Fuels & Lubricants for Fuel Economy and Emissions Control

Dr. R.K.Malhotra
Director (R&D)

IndianOil R&D The Power of Possibilities

International Workshop on "Transport and Climate-Taming Emissions and Energy Guzzling from Vehicles"
Centre for Science and Environment
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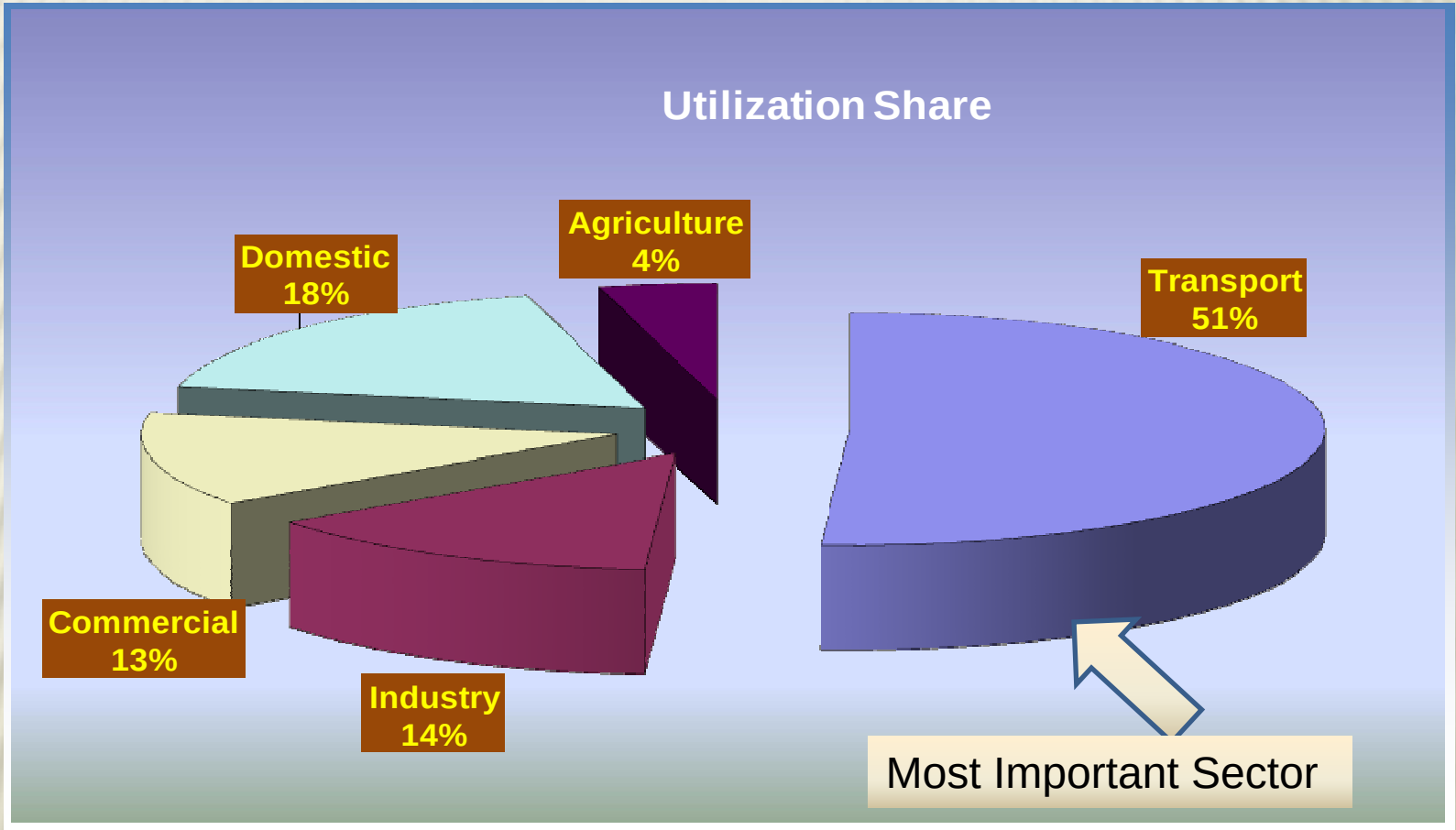
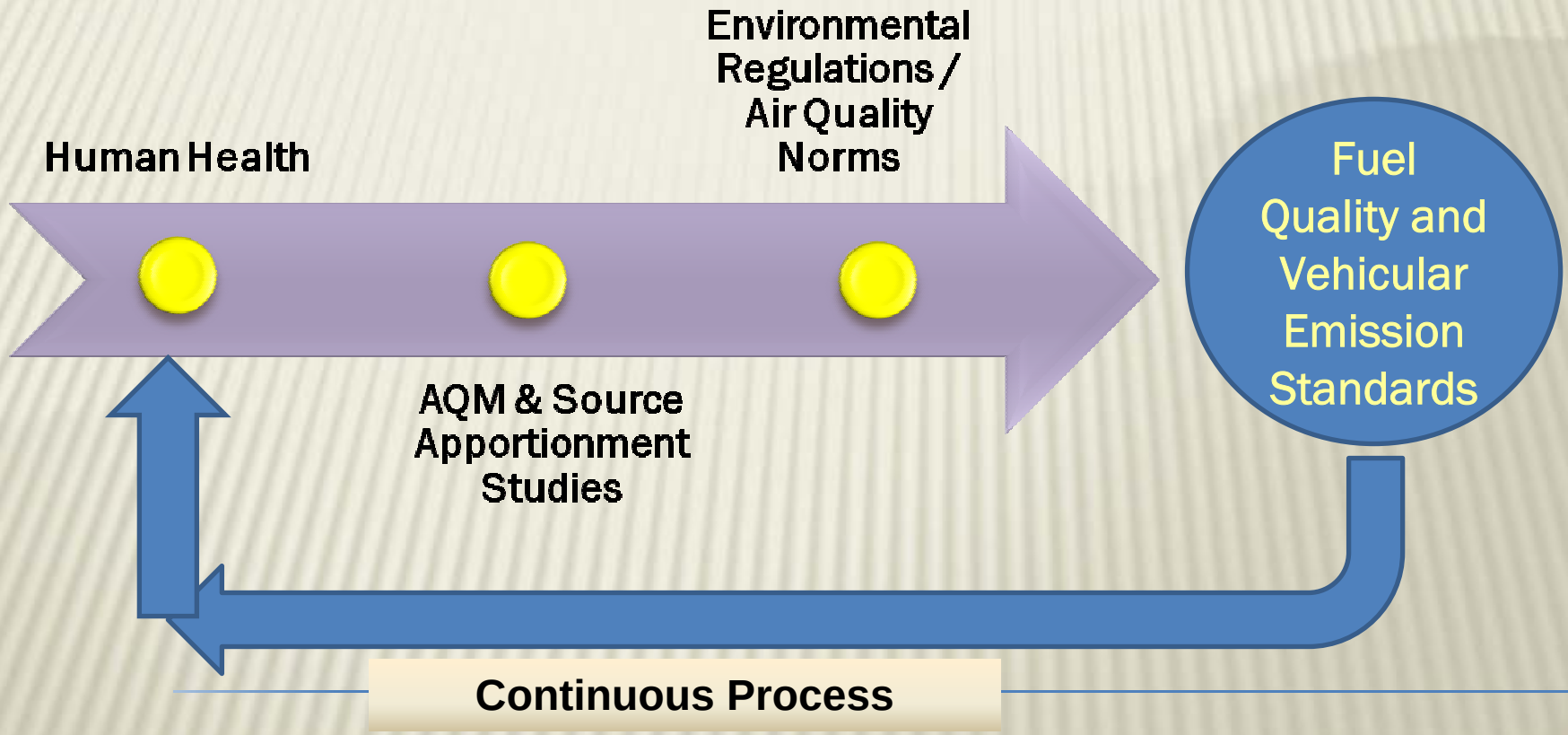
PETROLEUM PRODUCTS UTILIZATION SHARE IN INDIA



