Automotive Development Trends and Associated Fuels in Japan

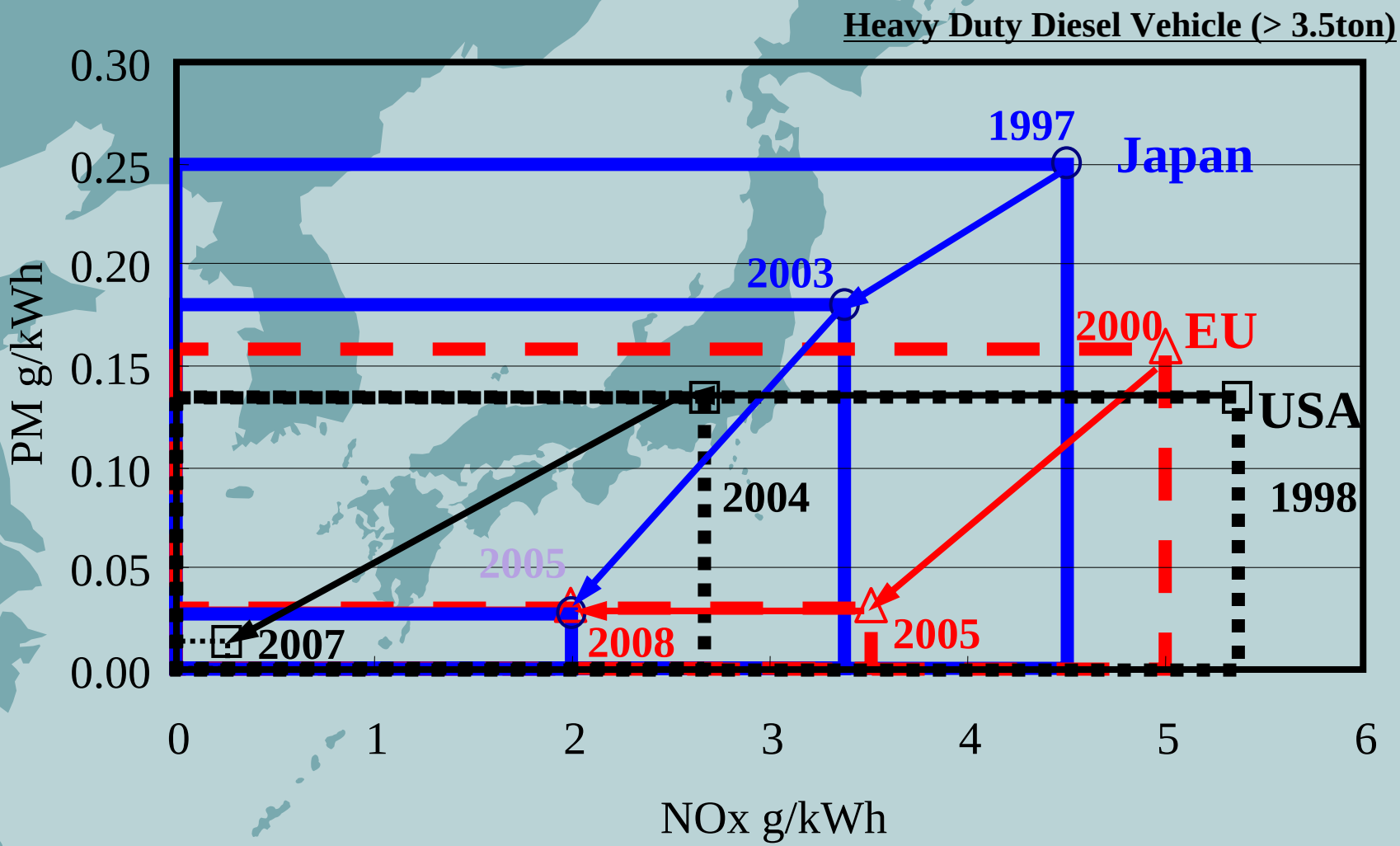
Koichi Nakazawa
Showa Shell Sekiyu K.K.

