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“Developing Advanced Technologies for Environmentally Friendly Vehicles”

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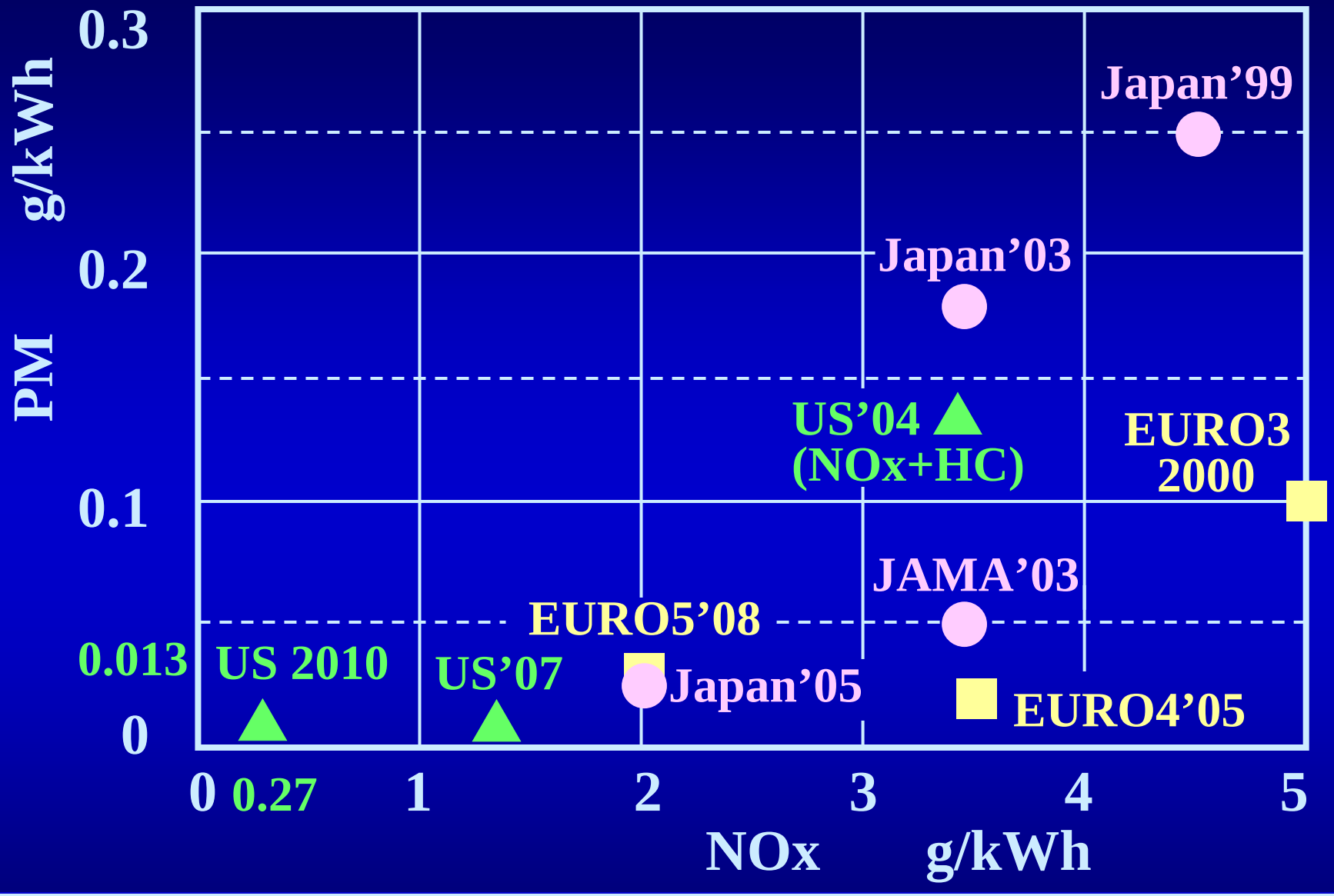
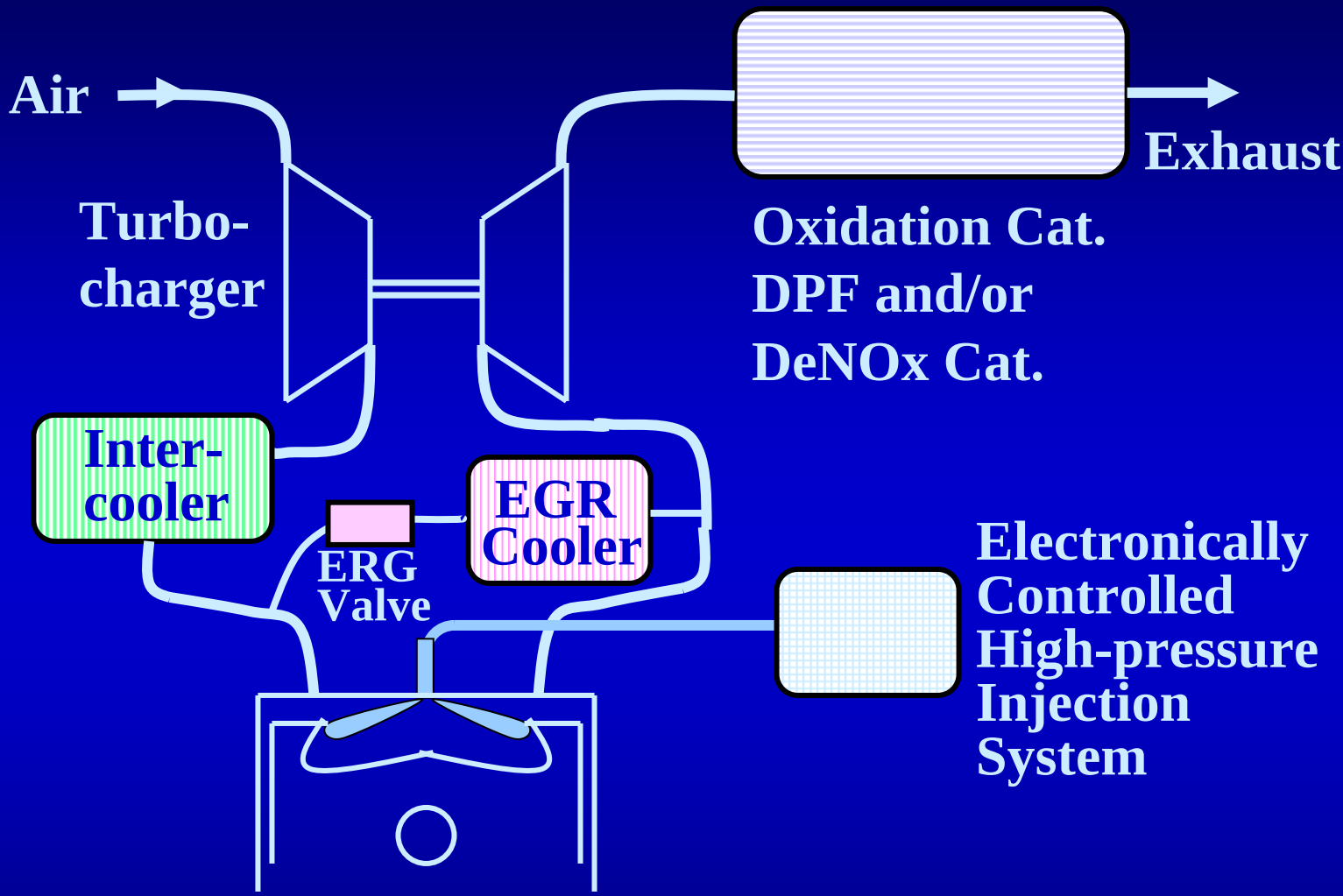
Requirements of Environmentally Friendly Vehicles and Fuels