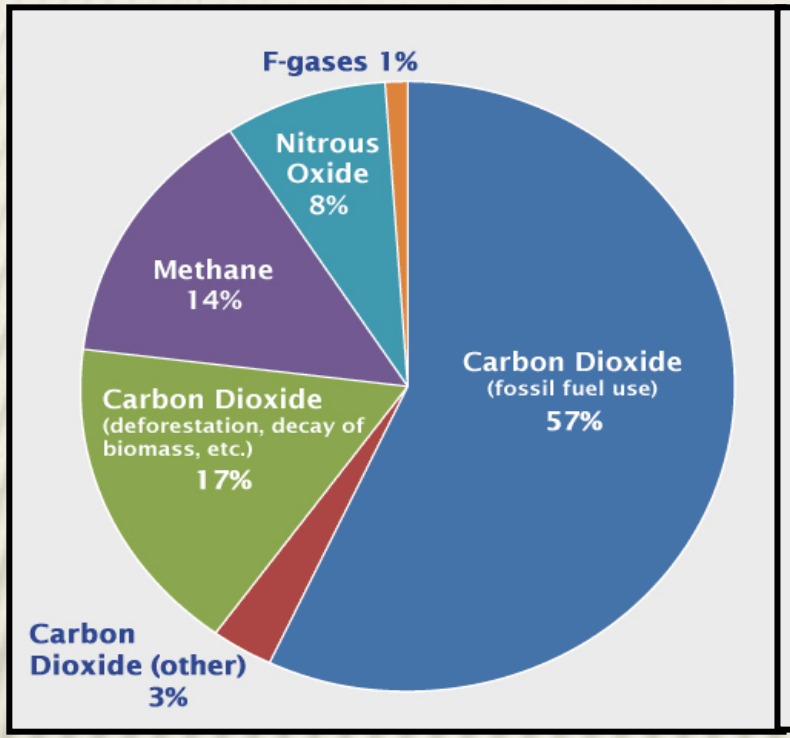
Source : PetroFed

FUEL QUALITY AND EMISSION LEGISLATION FORMULATION PROCESS

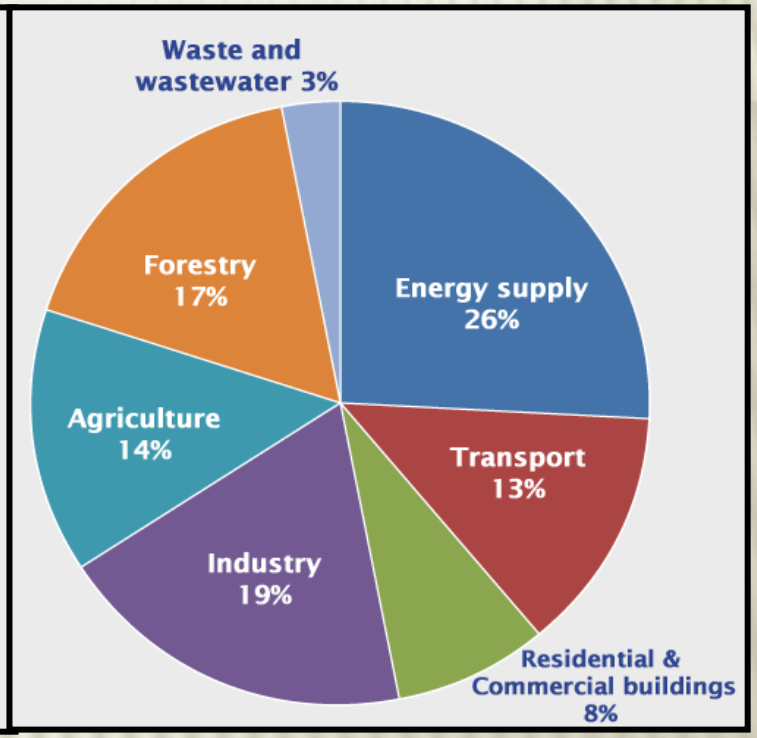


Vehicular Emissions include CO_2 also – Direct relationship with Fuel Economy

GLOBAL GREENHOUSE GAS EMISSIONS



Global Greenhouse Gas Emissions by Gas

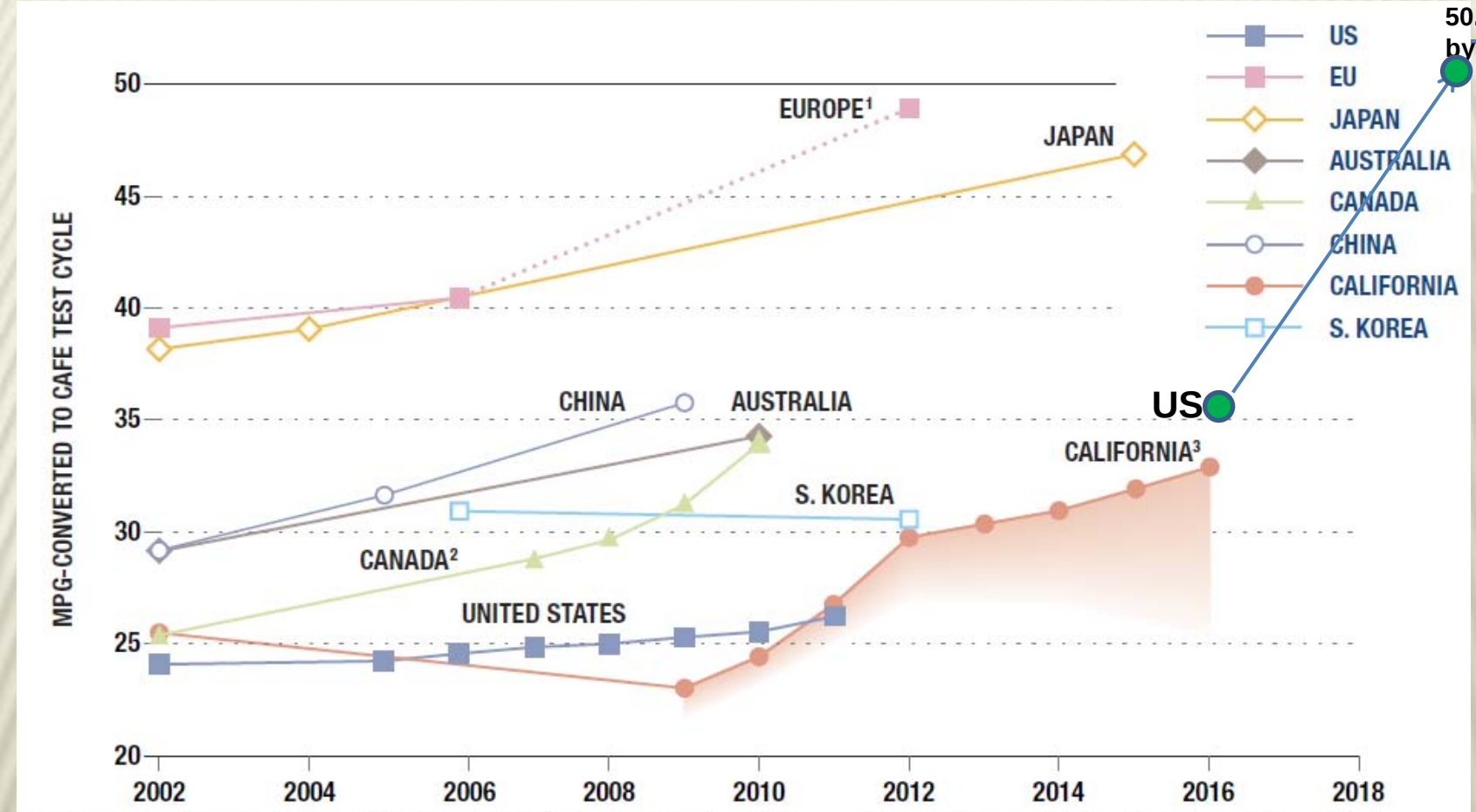


Global Greenhouse Gas Emissions by Source

Reduction of CO_2 emissions and improvement in Fuel Economy imperative in Transport Sector

Source: US EPA

GLOBAL FUEL ECONOMY STANDARDS*



[1] The relative stringency of Europe's CO_2-based standards is enhanced under a fuel economy standard because diesel vehicles achieve a boost in fuel economy ratings due to the higher energy content of diesel fuel.

[2] For Canada, the program includes in-use vehicles. The resulting uncertainty of this impact on new vehicle emissions was not quantified.

[3] Shaded area under the California trend line represents the uncertain amount of non-fuel economy related GHG reductions (N_2O, CH_4, HFCs, and upstream emissions related to fuel production) that manufacturers will generate from measures such as low-leak, high efficiency air conditioners, alternative fuel vehicles, and plug-in hybrid electric vehicles.