Toulouse, France
June 10, 2004

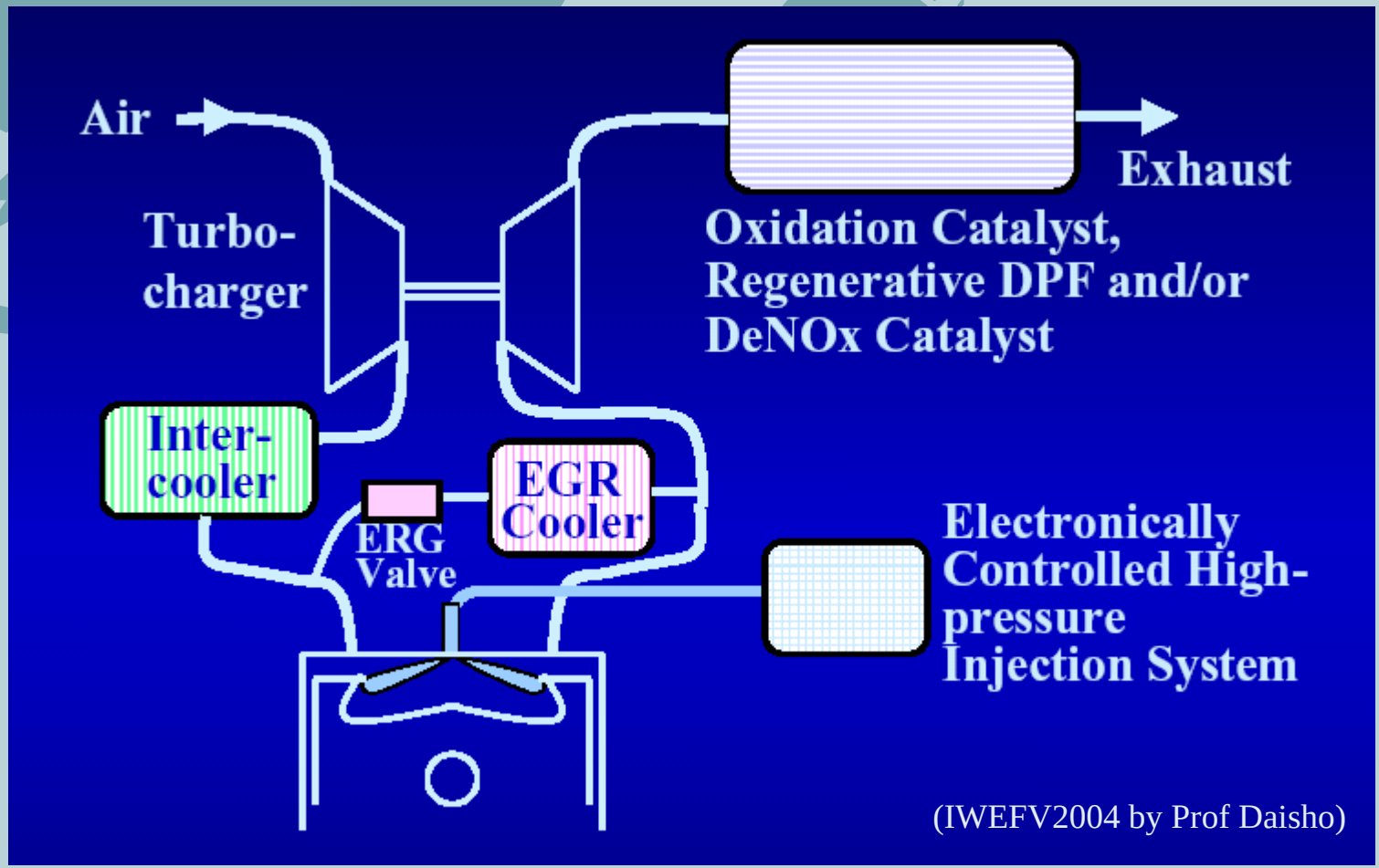
Contents

- Automotive Technology Trends
- Conventional Fuels
- Alternative and Renewable Fuels

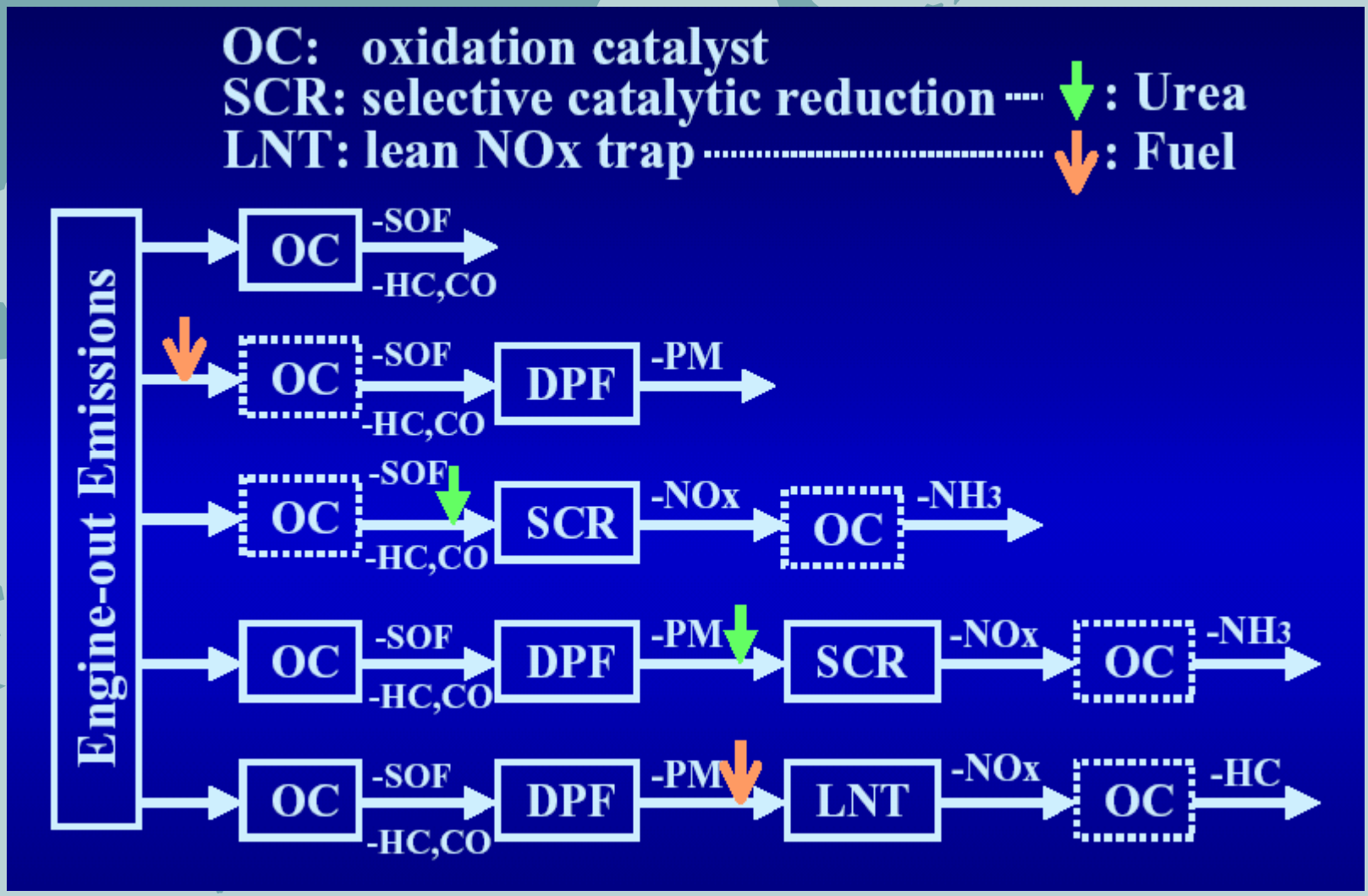
Heavy Duty Diesel PM and NOx Emissions Regulation