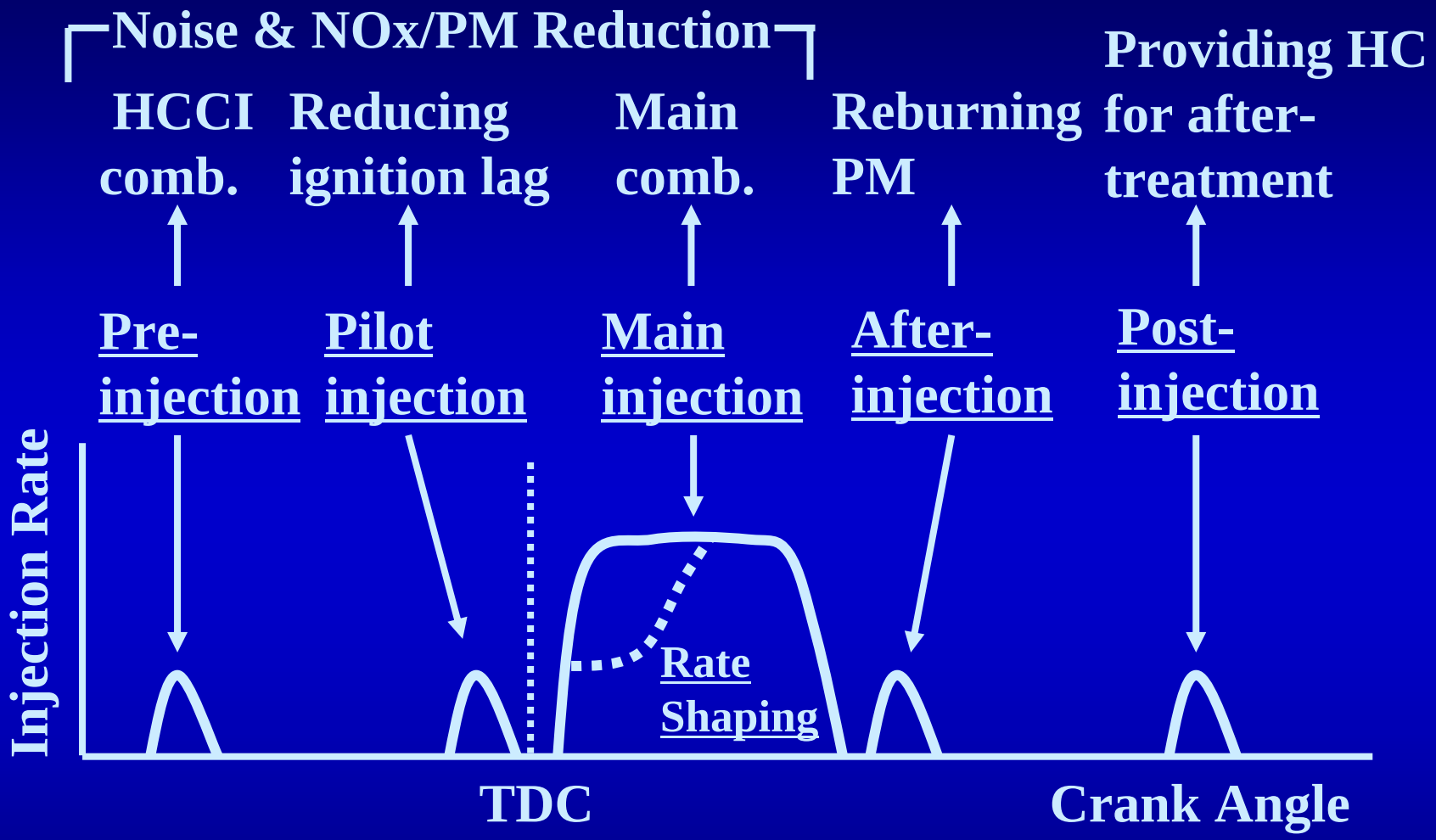
- High Vehicle Performance
- Safe, Reliable and Durable
- Ultra-Low/Zero Emissions
- Highly Efficient
- Low CO_2 Emission
- Energy Diversity
- Renewable
- Sustainable
- Affordable
- Available
- Cost-Effective
- Symbolic



HD Diesel NOx and PM Emissions Regulations



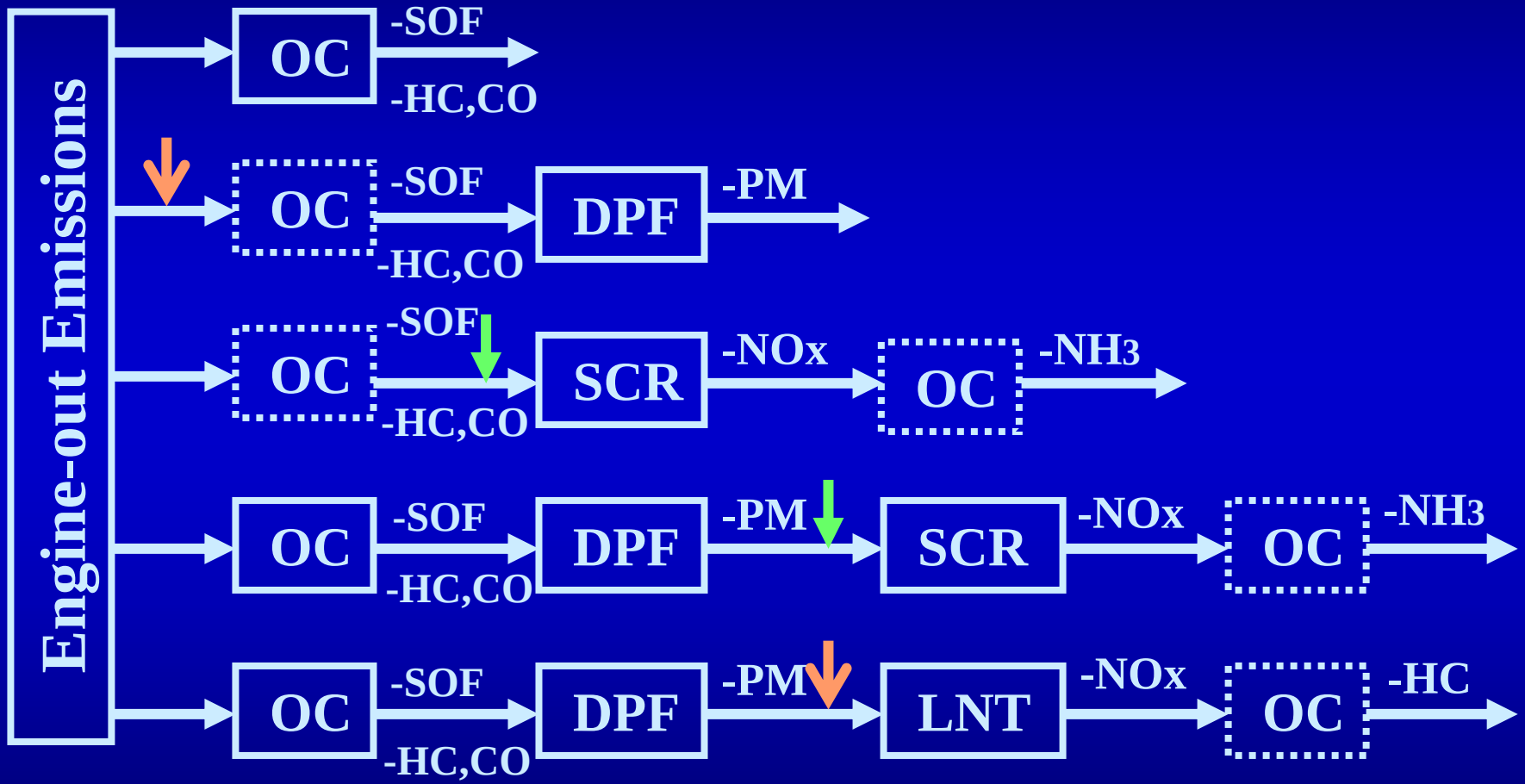
A Typical Diesel Emission Control System



