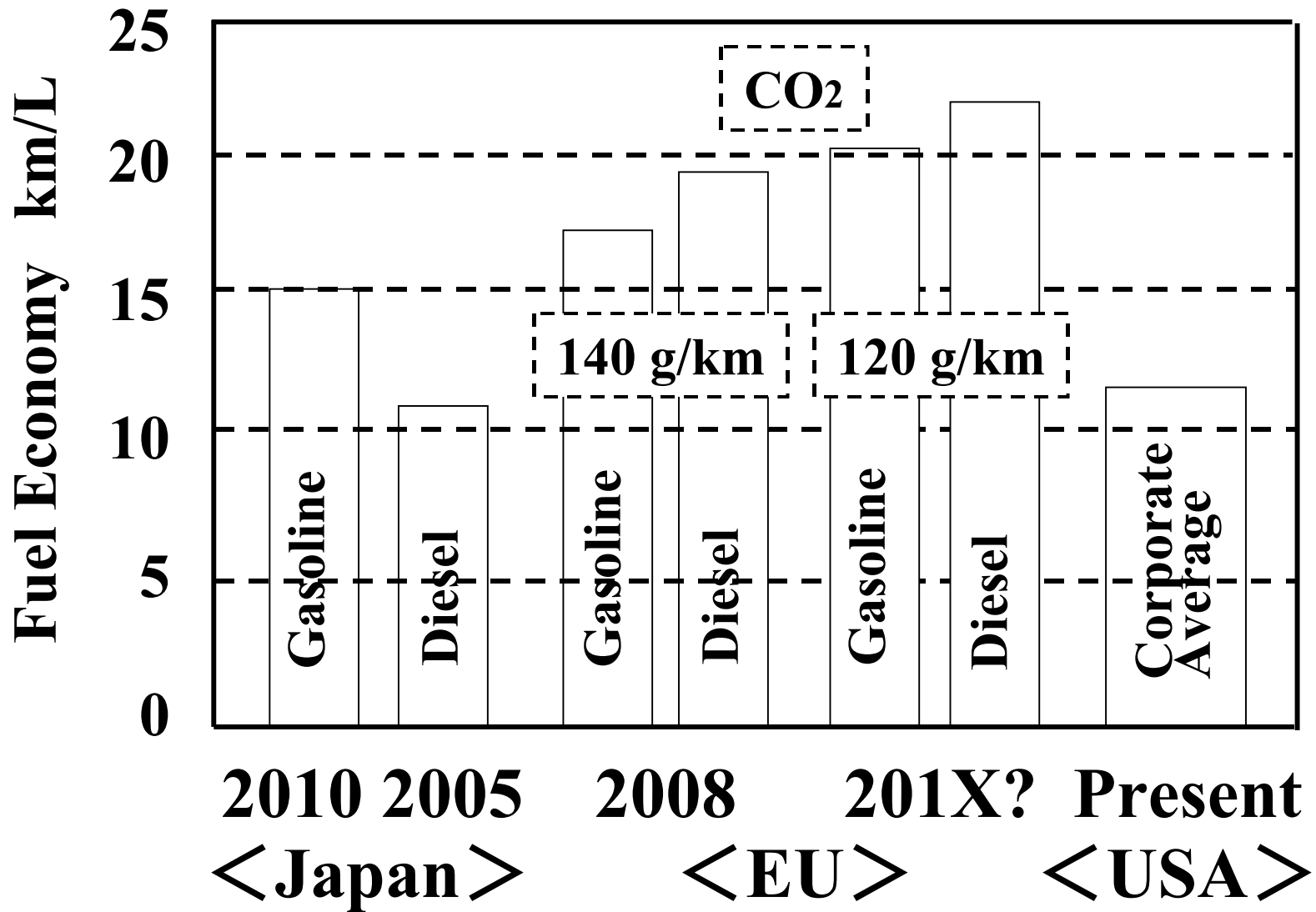




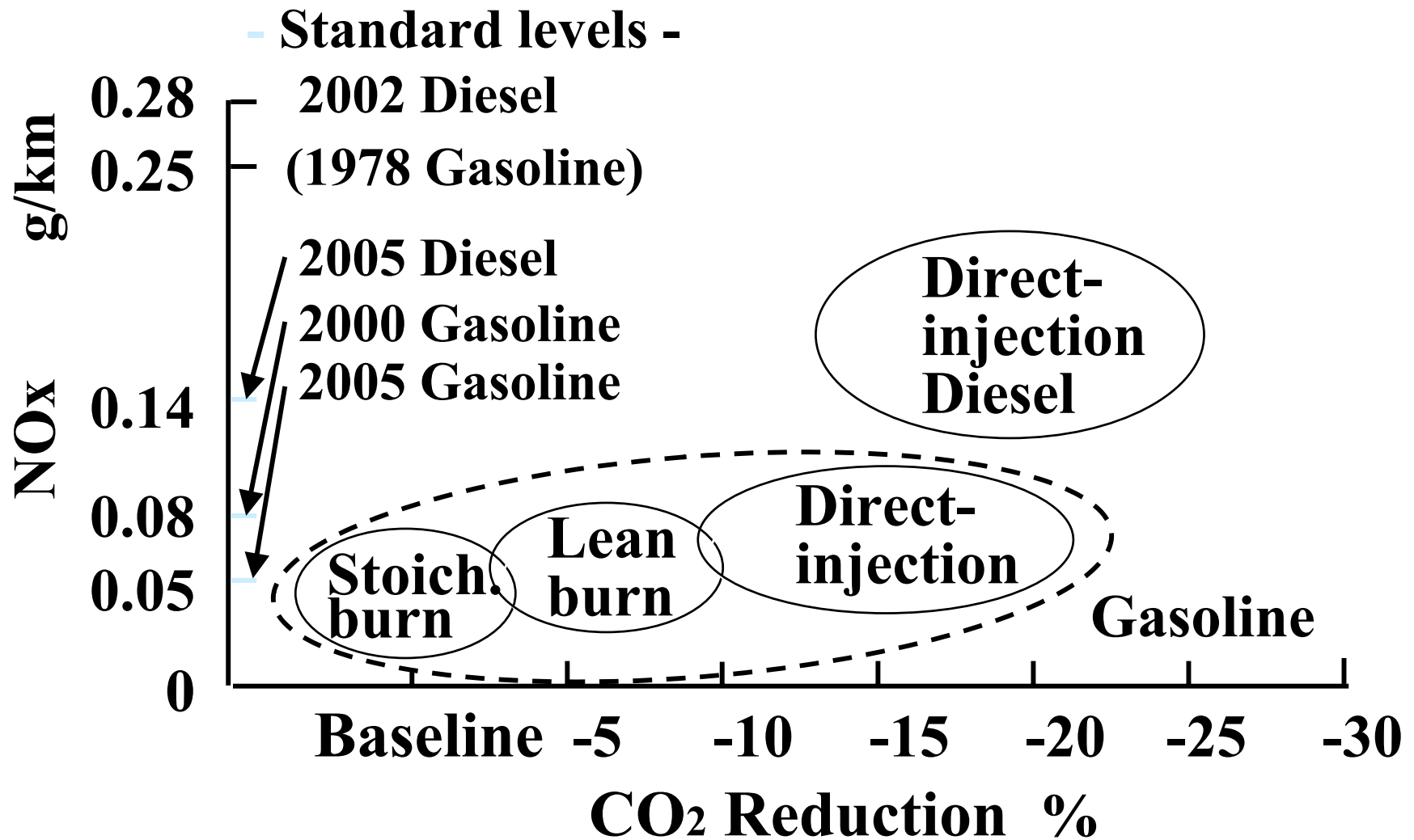
**Present Standard and Low Emission Levels  
for Gasoline Passenger Cars in Japan**