A Typical Diesel Emission Control System

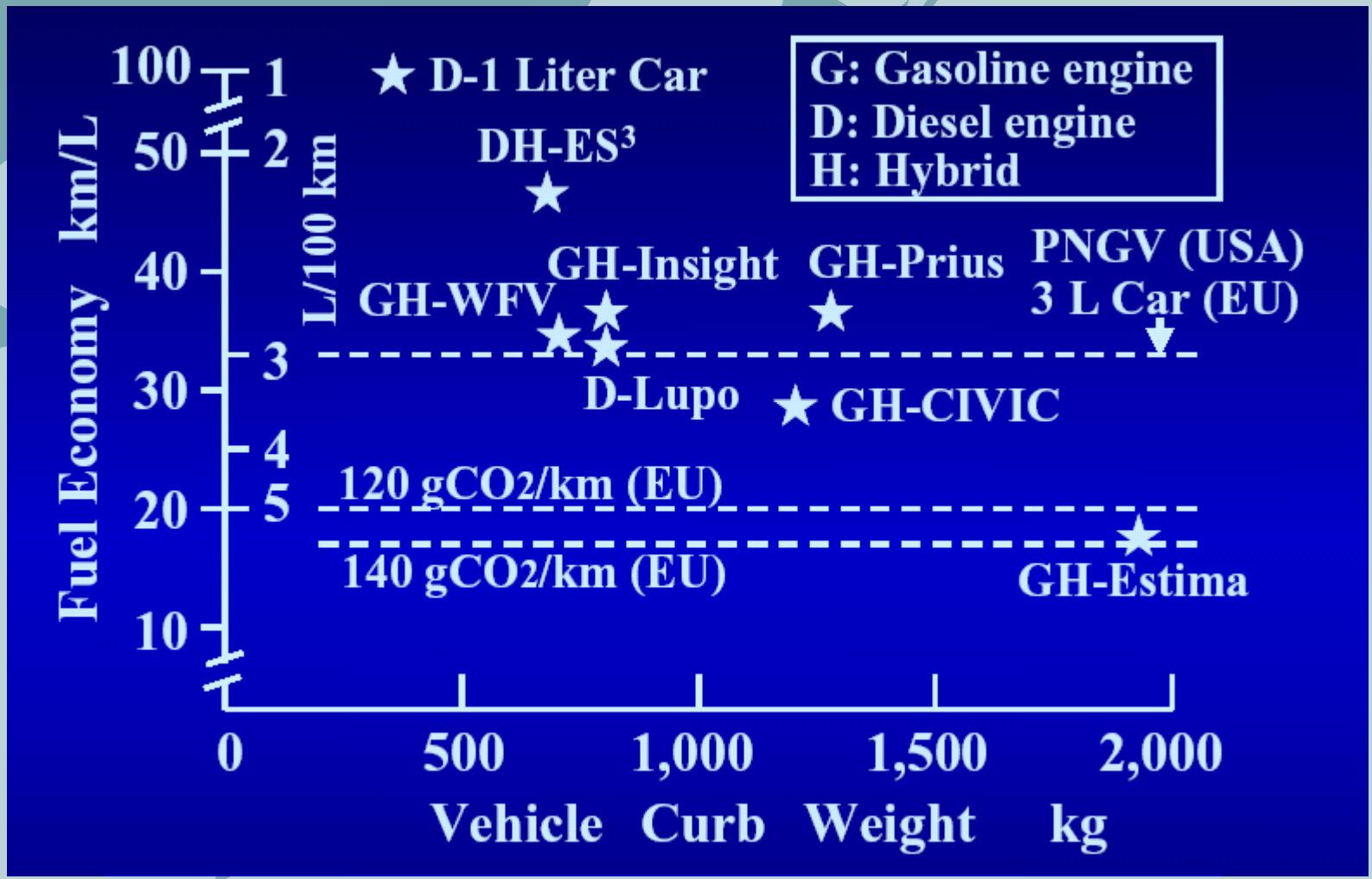


Various Diesel After-treatment Systems



(IWEFV2004 by Prof Daisho)

Fuel Economy of Advanced Diesel and Hybrid Vehicles



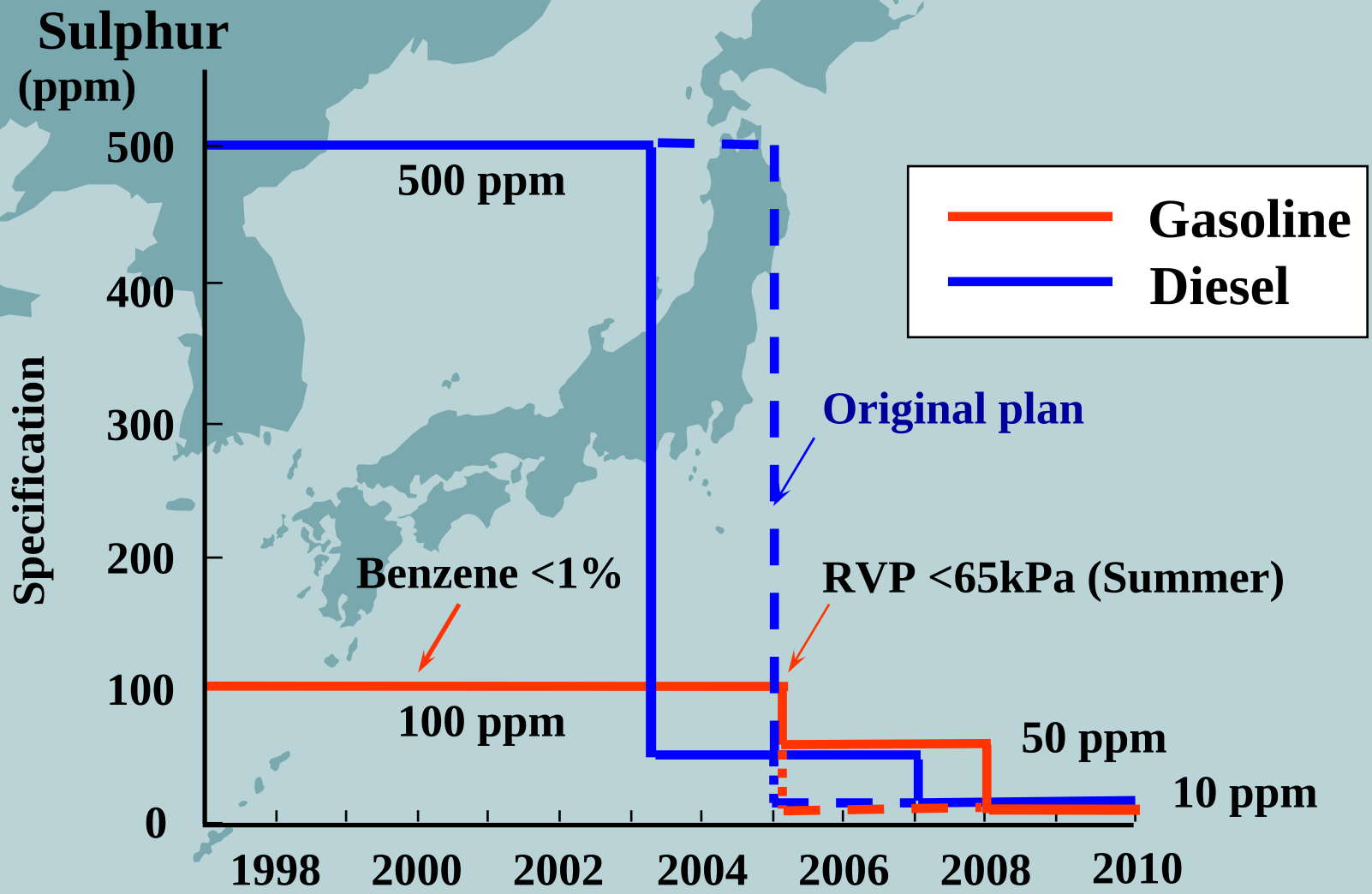
(IWEFV2004 by Prof Daisho)