Controlling Diesel Combustion by means of Multiple-Injection

OC: oxidation catalyst
SCR: selective catalytic reduction
LNT: lean NOx trap

: Urea
: Fuel



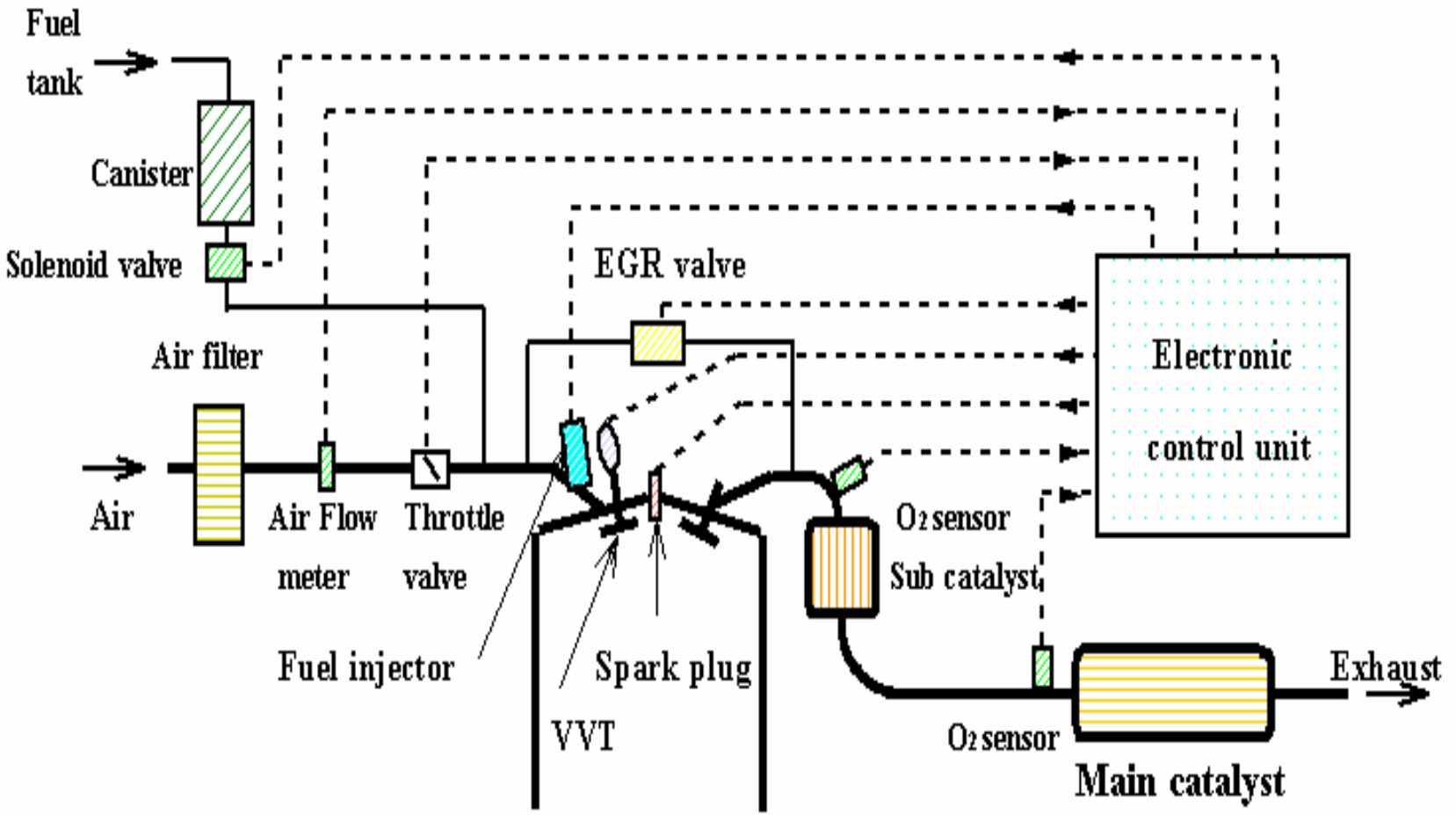
Various Combined Diesel Aftertreatment Systems

Problems with DPFs

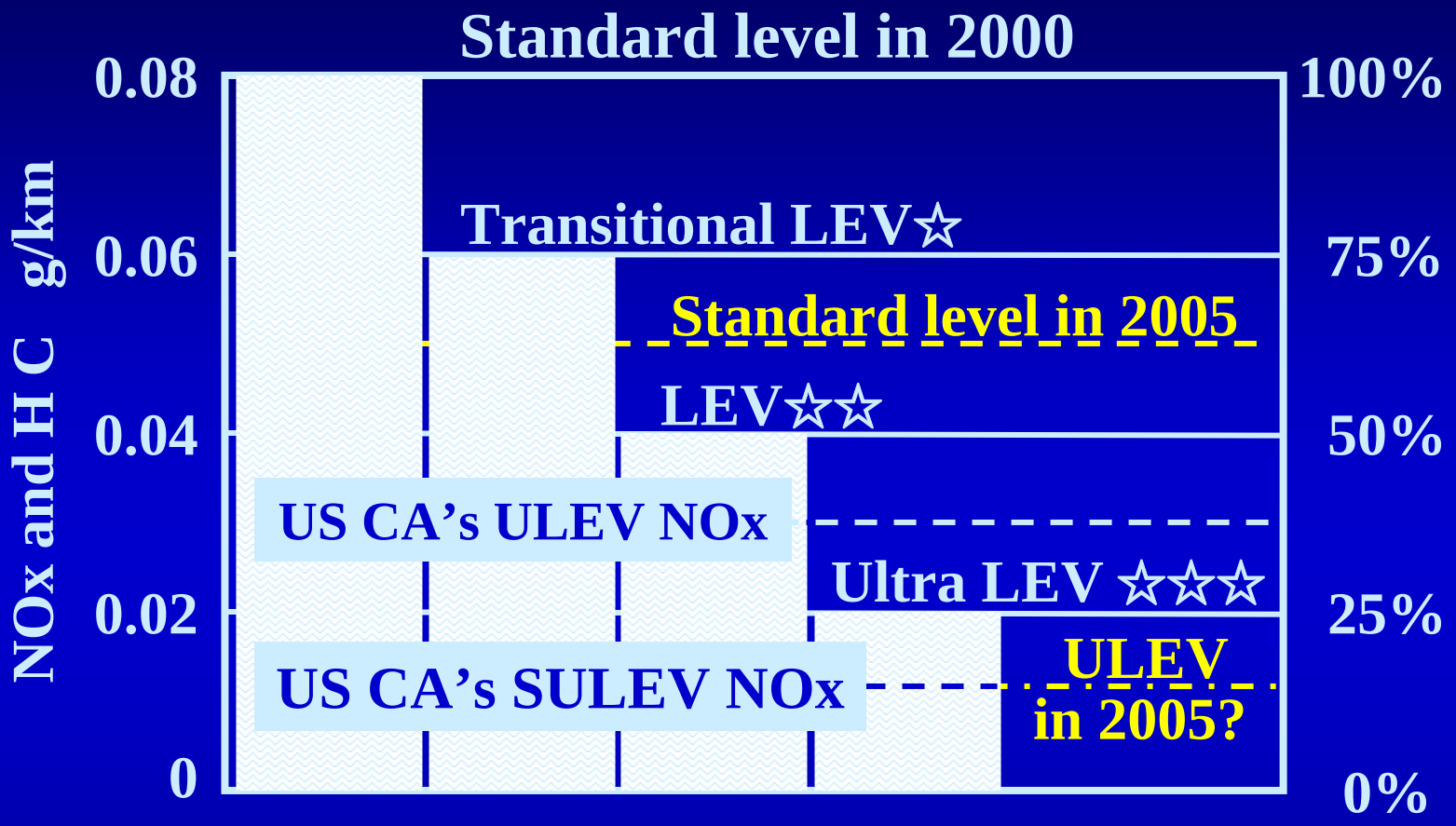
- Optimizing regeneration at low speed and load
  - * Raising exhaust temperatures with post-injection
  - * Co-using an oxidation catalyst
  - * Doping catalytic fuel additives to lower regeneration temperatures
- Optimizing the filter material and pore structure
- Ash deposition within the filter
  - * Using ash-free lubricants
- Sulfur poisoning of the catalysts
  - * Removing sulfur by raising exhaust gas temperatures
  - * Using low-sulfur fuel
- Adsorbed HCs, SOF and nano-particles
  - * Using an oxidation catalyst

Problems with SCR and LNT

- Problems in general
  - * Improving conversion efficiency under transient and low-speed/load conditions
  - * Improving durability and reducing cost
- SCR(Selective Catalytic Reduction)
  - * Locating urea-supply stations
  - * Reducing side-emissions (HCNO, N_2O, NH_3 , etc.)
- LNT(Lean NOx Trap)
  - * Recently significantly improving
  - * Optimizing fuel supply as a reductant
  - * Removing adsorbed sulfur
    (Sulfur-free diesel fuel is necessary.)



