

Introduction to Automotive Emissions and Their Standards

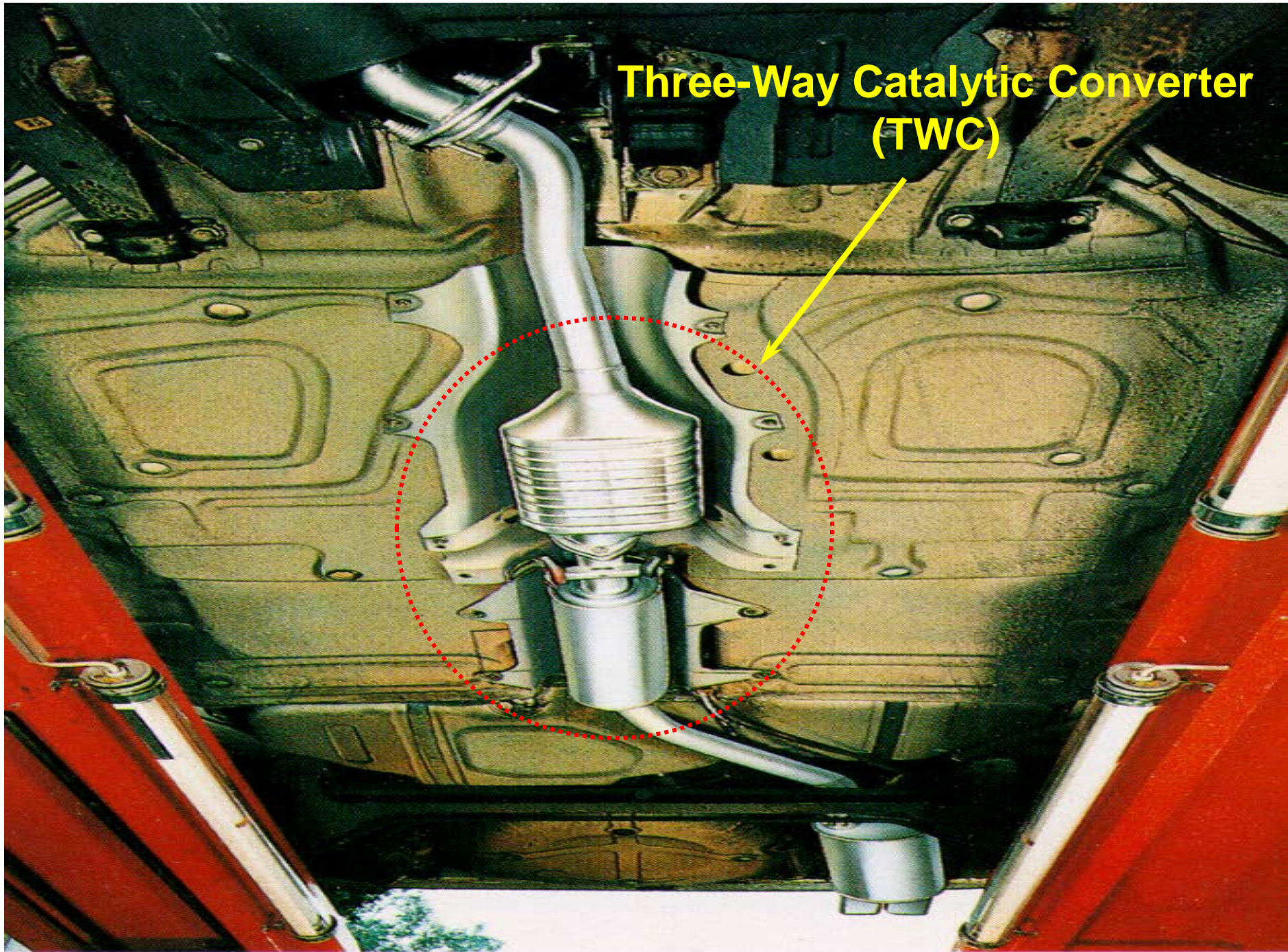
Total vehicle price: 24,000,000 Won



Engine price (2.0 L Smartstream G2.0): \approx 1,600,000 Won



**Three-Way Catalytic Converter
(TWC)**



Catalytic converter price: 1,900,000 ~ 2,400,000 Won



Presentation Overview

- ☞ Conventional ICEs vehicle
- ☞ Engine-out emissions and their regulations
 - Gasoline engine vehicles
 - Diesel engine vehicles
- ☞ Catalytic aftertreatment technology
- ☞ HCCI engines development
- ☞ Update on recent progress
- ☞ Concluding remarks

Fuels and Vehicle Propulsion

Fuels:

- o Gasoline
- o Diesel
- o Methanol
- o Compressed natural gas (CNG)
- o Hydrogen
- o Electric power

Vehicle propulsion system:

- o Spark ignition internal combustion engines (SI-ICEs)
- o Compression ignition ICEs (CI-ICEs)
- o ICE-hybrids (combined ICE and battery power plants)
- o Fuel cell (FC) hybrids (combined FC and battery power plants)
- o Battery-powered electric vehicles