HCCI (Homogeneous Charge Compression Ignition)

- Significantly low NOx and PM emissions at light load, achieving high energy efficiency compared to conventional diesel engines
- ✖ High HC and CO emissions
- ✖ Unacceptable explosive combustion at heavy load
- Highly dependent on temperatures and charge homogeneity
- Precise combustion control system must be developed
  - * flexible injection, EGR, variable valves, ignition sensing system, etc.
- Possible to improve SI engines' efficiency and emissions at light load
- Numerical combustion modeling is required

(Based on IWEFV2004 by Prof Daisho)

Specification of Sulphur Content for Gasoline & Diesel

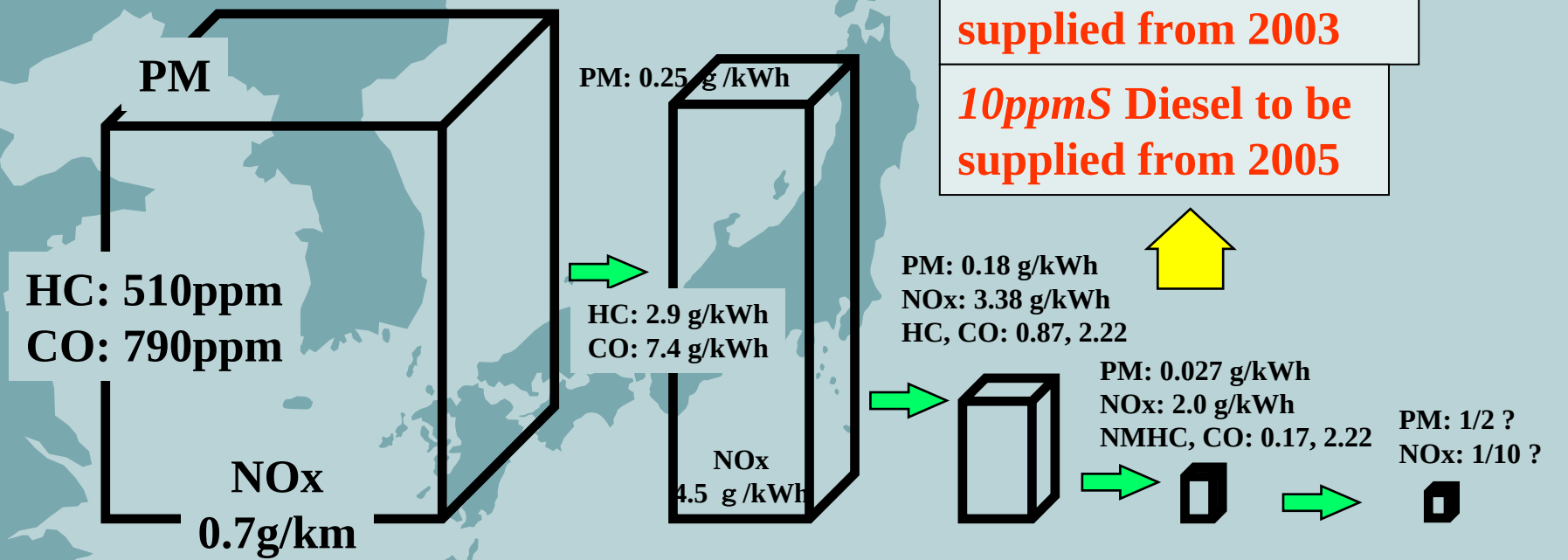


HD Diesel Emissions Regulation & Diesel Sulphur Content in Japan

Heavy Duty Diesel Vehicle (> 3.5ton)

Both New LT vehicles & *50ppmS* Diesel were supplied from 2003

***10ppmS* Diesel to be supplied from 2005**



1986	1992	1997	1998	2002	2005	Beyond 2010
before ST Reg			LT	New ST	New LT	Post New LT

S content in AGO

5000ppm 2000ppm 500ppm 50ppm 10ppm (2007)

ST: Short term LT: Long term

Study on E3 in Japan

MOE (Ministry of the Environment)

MOE have strong intention to introduce Ethanol blended gasoline into Japan to help COP3 target

* 1st step: Demonstration of E3 in cooperation with METI in 2004
  A few demonstrations by local governments
* 2nd step: Expand the use of E3 from 2005 to 2012. In 2012 most gasoline is expected to be a E3 blend

Final target is to launch E10 in conjunction with the introduction of E10 compatible vehicles into the Japanese market following E3 introduction

E3 Demonstration program by METI (2004 - 2005)

* To study the effects of ethanol blend, E3 demonstration is planned, focusing mainly on the fuel distribution system in Japan with respect to water contamination and so on.
* 6 service stations in the market place were selected and blending to refueling will be examined.
* Model tests with S/S tanks are also to be carried out

BDF Introduction into Japan

Objective

* BDF (FAME) is considered as a renewable fuel
* To identify best practice to use BDF as a blend component for diesel
* Max. percentage applicable for the existing vehicles in market place
* Specify FAME concentration in the Japanese specification.