**** Normalized to New European Driving cycle***

Source: ICCT

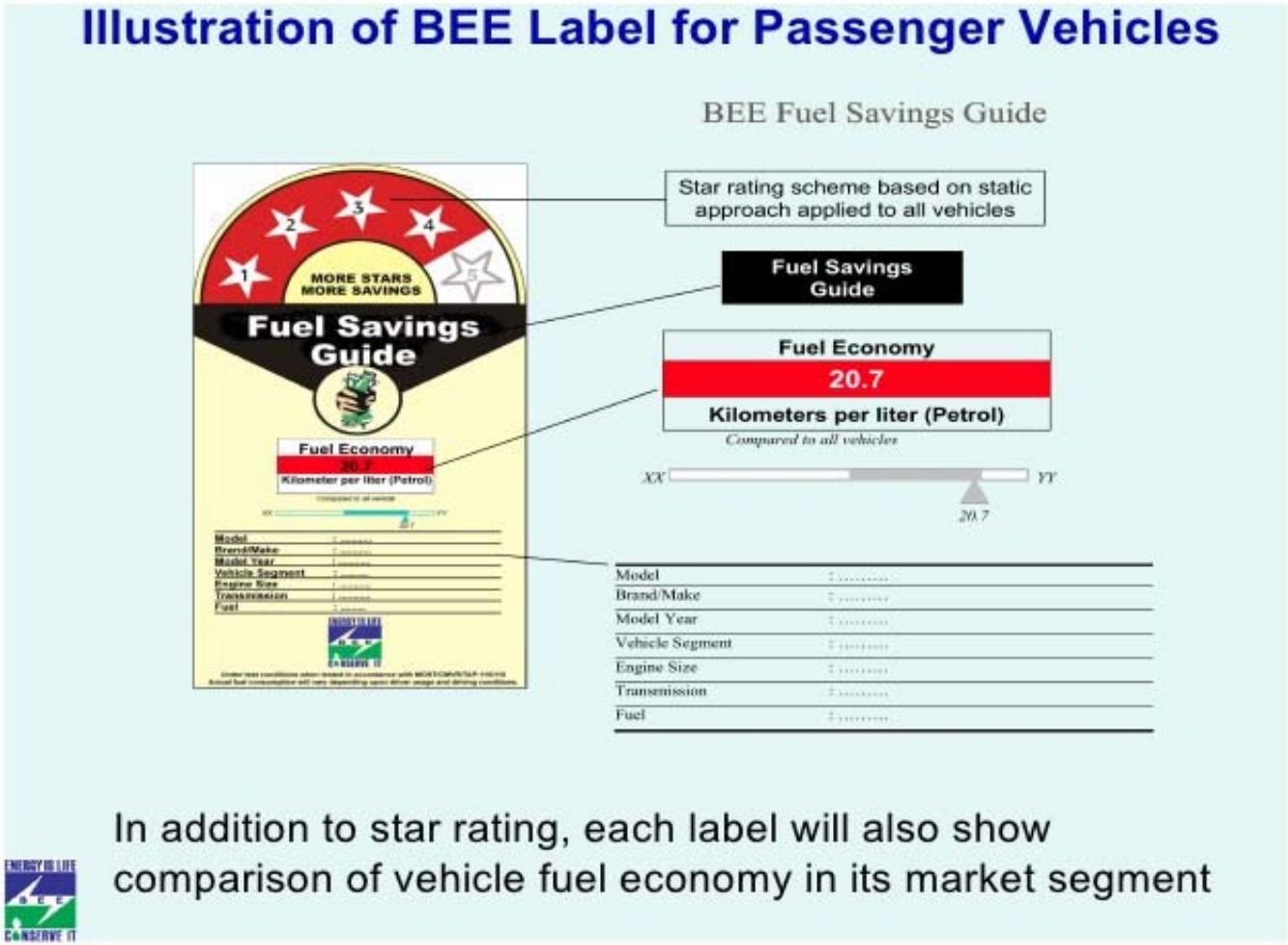
FUEL ECONOMY RELATED POLICY IN INDIA

- Energy Conservation Act, 2001
  - Formation of BEE
- Auto Fuel Policy, 2003
  - " Declaration of Fuel Economy Standards by automobile manufacturers would be made mandatory…" (pg. 7)
  - "Quality of liquid fuels would be progressively upgraded inline with vehicular emission norms…." (pg.5)
- Integrated Energy Policy , 2006
  - "… enforce truthful labelling on equipments… Enforce minimum fuel efficiency standards for all vehicles…" (overview pg. xxi)
- National Action Plan on Climate Change, 2008
  - " the Energy Conservation Act of 2001 provides a legal mandate for the implementation of the energy efficiency measures through the institutional mechanism of the Bureau of Energy Efficiency (BEE)…" (pg.3)
  - "… tightening of regulatory standards such as enforcing fuel-economy standards for automobile manufacturers…" (pg.29)

SIAM and BEE are working to finalize the Fuel Economy standards for different vehicles