A Typical System for Reducing Emissions in the SI Engine

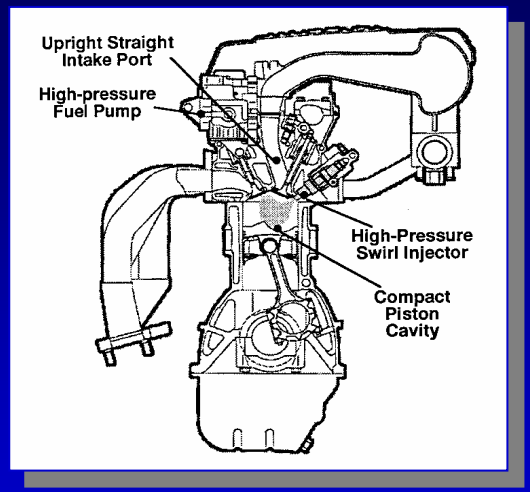


Present Standard and Low Emission Levels for Gasoline Passenger Cars in Japan

Technologies for Improving Fuel Economy

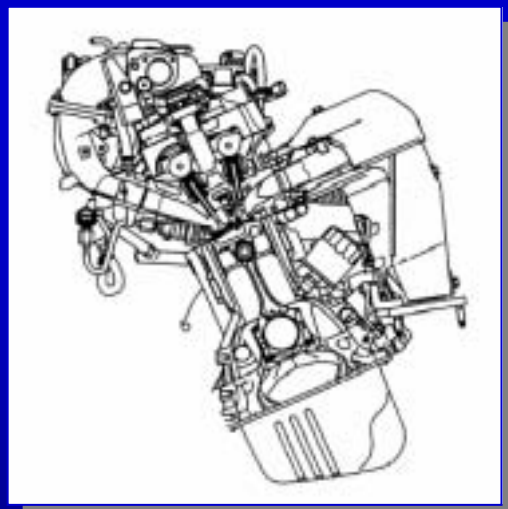
Improvement ◎: 10%< ○:5-10% □:5%>

Items		Technologies
Engine	New concept	◎Direct-injection ◎Hybridization ◎Miller cycle ○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 ○Automated MT □Lockup mechanism
Vehicle body		◎Lightweight materials ◎Low air drag □Low rolling resistance tires