Tests

* Phase 1: Many kinds of FAME including recycled food oil ME are under evaluation. FAMEs themselves and their blends are evaluated. Emission tests on the selected FAMEs are also planned
* Phase 2: From safety point of view durability tests with fuel injection systems and engines are planned for candidate FAMEs and different blend ratio

Legislation issue

* Conclusions will be made by end of 2004
* Maximum concentrations for FAME and oxygenates are to be regulated in the diesel fuel specification of the Fuel Quality Maintenance Law

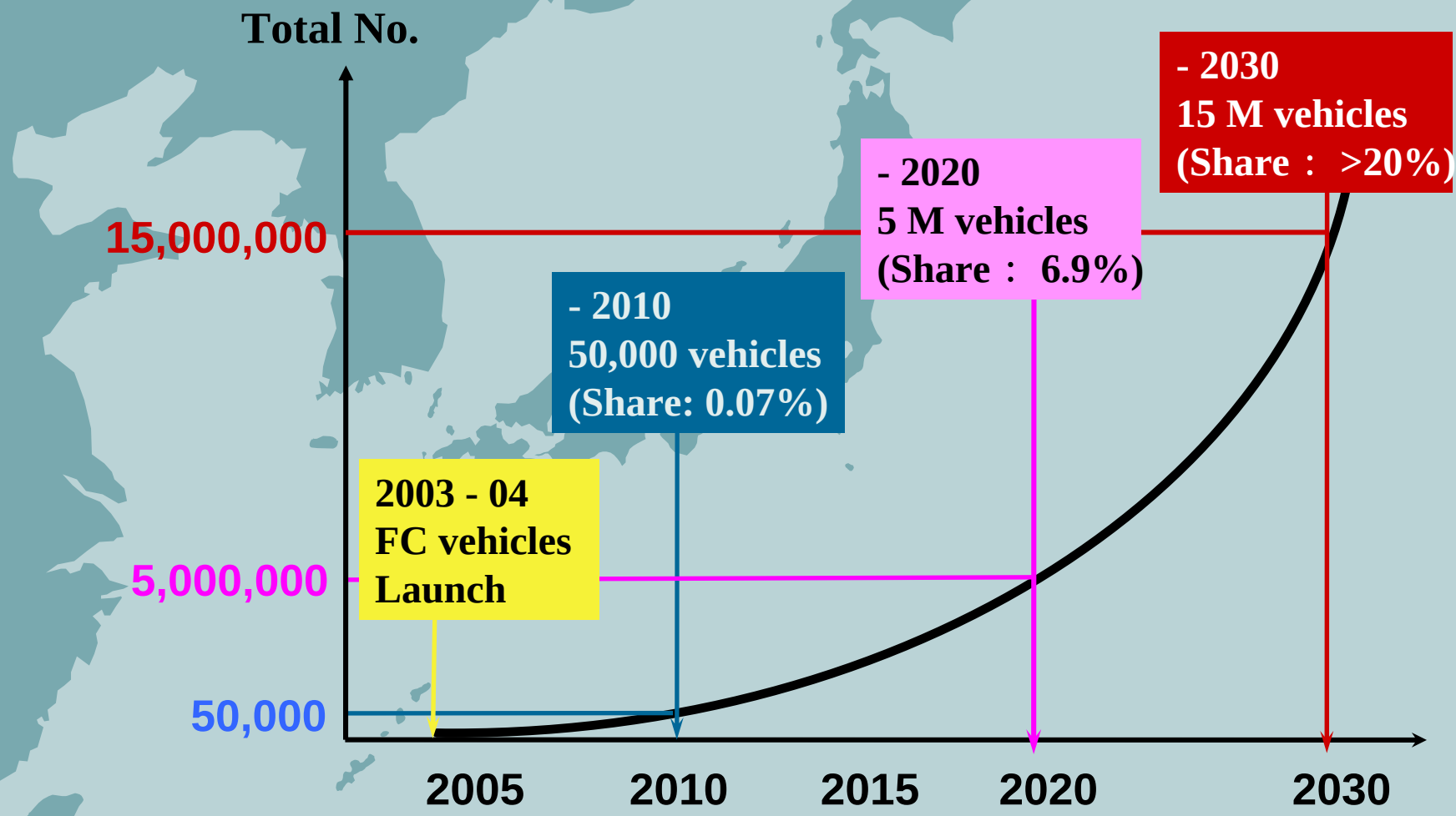
Expected Clean Energy Vehicles in 2010

Vehicle Type	2010 (present)
Electric Vehicles	110,000 (5,700)
Hybrid Electric Vehicles (including 50,000 FCVs)	2,110,000 (120,000)
Natural Gas Vehicles	1,000,000 (20,000)
LPG Trucks	260,000 (21,000)
Total	3,480,000 (167,000)

（Agency of Natural Resources and Energy, Japan, 2001）

(IWEFV2004 by Prof Daisho)

METI Target for FC Vehicles in Japan



Fuel Cell Vehicle Participating in JFFC

JHFC
Japan Hydrogen & Fuel Cell Demonstration Project

Ariake Hydrogen Station

Future Possibility for Various Automotive Fuels

	Clean gasoline	Clean diesel	CNG	LPG	FTD (GTL)	DME	Bio EtOH blended gasoline	BDF blended diesel	Renewable hydrogen
1. Vehicle Performance									
1) Running range (Energy density)	B/A	A	C	C	B	C	B	B	C
2) Max speed, Max power, etc.	B/A	B/A	B/C	B	A/B	C	B	B/C	B
2.Economics									
1) Vehicle cost	B/C	B/C	C	B	B	C	C	B	C
2) Fuel cost incl. Infrastrucutre		A	B/C	B	B/C	C	B/C	B/C	C
3. Local emissions									
1) Toxic emissions	A	B/A	A/B	B	B/A	B/C (aldehyde)	A/C	B	A
4. Efficiency, CO2									
1) WtW efficiency	B/A	A	B	B	B	C	B/C	B/A	A
2) CO2 emission	B/A	A	A	B	B/A	C	A	A	A
5. Energy supply									
1) Reserve volume, Diversification	B	B	A/B	C/B	A	A	B/C	C	A