PROPOSED FUEL ECONOMY LABELLING

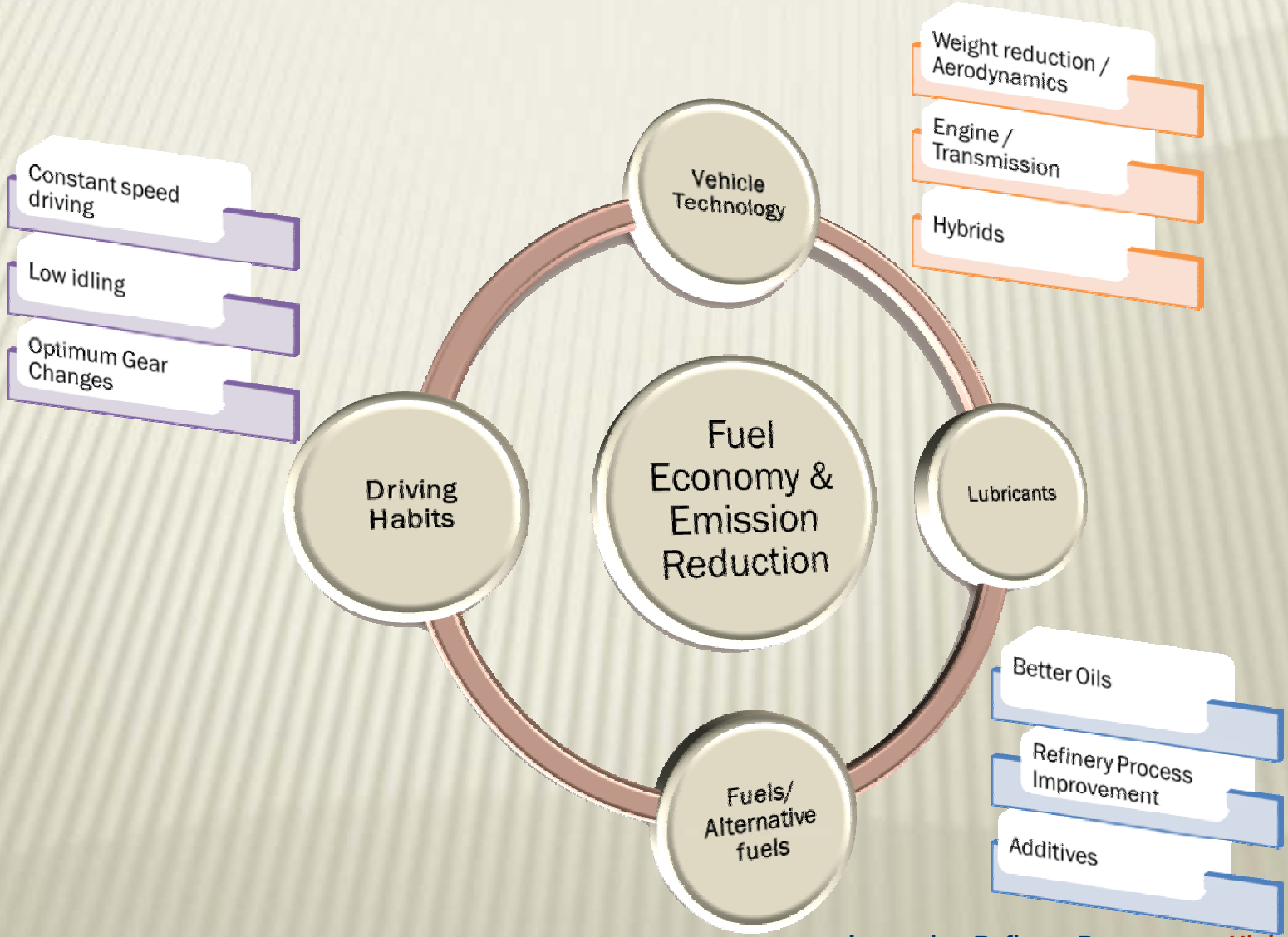
Illustration of BEE Label for Passenger Vehicles



In addition to star rating, each label will also show comparison of vehicle fuel economy in its market segment

Source: BEE

FUEL ECONOMY & EMISSIONS REDUCTION - OPTIONS



Improving Refinery Processes – *High Cost*
Use of Fuel / Oil additives – *Low Cost*

FUEL QUALITY IMPROVEMENTS

- **Sulfur levels have fallen dramatically**
  - Gasoline: 2000 ppm to 150 ppm (50 ppm in 20 cities)
  - Diesel: 10,000 ppm to 350 ppm (50 ppm in 20 cities)
- **Octane number increased in gasoline**
  - Regular: 88 to 91
  - Premium: 93 to 95
- **Benzene levels reduced in gasoline**
  - 3% to 1%
- **Aromatic content reduced**
  - No regulation to 35% maximum
- **Use of sulfur-free CNG and LPG has increased, especially in city buses and autorikshaws**

MULTIFUNCTIONAL ADDITIVES

- **These additives provide more than one benefits**
- **Provides Following Benefits**
  - Fuel Economy
  - Dispersancy
  - Combustion Improvement
  - Increase Fuel Injector Life
  - Exhaust Smoke Control
  - Anti-Wear
    - Alkaline MFA Neutralize Acidic Diesel combustion products there by reducing their attack on metal surface