Mitsubishi's GDI, 1995

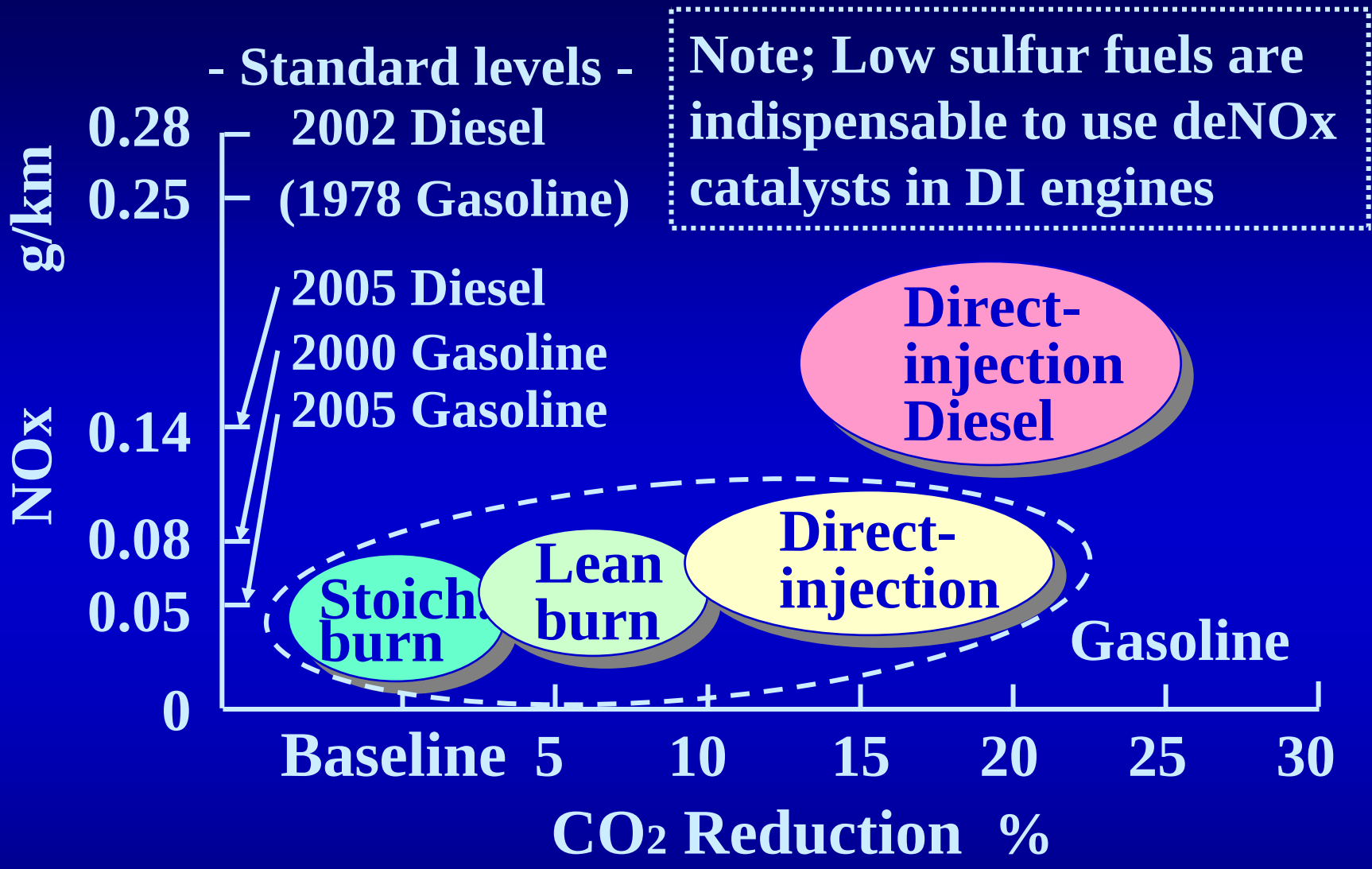
Nissan's NEO-DI, 1997



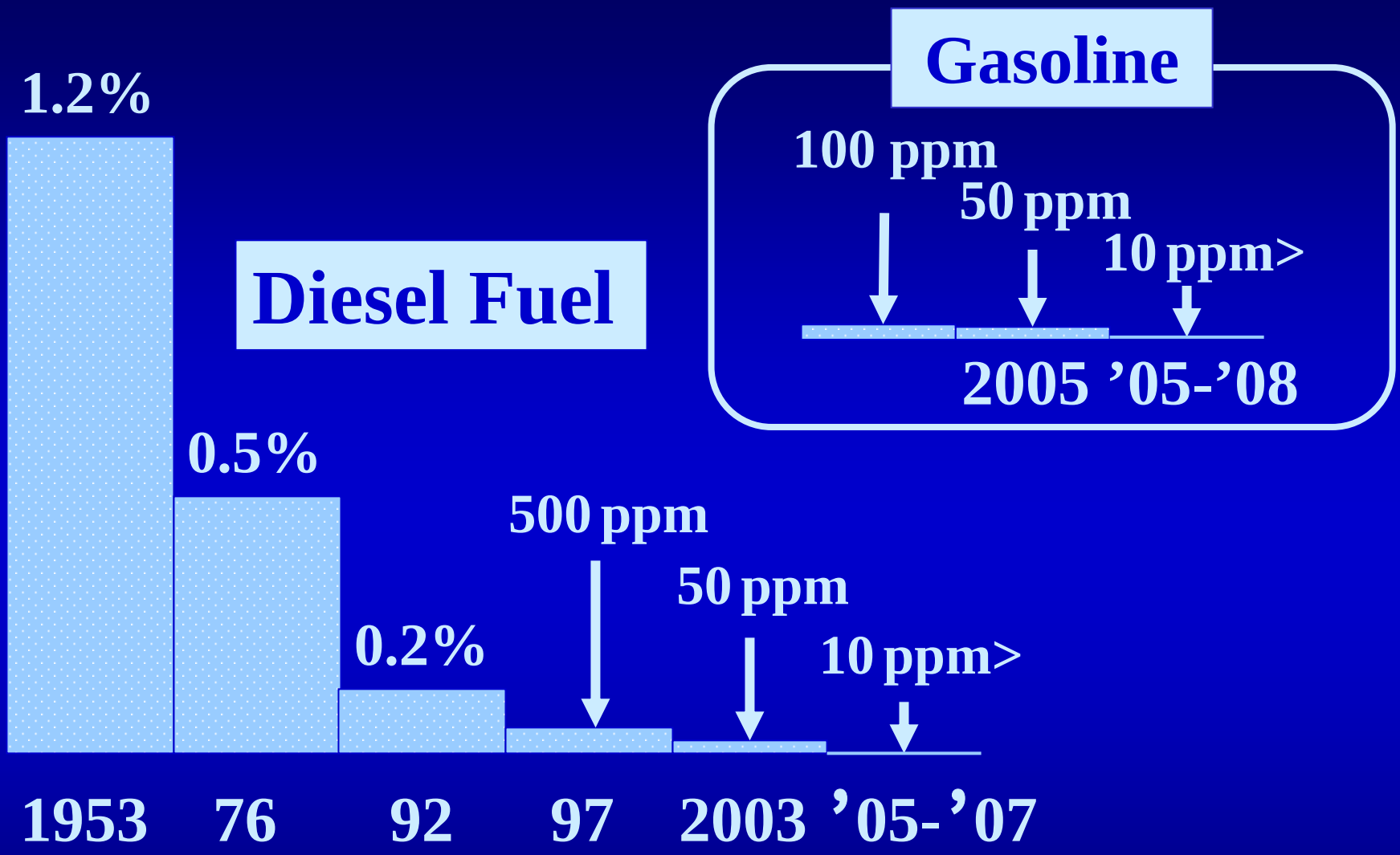
Toyota's D4, 1995

Honda's i-VTEC I, 2004

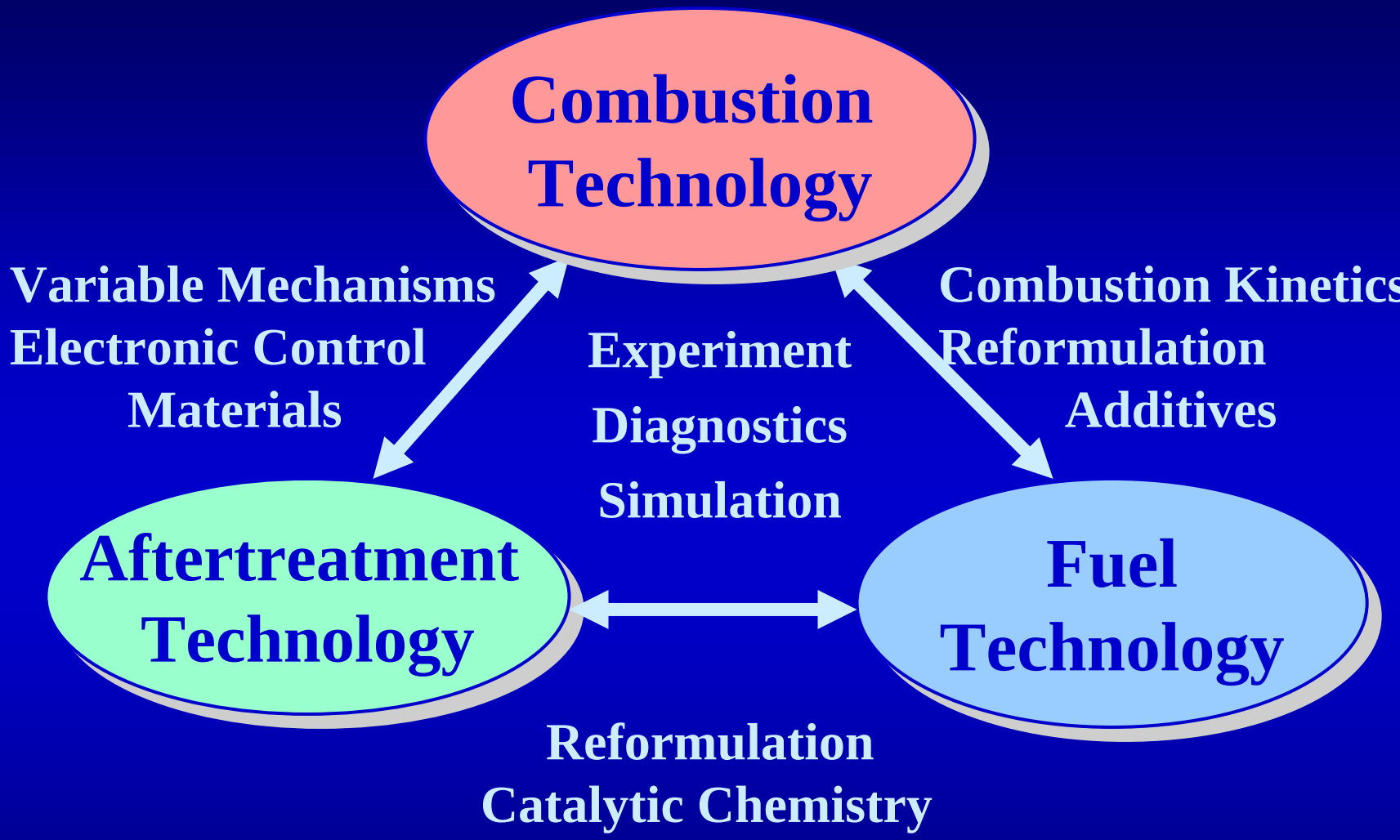
Direct Injection Gasoline Engines



NOx-CO_2 Trade-offs of Gasoline and Diesel Passenger Cars



Desulfurizing Fuels in Japan



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

"The Action Plan for Developing and Disseminating Low Emission Vehicles"

~ MLIT, METI and MOE in July, 2001 ~

- **Disseminating 10 million LEVs for practical use by the year 2010. Included are:**
  - **a) CNG, Electric, Hybrid and Methanol Vehicles**
  - **b) Vehicles meeting the 2010 fuel economy standard and 2000 LEV guideline.**
- **Developing "Next-Generation LEVs" including:**
  - **a) FC Vehicles (50,000 FCVs introduced by 2010)**
  - **b) Super clean diesel, advanced hybrid system and DME engine for heavy duty vehicles**
- **Policy measures will be taken to achieve the targets.**

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_2 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 NOx Std. (0.2 g/kWh)
*Nearly Zero PM
*Diesel-Like Efficiency

Vehicle Types

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

MLIT's Project on Developing Next-Generation Heavy-Duty EFVs (2002-2004)

Vehicle Type (GVW)	Automaker	NOx	PM	CO_2 (Fuel Consump.)
DME Truck (20 t)	Nissan Diesel	1/4	nearly zero	equivalent to diesel
CNG Truck (25 t)	Japan Gas Association	1/4	zero	equivalent to diesel
Series Hybrid Bus (80 pass.)	Mitsubishi	1/10	1/4	1/2
Parallel Hybrid (15 t)	Hino	1/10	1/10	1/2
Super Clean Diesel (25 t)	New ACE	1/10	1/2	10% Reduction

Note: NOx and PM levels are relative to the 2005 new long-term diesel emission standard levels, and should be reduced to 1/10 and to nearly zero, respectively after 2010.

Electronically controlled EGR system with a cooler

Electronically controlled injection nozzles

Electronically controlled turbocharger

Four valve system

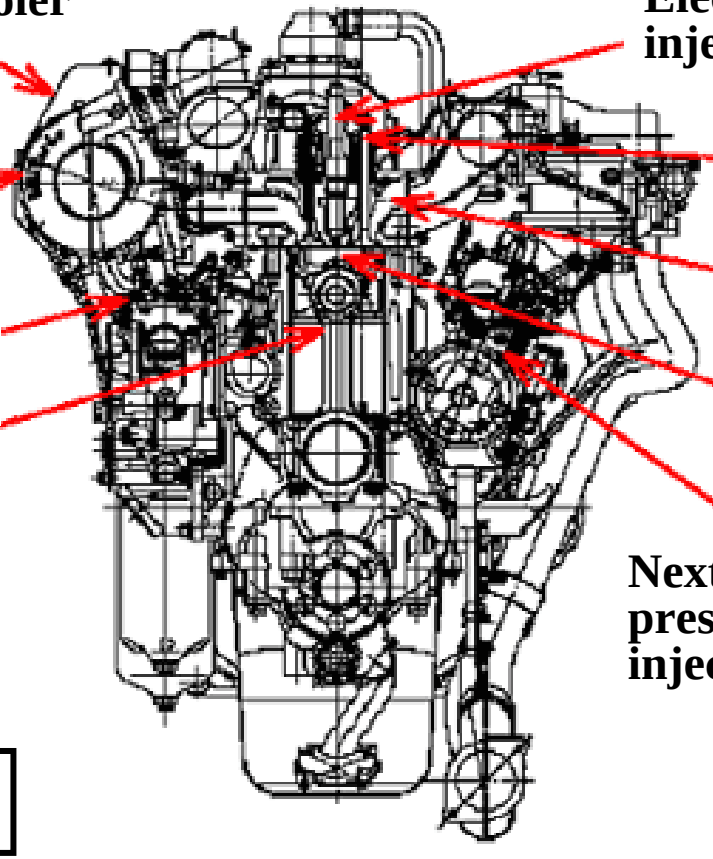
NOx & PM after-treatment system with NOx and O_2 sensors