Baseline: Clean gasoline = B
Left: Conventional Gasoline vehicles
Right: Hybrid system

A: Better
C:Worse

(Toyota Presentation at METI Committee)

Cleaner Fuels for EFVs

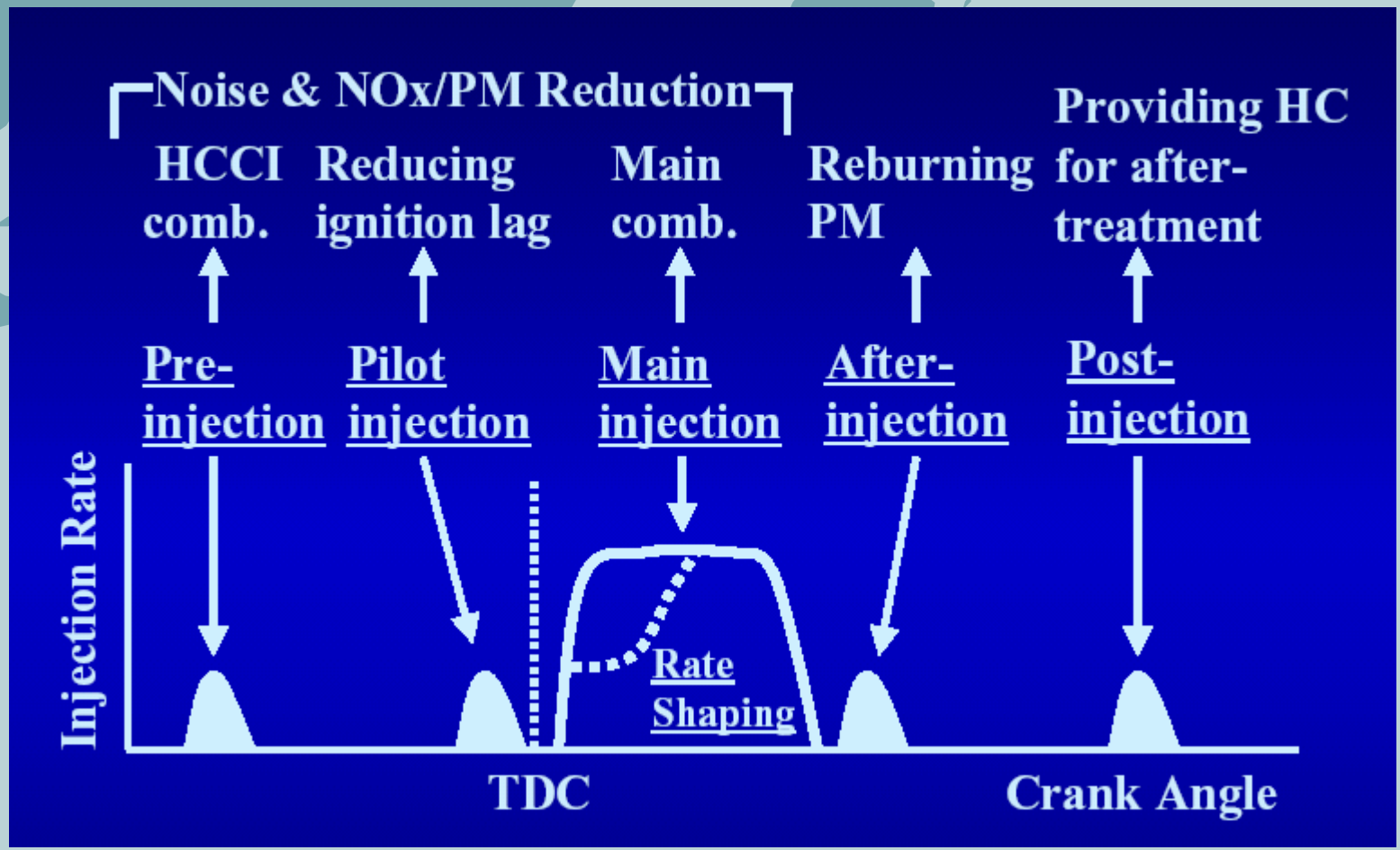
- **Gasoline**
  - * Sulphur free (<10 ppm) for LNTs (or NSR)
    - ***Earlier introduction: 2005, Mandatory: 2008***
  - * To study to increase RON for higher engine efficiency
- **Diesel Fuel**
  - * Sulphur free (<10 ppm) for LNTs
    - ***Earlier introduction: 2005, Mandatory: 2007***
  - * To study the effects of distillation temperature (T90) and aromatic content to reduce PM
- **Alternative and Renewable Fuels**
  - * To standardize fuel properties including GTL and renewable fuels (bio-ethanol and bio-diesel) blends
  - * Compatibility, availability and affordability
- **Hydrogen**

(Based on IWEFV2004 by Prof Daisho)


Thank You!