**A Typical System for Reducing Emissions in the SI Engine**



**Passenger Car Fuel Economy Standards  
in Japan, EU and USA**

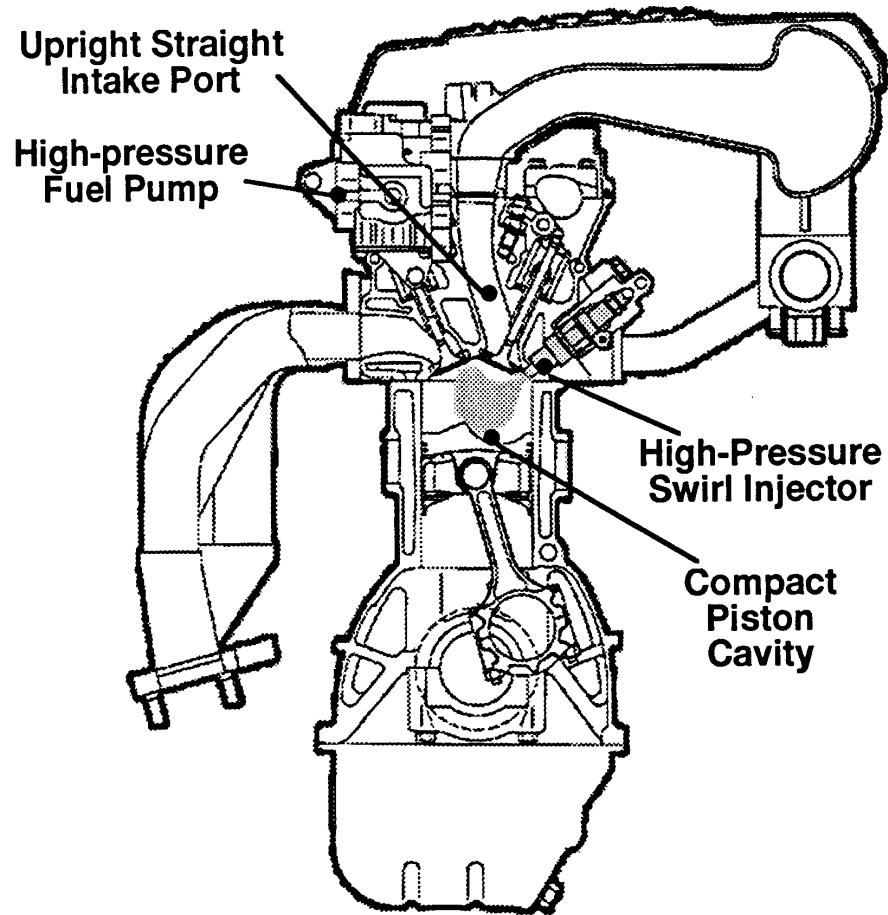


**NO<sub>x</sub>-CO<sub>2</sub> Trade-offs of Gasoline and Diesel Passenger Cars**

# Technologies for Improving Fuel Economy

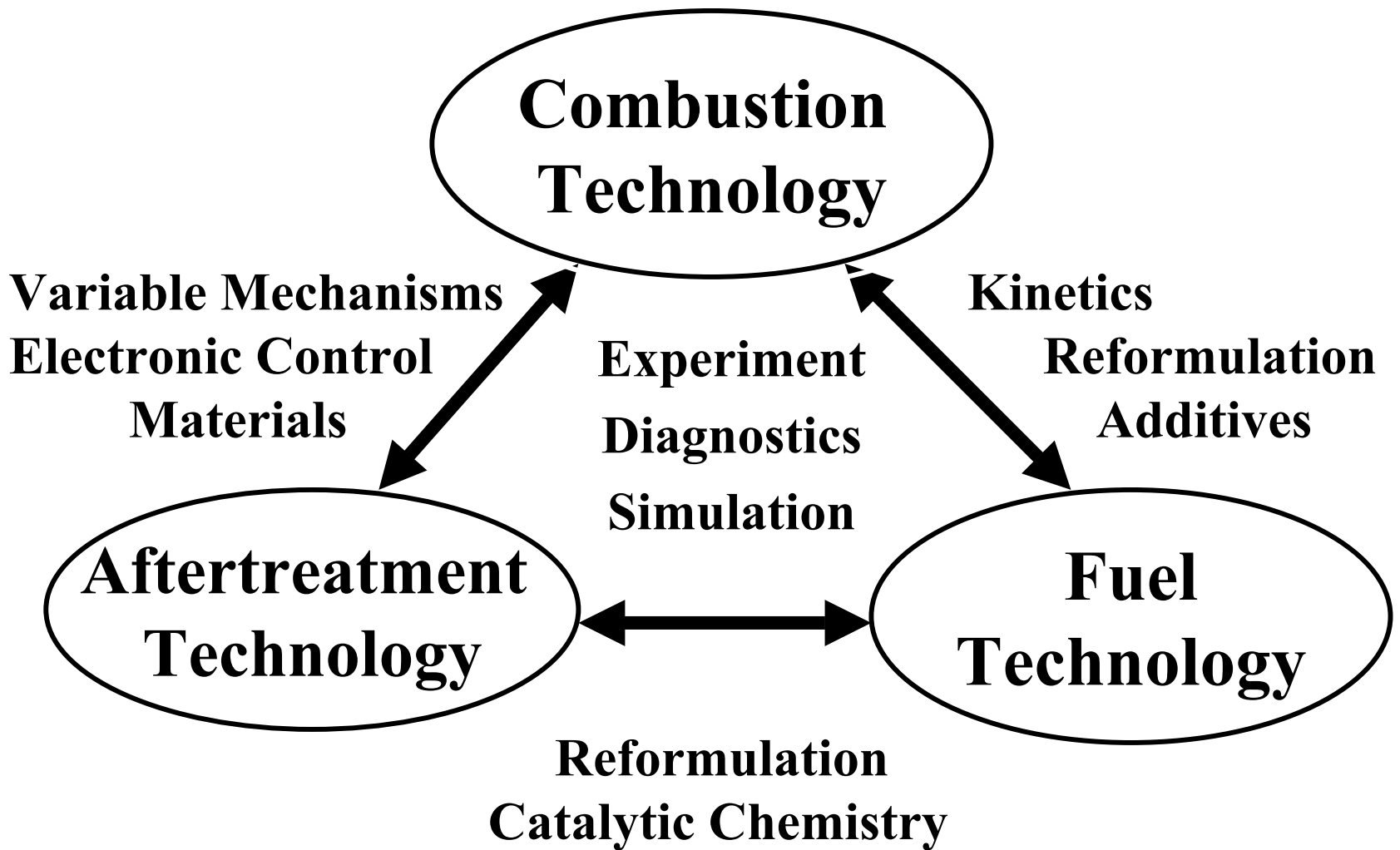
Improvement    ⊙: 10%<    ○: 5-10%    □: 5%>

Items		Technologies	
Engine	New concept	⊙GDI ⊙Miller cycle	⊙Hybridization ○Lean burn
	Control		○Stopping engine at idle □Precise fueling and ignition timing □Variable Intake/Valves (SCV, VVT)
	Pumping loss reduction		○Modulated displacement □Four valves
	Friction reduction		□Improving lubrication □Lightweight moving parts
Drivetrain		○CVT □Lockup mechanism	○Automated MT
Vehicle body		⊙Lightweight materials ⊙Low air drag □Low rolling resistance tires	



# Gasoline Direct Injection Engine

(Mitsubishi Motors Corp., 1995)



**Three Key Technologies for Improving Emissions  
and Efficiency in SI and Diesel Engines**

**Ordinary EV**

```
graph TD; A([Ordinary EV]) --> B[Advanced Technologies]; B --> C[Batteries, Electronic Control, Lightweight Materials, Devices, and Engines]; C --> D([Micro EV]); C --> E([Fuel Cell Vehicle]); C --> F([Hybrid Vehicle]);
```

**Advanced Technologies**

**Batteries, Electronic Control,  
Lightweight Materials, Devices, and  
Engines**

**Micro EV**

**Fuel Cell Vehicle**

**Hybrid Vehicle**

**Variations of the Electric Vehicle**



# **Next Generation EFVs to be Developed by 2010 and to be Disseminated by 2020 (proposed by MLIT, 2001)**

## **Passenger Cars & Light-Duty Vehicles**

### **Technical Targets**

- \*Halved Fuel Consump.**
- 1/2 CO<sub>2</sub> Reduction**
- \*Near Zero Emissions**