**Gasoline-Electric Hybrid Car
Prius of Toyota Motors
(October 2003)**



Gasoline fueled car: Sonata of Hyundai Motors



Diesel fueled car: Volkswagen Jetta TDI

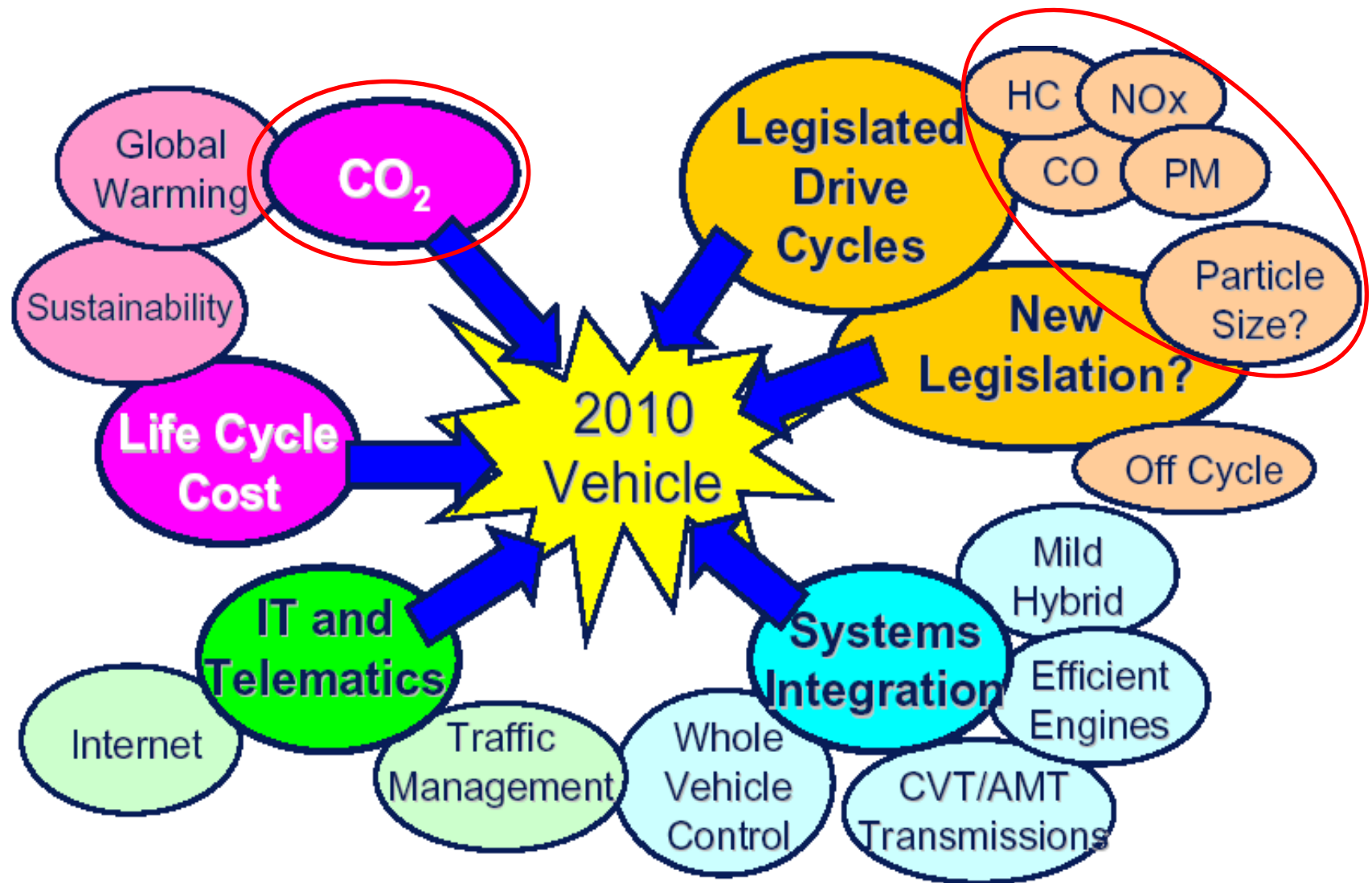


H₂-Powered BMW 750hL

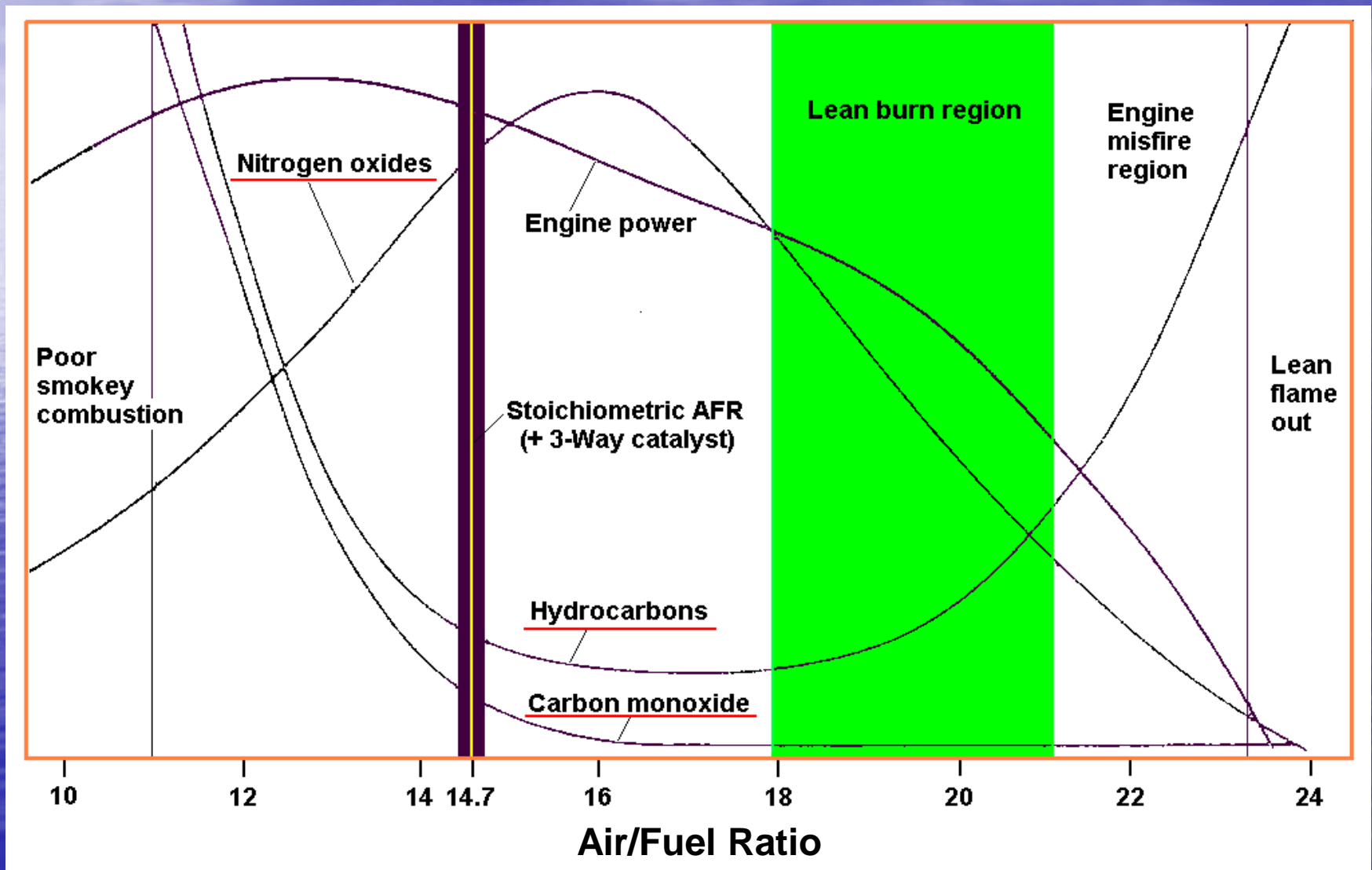


LPG fueled car: Camry of Toyota Motors

Future Challenges to Automobile Industries



AFR vs. Gasoline Engine-out Emissions



Components and Compositions of Engine-out Emissions from Current ICEs