Back-up slides

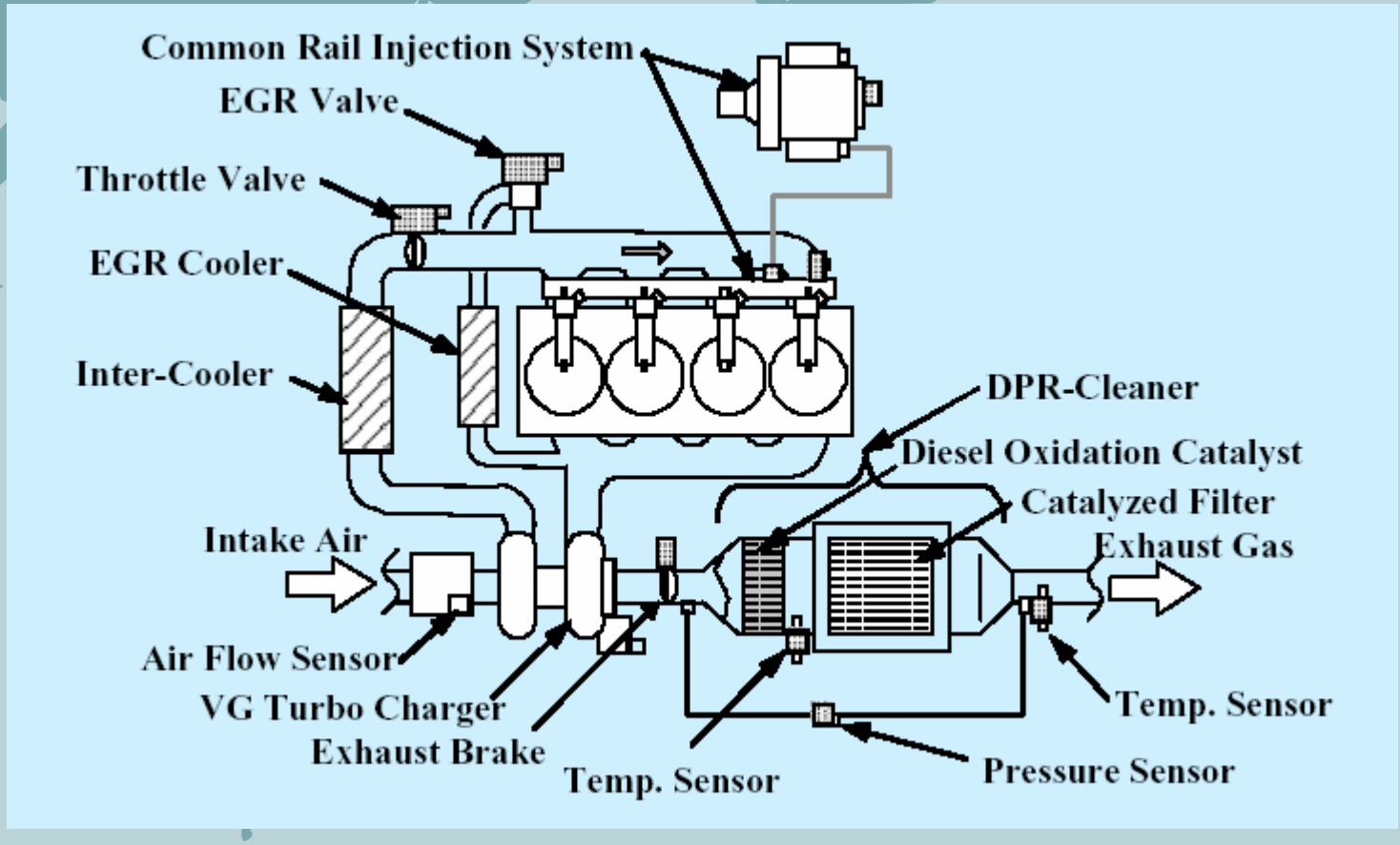
Multiple-injection to Control Diesel Combustion



(IWEFV2004 by Prof Daisho)

A Precisely Controlled DPF System, "DPR"

Hino Motors, 2003



(IWEFV2004 by Prof Daisho)

Issues for DPFs

- **Optimizing regeneration at low speed and low load**
  - To raise exhaust temperature with post injection
  - Co-use of oxidation catalyst
  - Fuel additive doping to lower catalyst regeneration temperature
- **Optimizing filter materials and pore structure**
  - To raise exhaust temperature with post injection
- **Deposit formation by ash**
  - Use low ash engine lubricants (This is controversial for lube supplier.)
- **Sulphur poisoning on the catalyst**
  - Sulphur removing operation to raise exhaust gas temperature, causing fuel consumption penalty
  - Use low sulphur fuels to overcome this penalty
- **Absorbed HCs, SOF and nano-particles**
  - Use oxidation catalysts

(Based on IWEFV2004 by Prof Daisho)

Issues for SCR and LNT

Problems in general

* To improve conversion efficiency under transient and low speed/load conditions
* To improve durability and to reduce cost of these apparatus
* Fuel additive doping to lower catalyst regeneration temperature

SCR (Selective Catalytic Reduction)

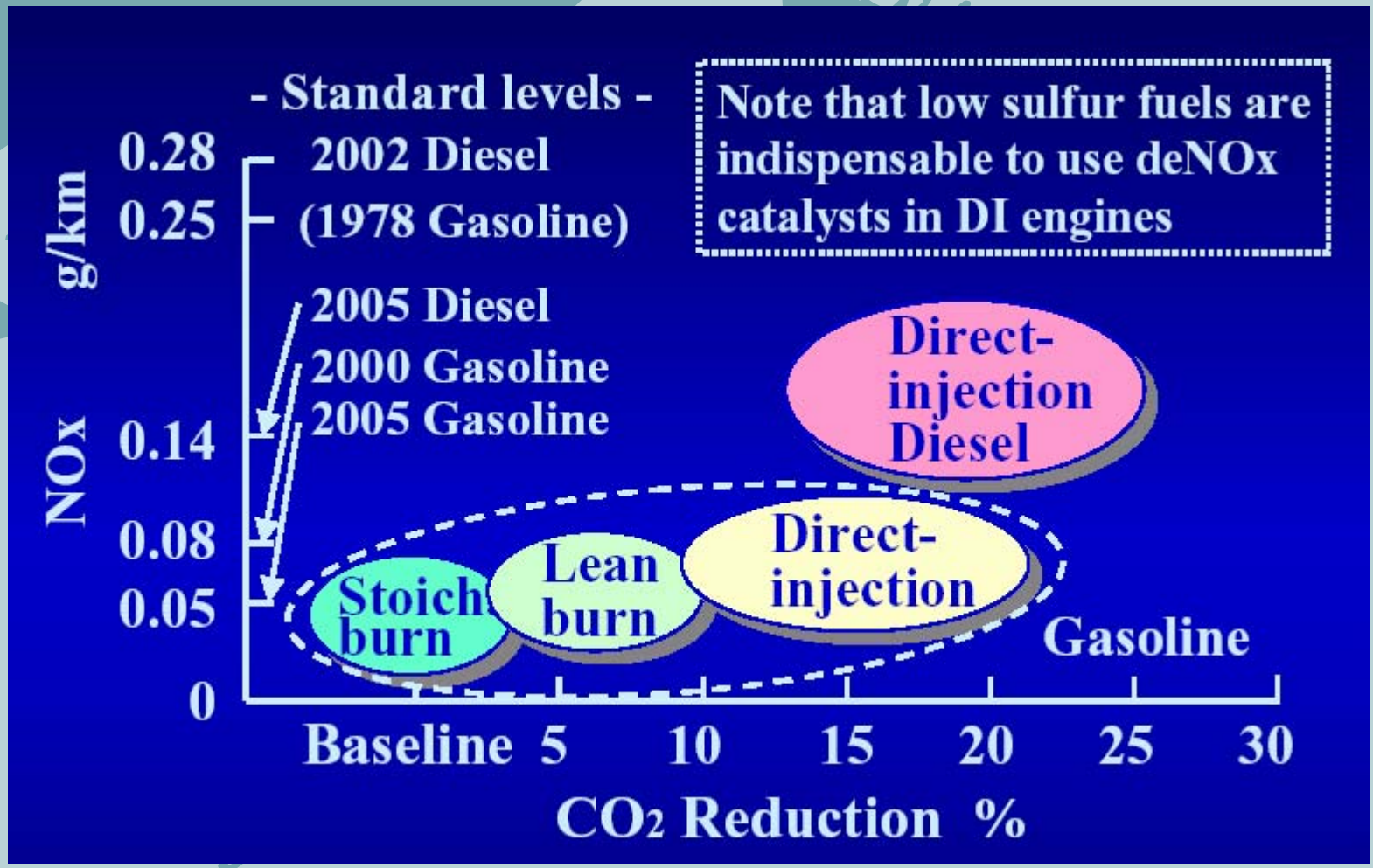
* Infrastructure for urea solution supply
* To reduce side-emissions (HCNO, N_2O, NH_3, etc.)