### **Vehicle Types**

- \*Hybrid PCs**    **\*FC PCs**
- \*LD Hybrid Vehicles**
- \*LD CNG Vehicles**

## **Heavy-Duty Vehicles**

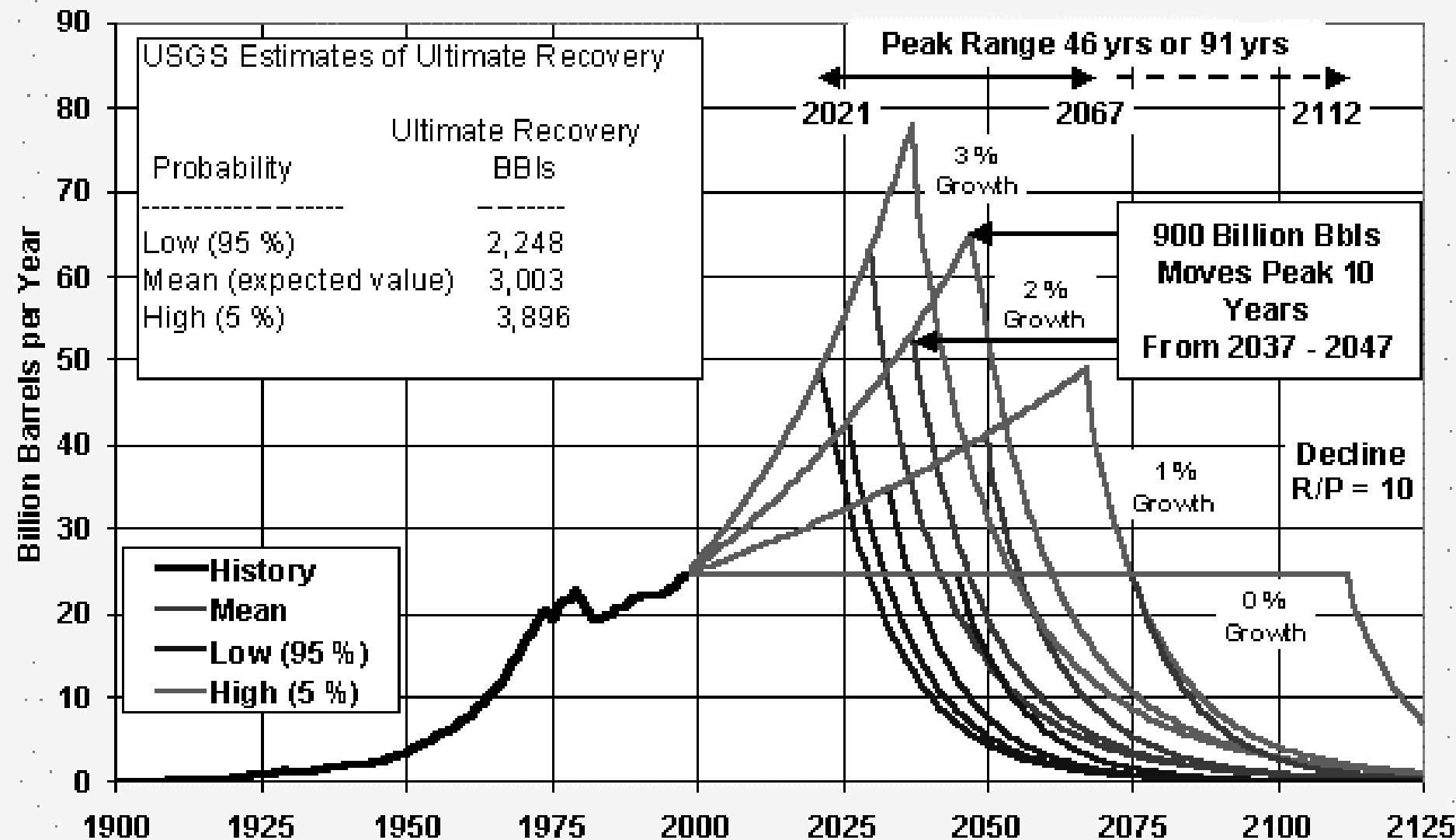
### **Technical Targets**

- \*1/10 of 2005 Diesel NO<sub>x</sub>  
Std. (0.02 g/kWh)**
- \*Near Zero PM**
- \*Diesel-Like Efficiency**