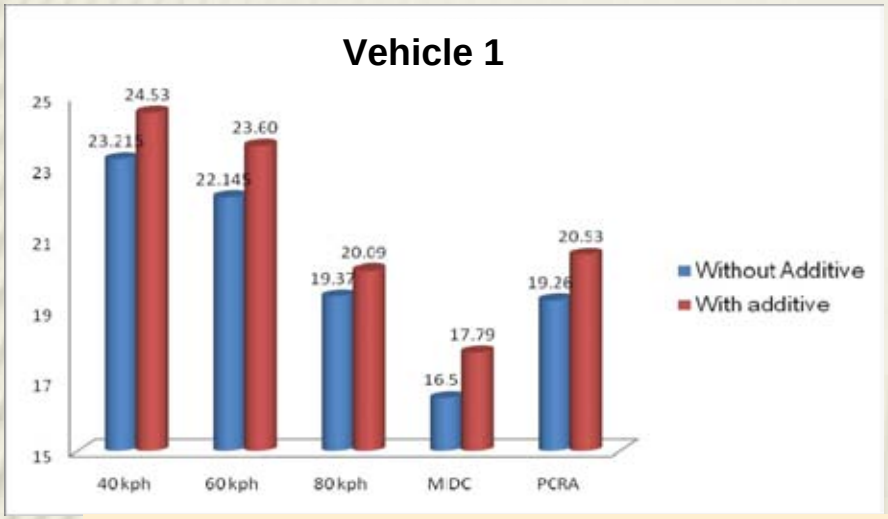
Higher Excise Duty on Branded Fuels decreased consumption of MFA Treated Fuels

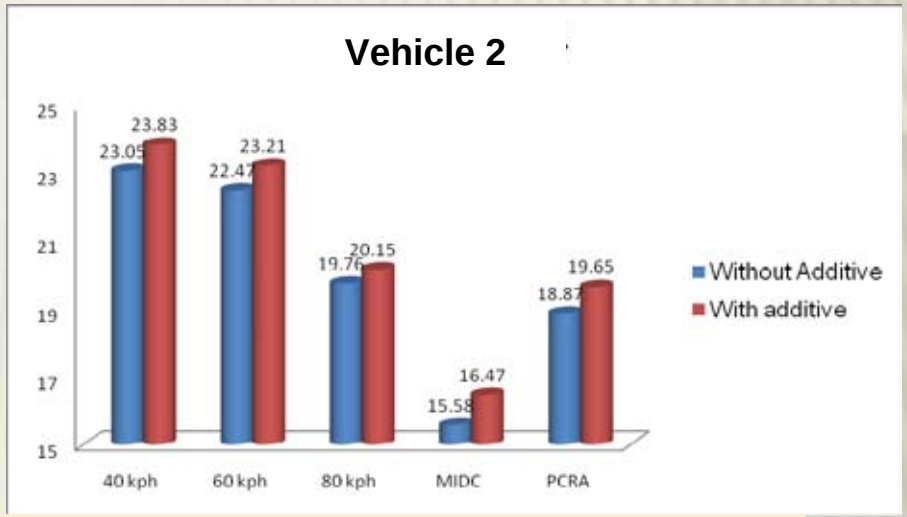
MFA DOPED GASOLINE IVD DEPOSITS

Heavily Scored Inlet Valve with Untreated Fuel

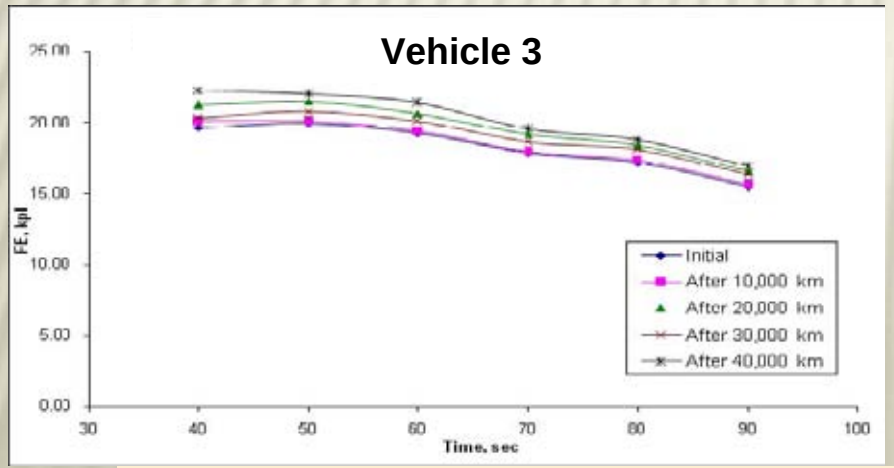
Clean Inlet Valve with additive treated Fuel