Engine-out emissions	Gasoline engine	Lean-burn gasoline engine	Diesel engine	HCCI engine
NO _x (ppm)	100 ~ 4,000	≈1,200	350 ~ 1,000	
HC (ppm C)	500 ~ 5,000	≈1,300	50 ~ 330	
CO (ppm)	0.1 ~ 6	≈1,300	300 ~ 1,200	
O ₂ (%)	0.2 ~ 2	4 ~ 12	10 ~ 15	
H ₂ O (%)	10 ~ 12	12	1.4 ~ 7	
CO ₂ (%)	10 ~ 13.5	11	7	
SO _x (ppm)	15 ~ 60	20	10 ~ 100	
PM (mg/m ³)	-	-	65	
T (°C)	R.T. ~ 1,100	R.T. ~ 850	R.T. ~ 650	R.T. ~ 350
GHSV (h ⁻¹)	30,000 ~ 100,000	30,000 ~ 100,000	30,000 ~ 100,000	
AFR	14.7	17	26	

Regulation for CO₂ Emissions

☞ Carbon Tax

Country	Designated to:	Introduction Year
Finland	Carbon tax	1990
Norway	Carbon tax	1991
Sweden	Carbon tax	1991
Denmark	Carbon tax	1992
Netherlands	Environmental tax	1996
Germany	Electricity tax	1999
United Kingdom	Climate change tax	2001
Switzerland	CO ₂ tax	2004
Japan	Carbon tax	2006
New Zealand	Carbon tax	2007