Variable swirl intake port

High Pmax-resistant engine structure

Optimized combustion chamber

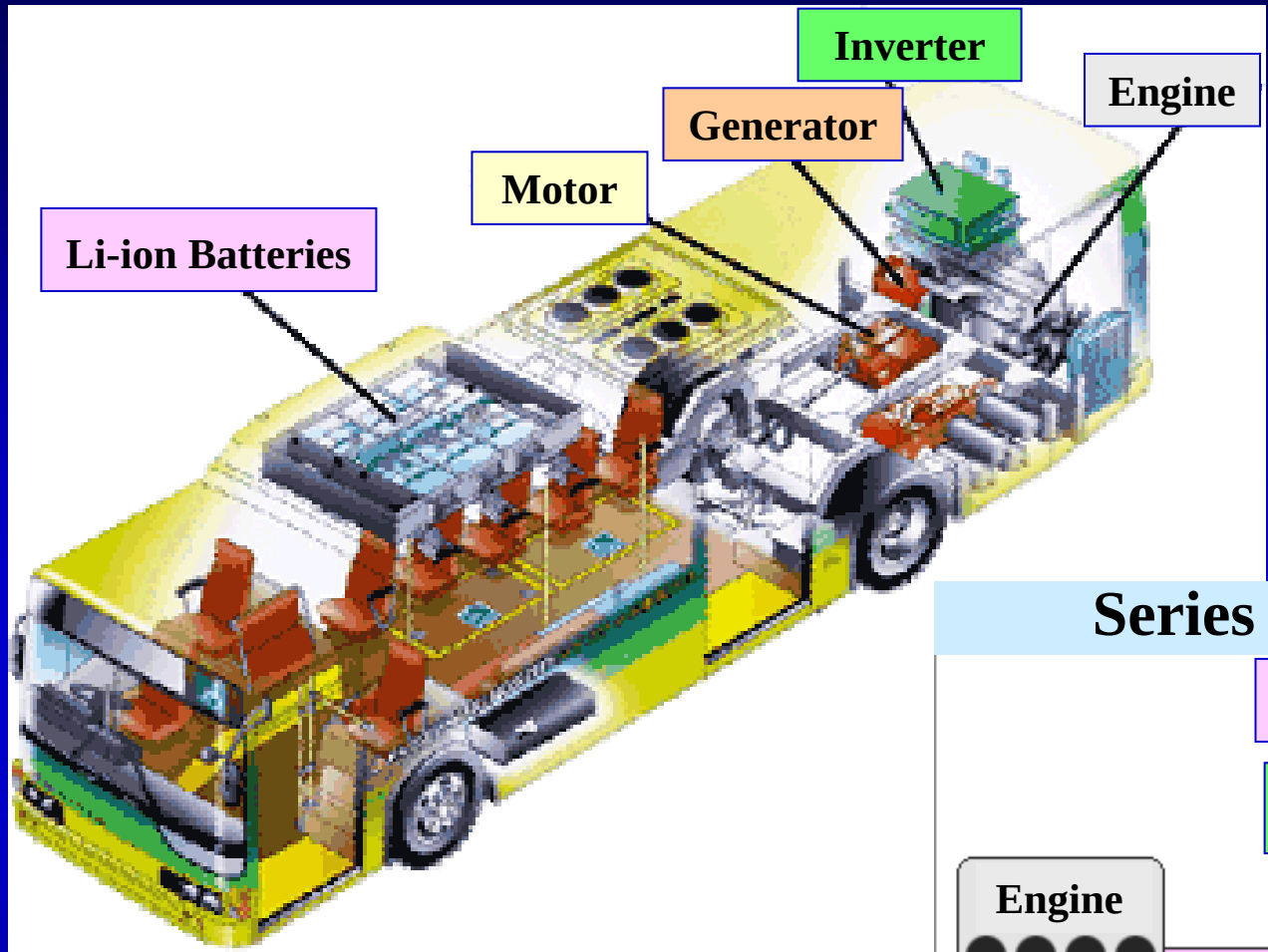
Next-generation high-pressure common rail injection system



Power: 280 kW

A Super-Clean Diesel Engine

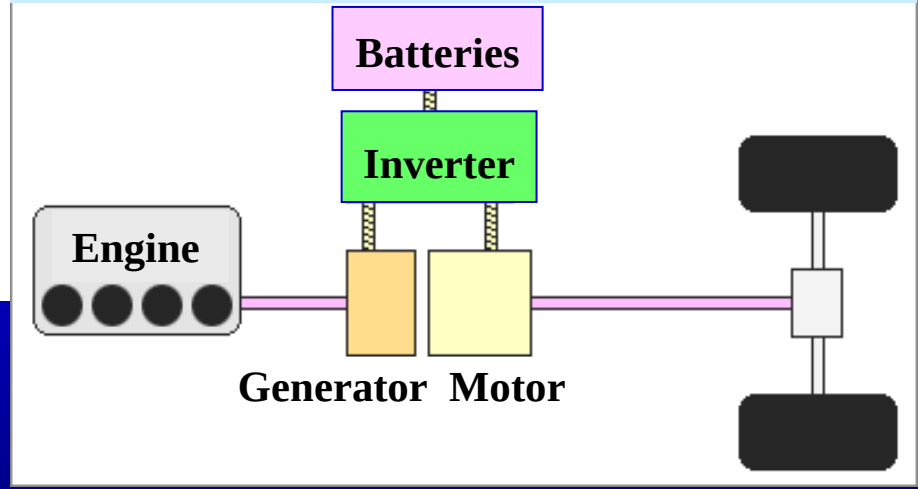
(New ACE, MLIT, 2002-2004)



Engine: 5 liters
Generator: 40 kW
Motors: 90 kW*2

GVW: 14 tons
Passengers: 78

Series Hybrid System

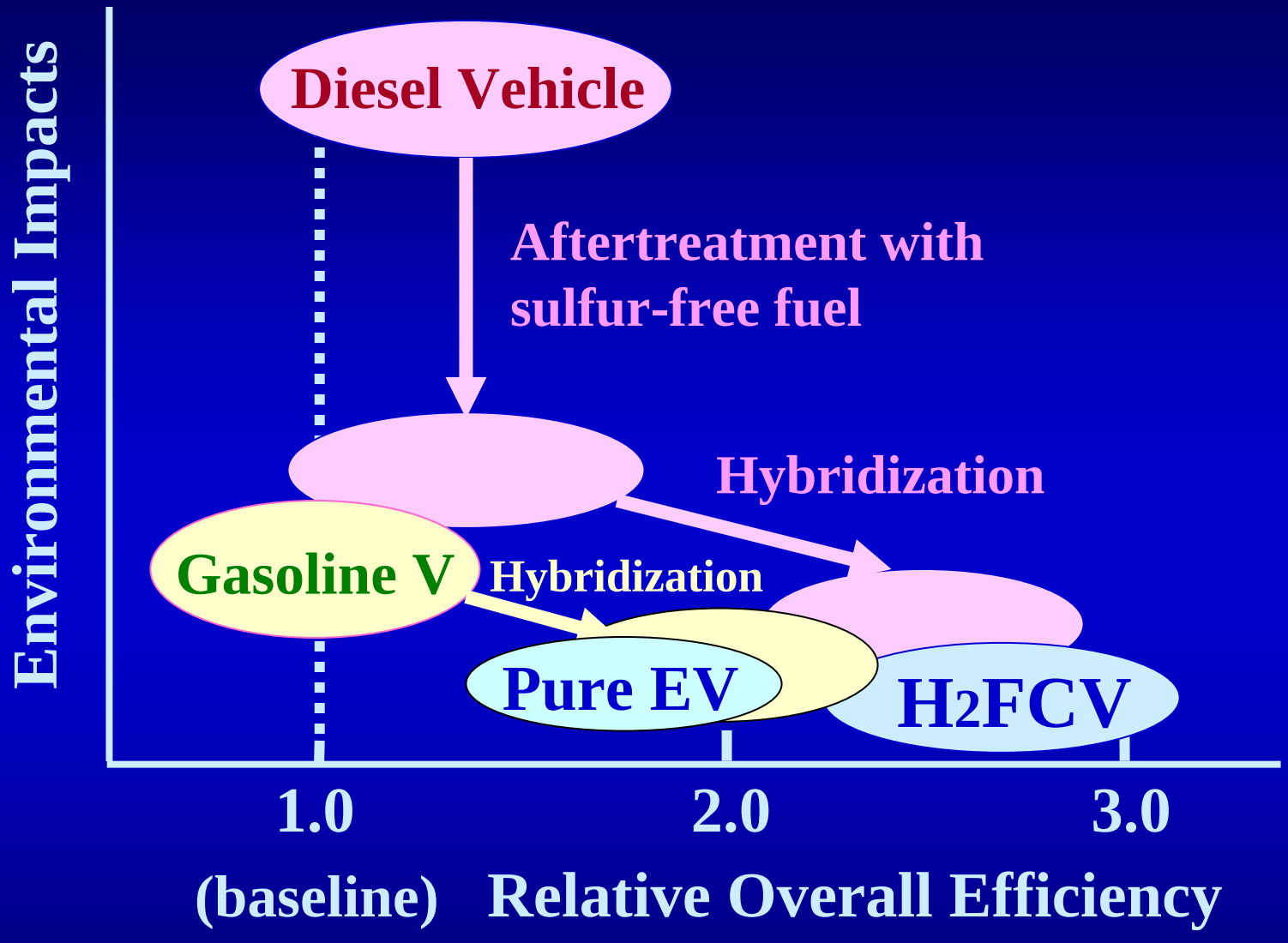


An Advanced Hybrid Bus (MLIT, 2002-2004)