### **Vehicle Types**

- \*Hybrid Vehicles**
- \*CNG & DME Vehicles**
- \*Super Clean Diesels**
- \*FC Buses**

# 12 EIA World Conventional Oil Production Scenarios

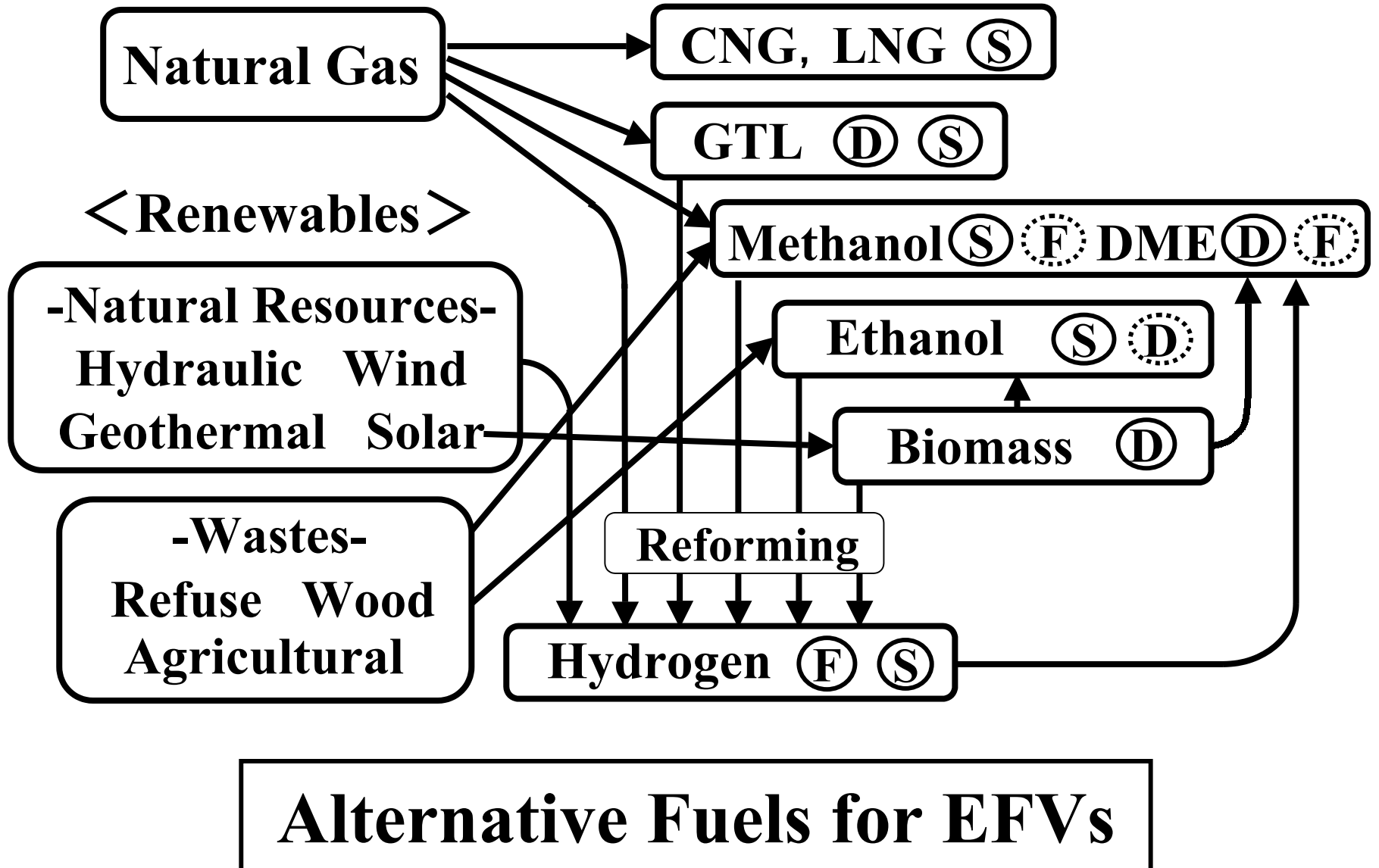


Note: U.S. volumes were added to the USGS foreign volumes to obtain world totals.