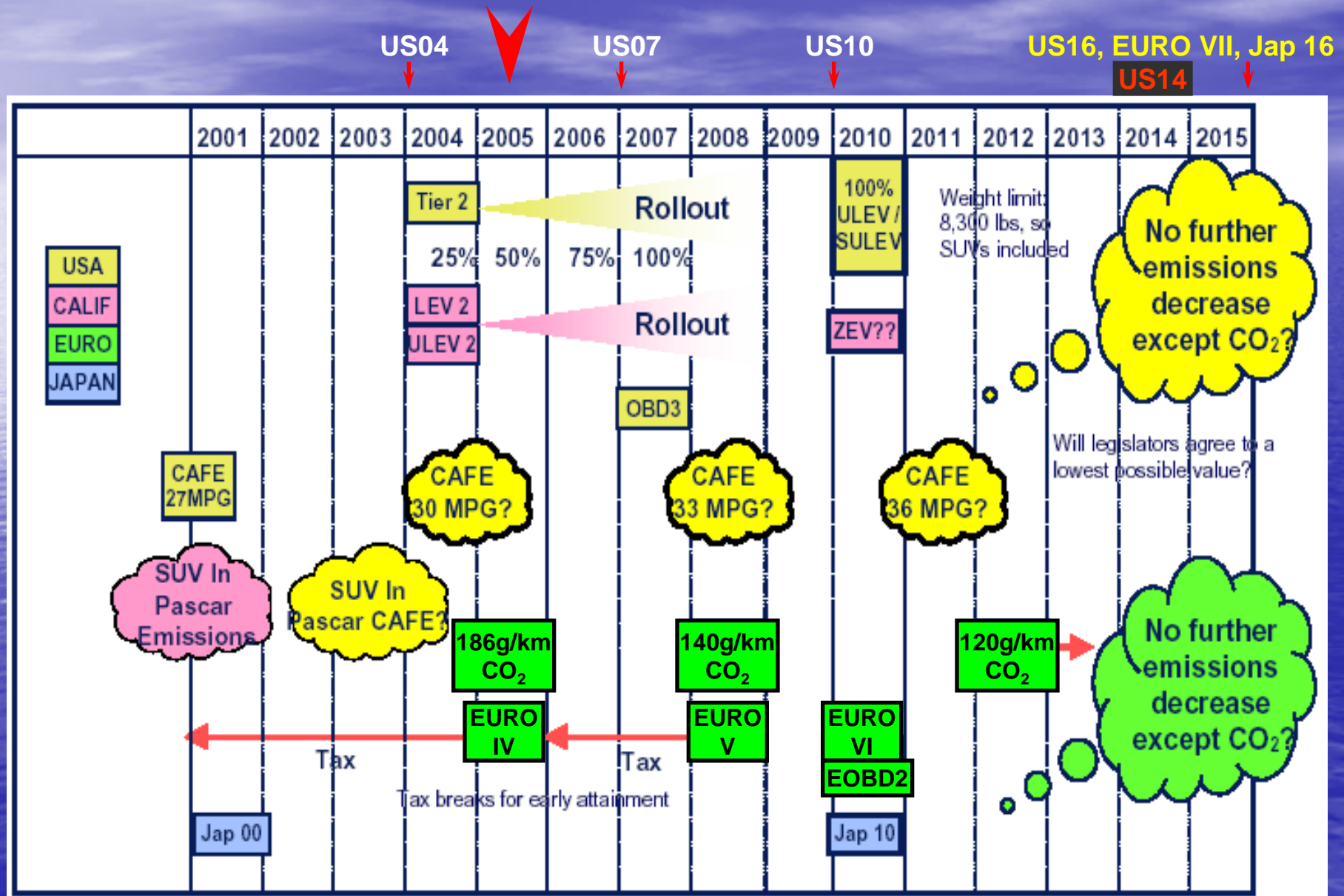
☞ CO₂ emission trading

- 7 ~ 10 €/ton CO₂ @ European climate exchange (ECX)
40 ~ 60 €/ton CO₂ in 2013
- ca. 10 \$/ton CO₂ @ Chicago climate exchange (CCX)

☞ CAFE (Corporate Average Fuel Economy)