-DME Truck-
GVW: 18 tons
Power: 200 kW

-CNG Truck-
GVW: 25 tons,
Power: 235-257 kW

Examples of Next-Generation EF Tracks (MLIT, 2001-2004)



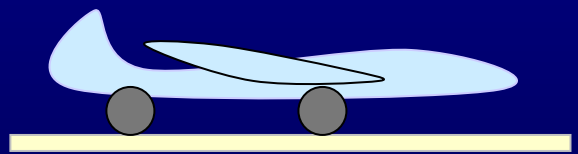
Comparison of Various EFVs

- Public Acceptance -

* Performance * Fuel economy
* Affordability * Reliability
* Safety * Zero-emission

- Policies -

* Incentives * Subsidies
* Deregulations
* Public awareness
* Standardizations



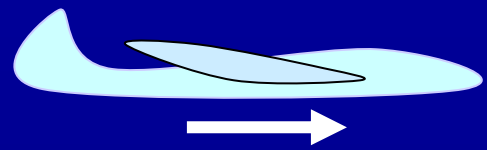
<Taxing on the runway>

~Demonstration~

2002 – 2010

(50,000 FCVs?)

(5,000,000 FCVs in 2020?)



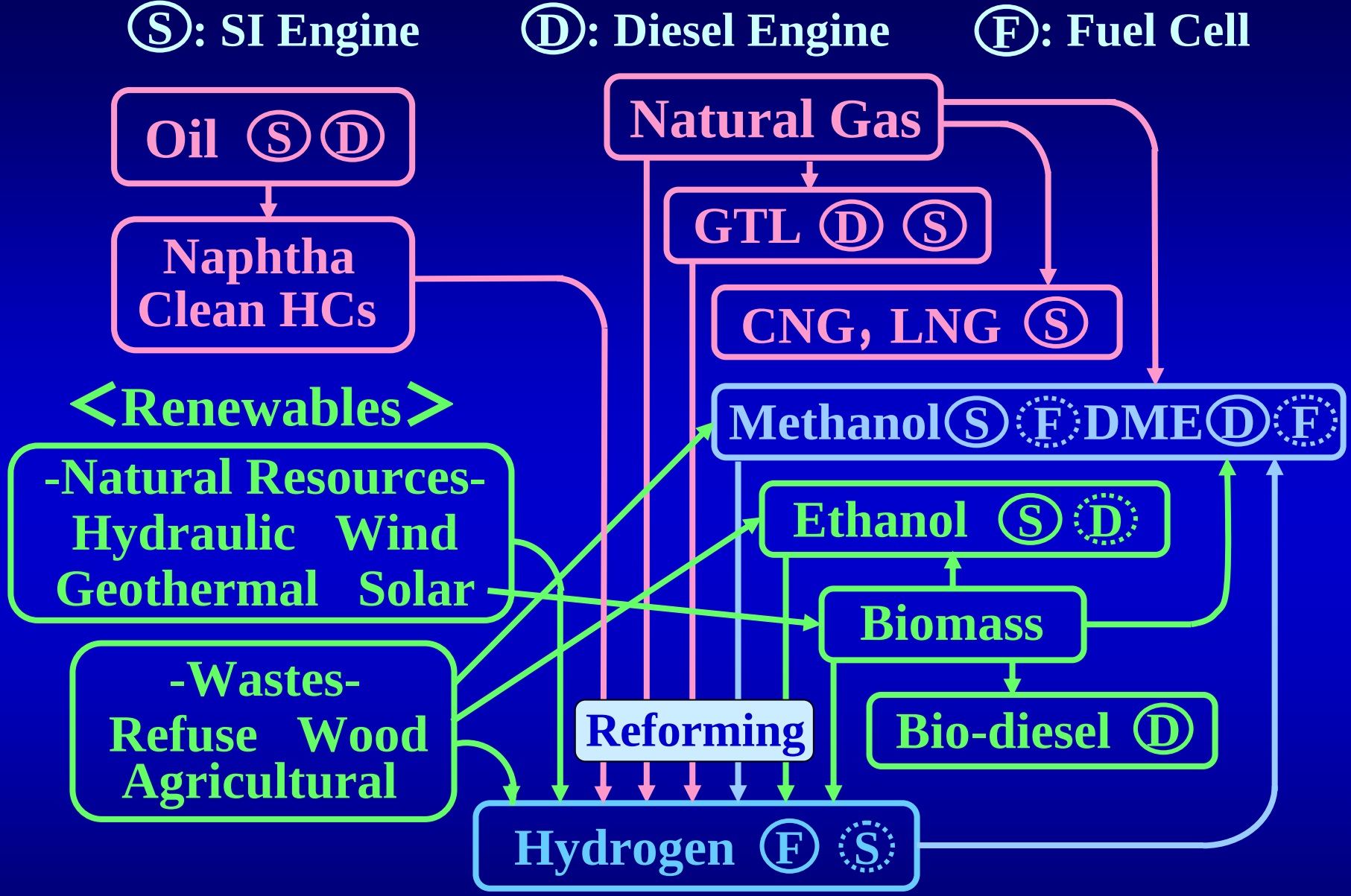
<Cruising>

~Commercialized~

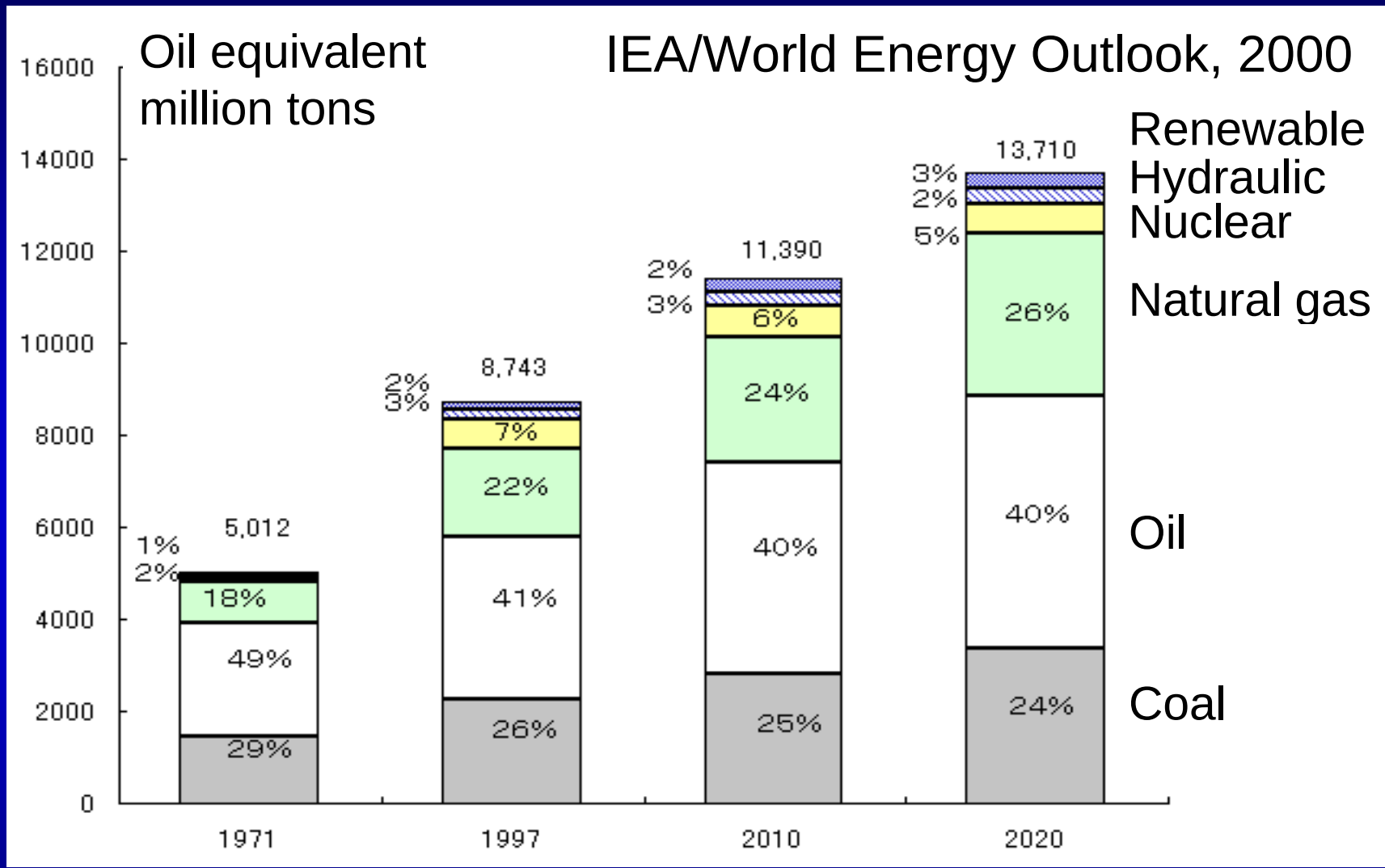
20X0

Coexisting and competing with conventional vehicles and fuels for decades

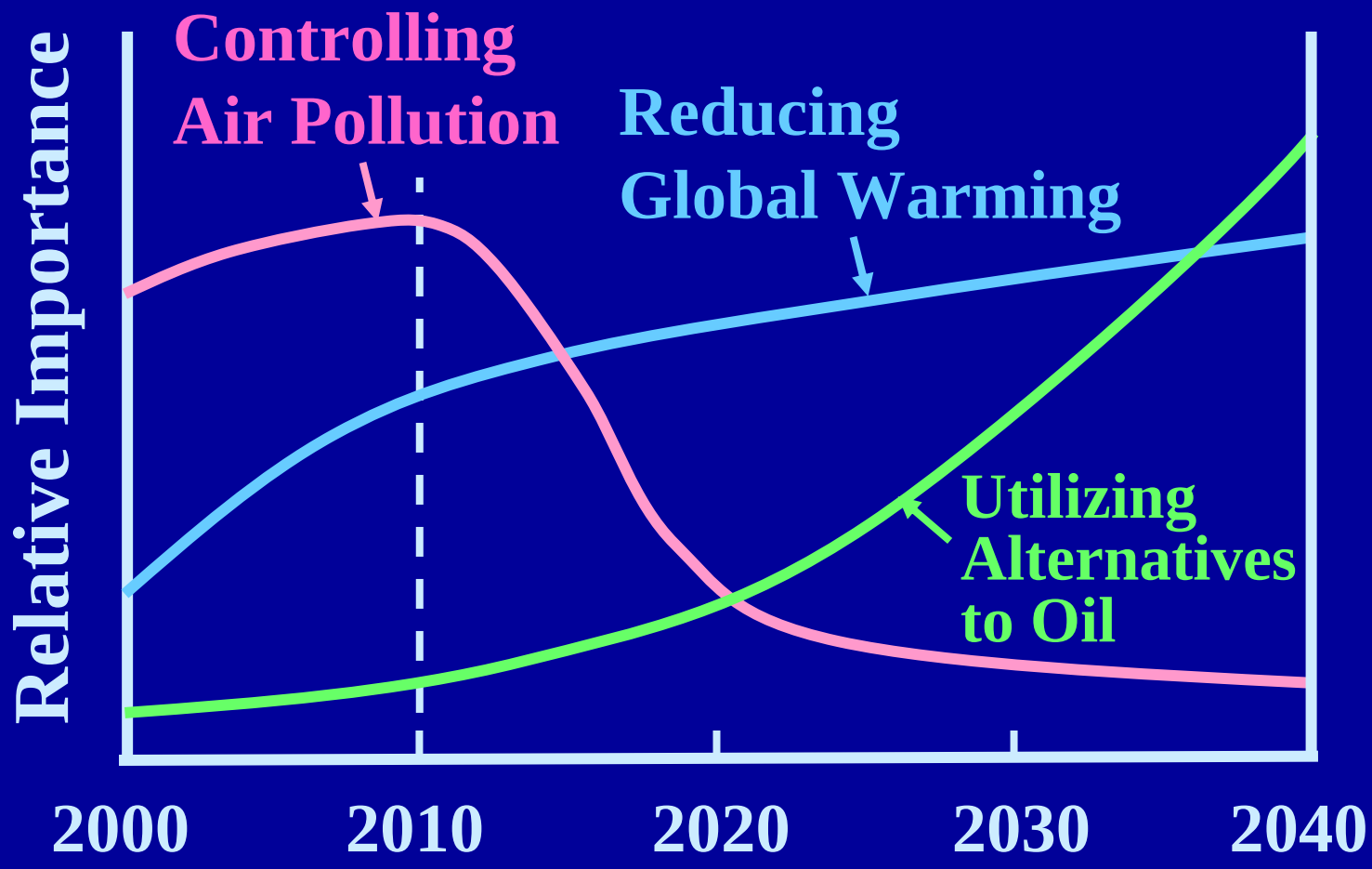
How to Create the Transitional Process for Introducing Fuel Cell Vehicles



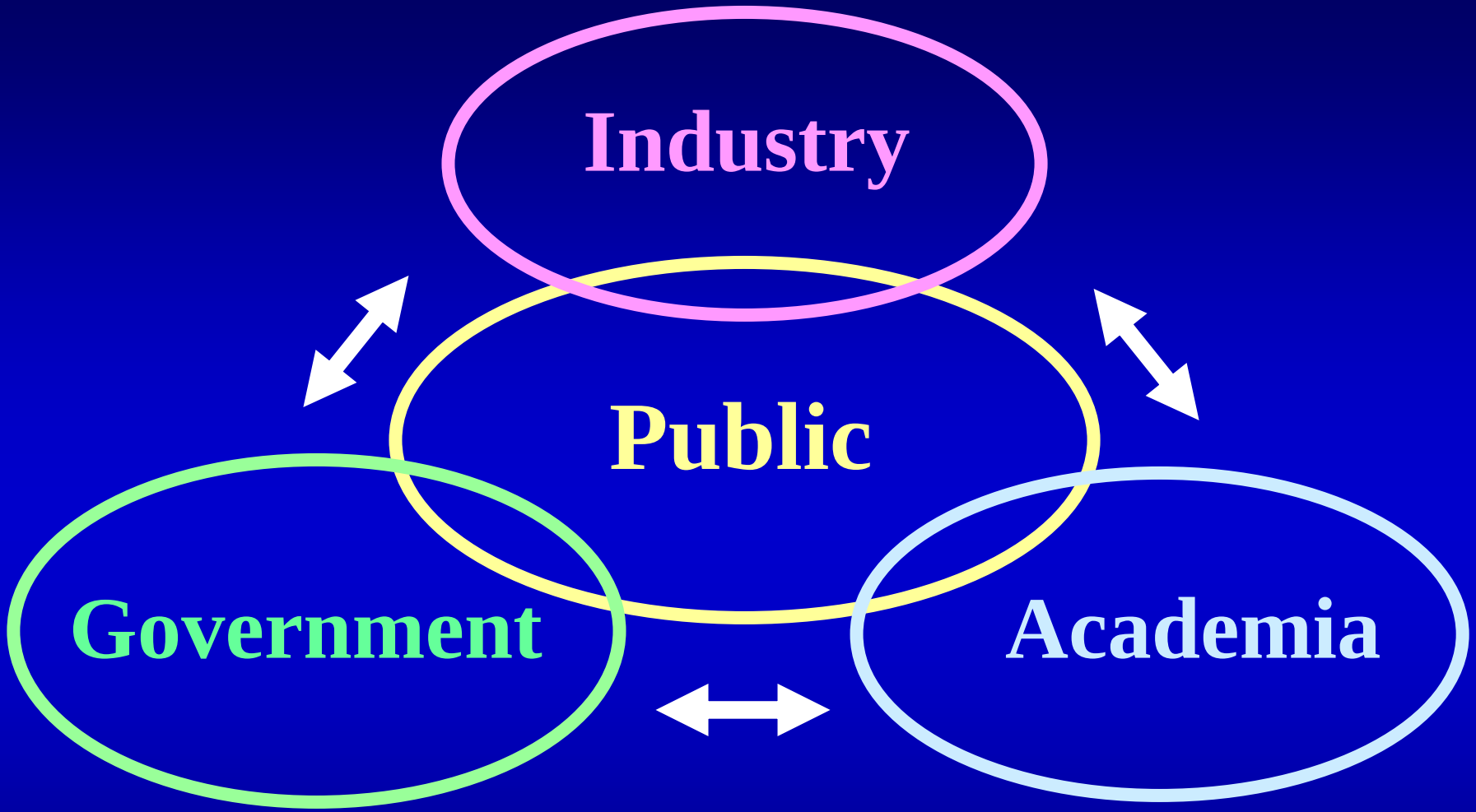
Alternative Fuels for EFVs



Energy Demand in the Past and the Future



Future Relative Importance of Policy and R&D for EVFs



R&D and Policymaking Collaboration

(Based on International Harmonization)