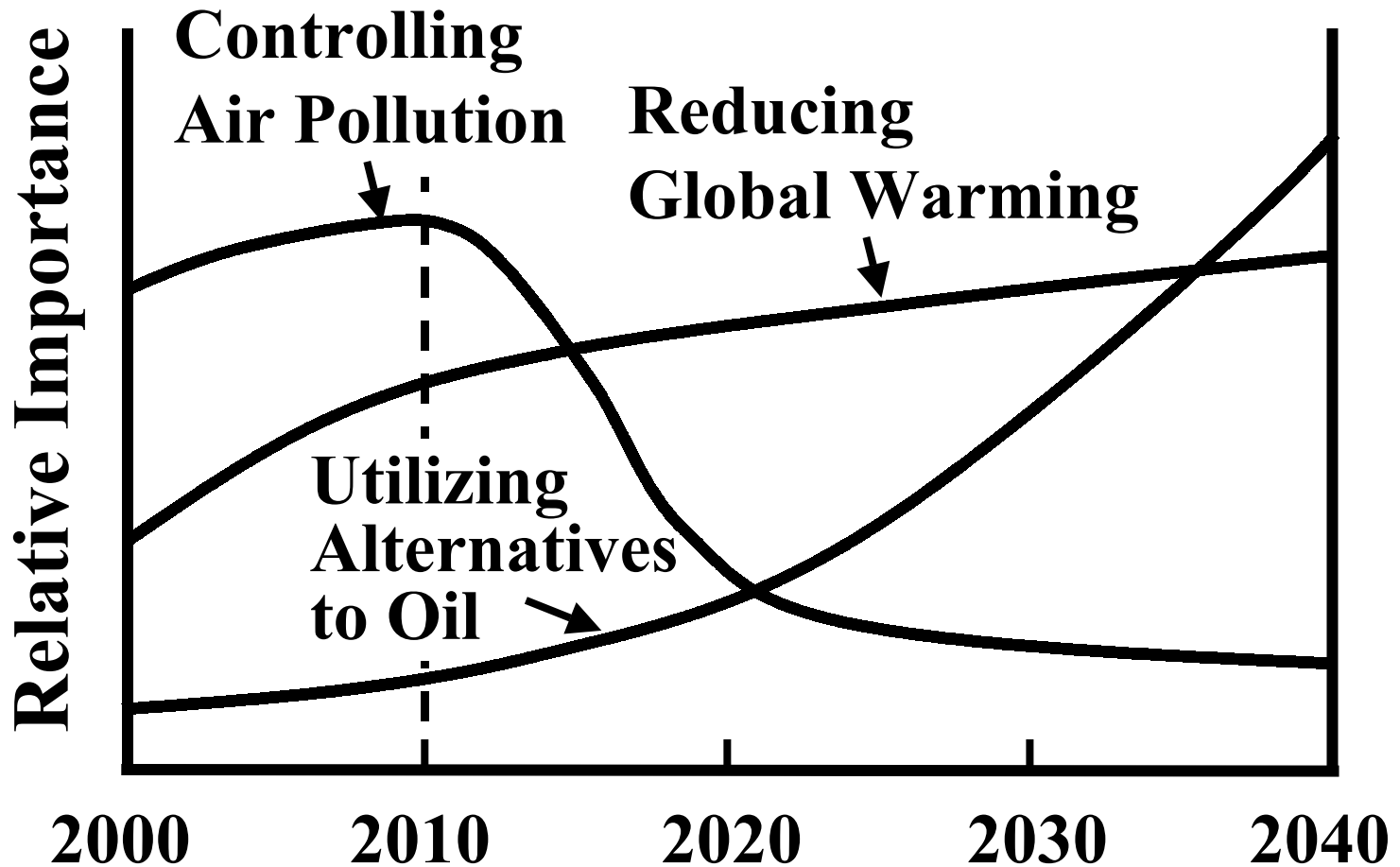
Ⓢ: SI Engine

ⓓ: Diesel Engine

ⓕ: Fuel Cell



**Alternative Fuels for EFVs**



**Future Relative Importance of Policy and R&D for EVFs**