☞ Mileage CO₂ emission rate

Future Regulations for Engine-out Emissions

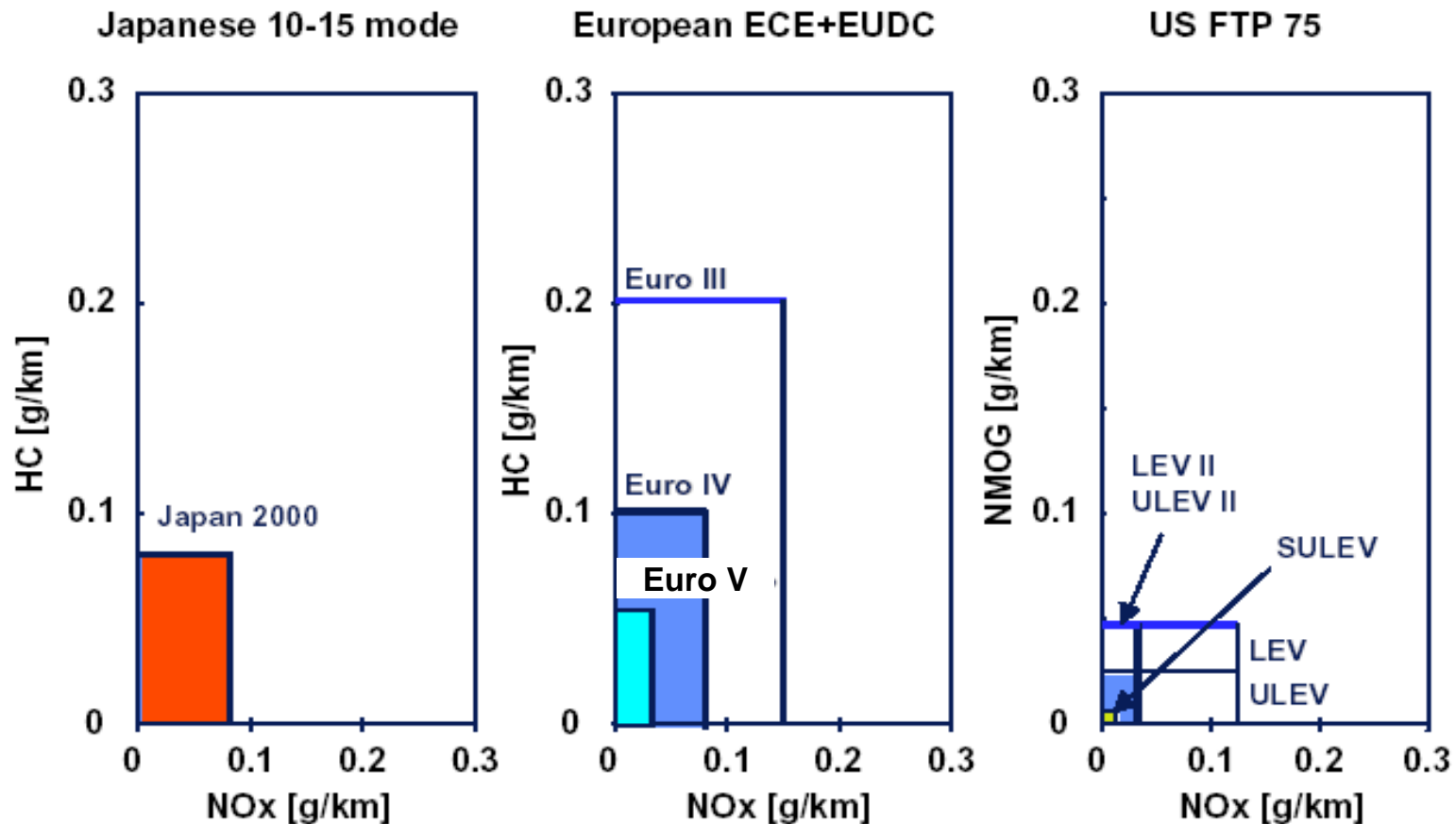


Gasoline Vehicle Emissions Legislation

ECE (Economic Commission for Europe)

EUDC (Extra Urban Driving Cycle)