LNT (Lean NOx Trap)

* Significant progress to develop LNT recently
* To optimize fuel supply as a reductant
* To remove absorbed sulphur
  Sulphur free fuel is necessary

(Based on IWEFV2004 by Prof Daisho)

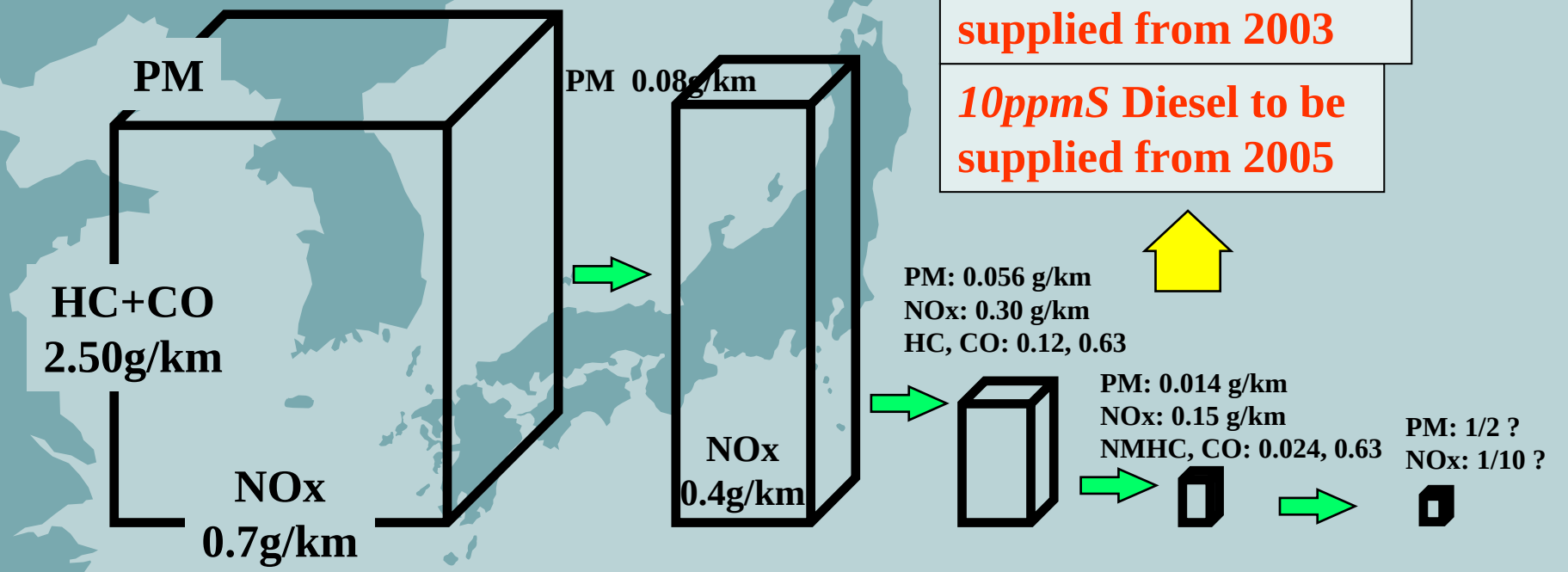
NOx-CO_2 Trade-off of Gasoline and Diesel Passenger Cars



(IWEFV2004 by Prof Daisho)

LD Diesel Emissions Regulation & Diesel Sulphur Content in Japan

Passenger Diesel Vehicle (< 1.265ton)



S content in AGO

5000ppm 2000ppm 500ppm 50ppm 10ppm (2007)

ST: Short term LT: Long term

Background of E3 Introduction in Japan

High alcohol containing Fuel

* High alcohol (>50%) containing gasoline has caused fuel leakage problem, due to material corrosion of vehicles fuel delivery lines. This resulted in vehicle fires in some cases.
* Emission measurement tests showed the fuel to give higher NOx and CO emissions. Therefore JAMA and the Japanese Government (METI, MLIT and MOE) have officially announced that these kinds of fuels should not be used for their vehicles.
* There was no regulation for alcohol use in the specifications of JIS and the old Fuel Quality Maintenance Law.

Tests on ethanol blends and legislation

* Tests on ethanol blends showed that a maximum concentration of 3% did not cause any metal corrosion with existing vehicles in market place.
* From safety point of view, the limit of 3% was newly regulated in the specification of Fuel Quality Maintenance Law in August 2003.