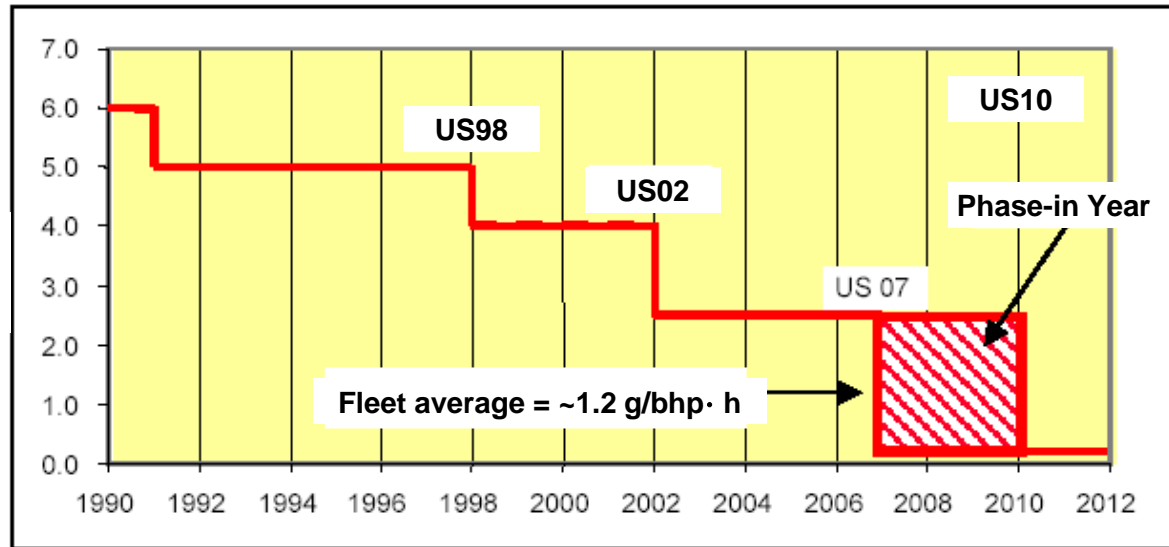
FTP (Federal Test Procedure)



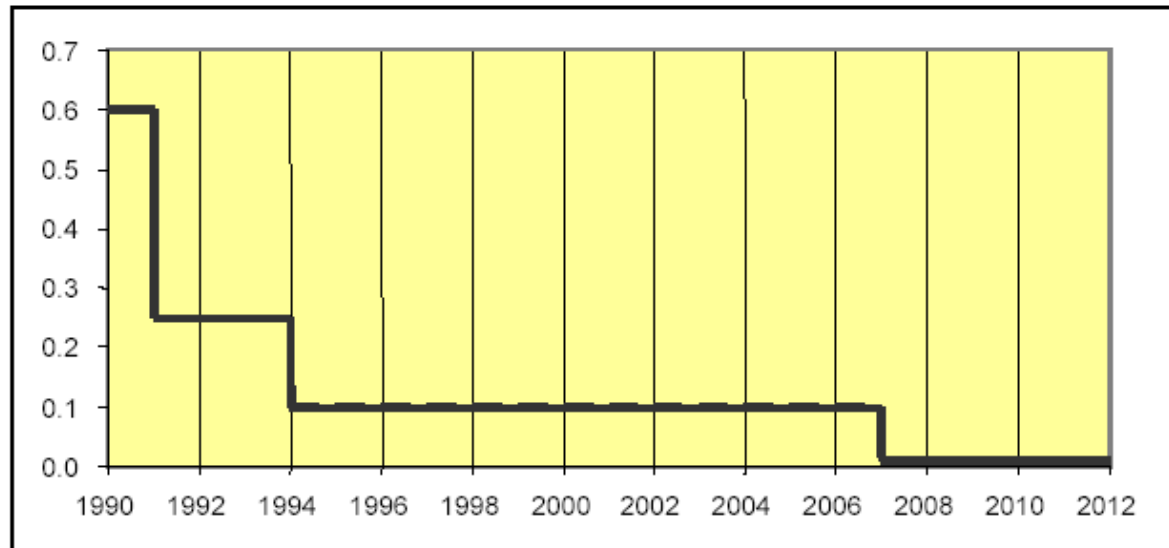
Much of the new technology is being driven by passenger vehicle emissions limits.

HD Diesel Vehicle Emissions Legislation

**NO_x Engine-out
(g/bhp·h)**



**PM Engine-out
(g/bhp·h)**



The Urgent Challenge of 2007/2010