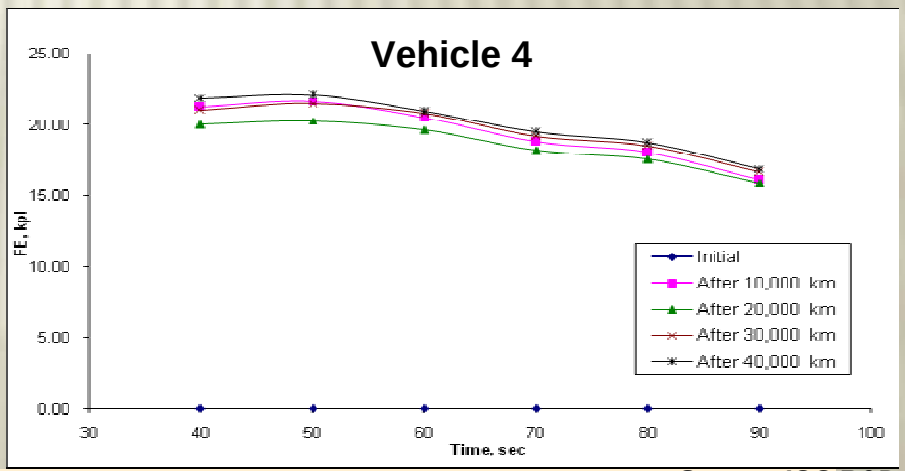
IMPACT OF MFA ON FUEL ECONOMY





Both Driving cycle and Constant fuel economy improved by gasoline multi-functional additive





Source: IOC R&D

The effect of MFAs is sustainable

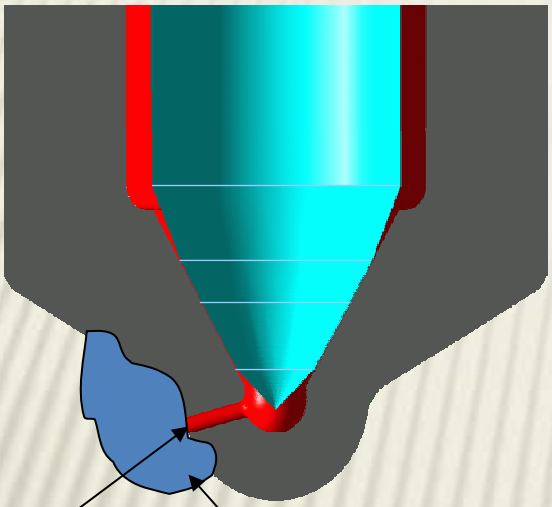
MFA DOPED DIESEL INJECTOR DEPOSITS

Heavily Scored Injector Pintle with Untreated Fuel

Clean Injector Pintle with additive treated Fuel

FUEL SPRAY PATTERN

Injector tip

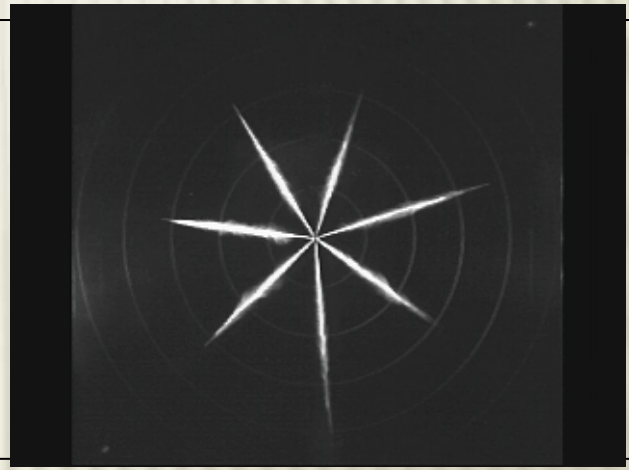


Injection hole

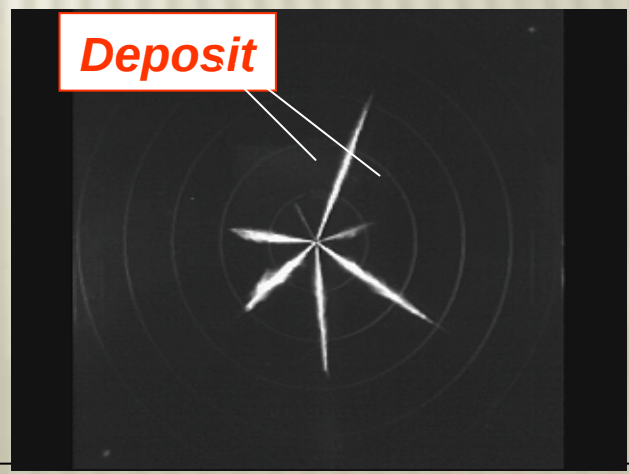
Foreign material

Bottom view

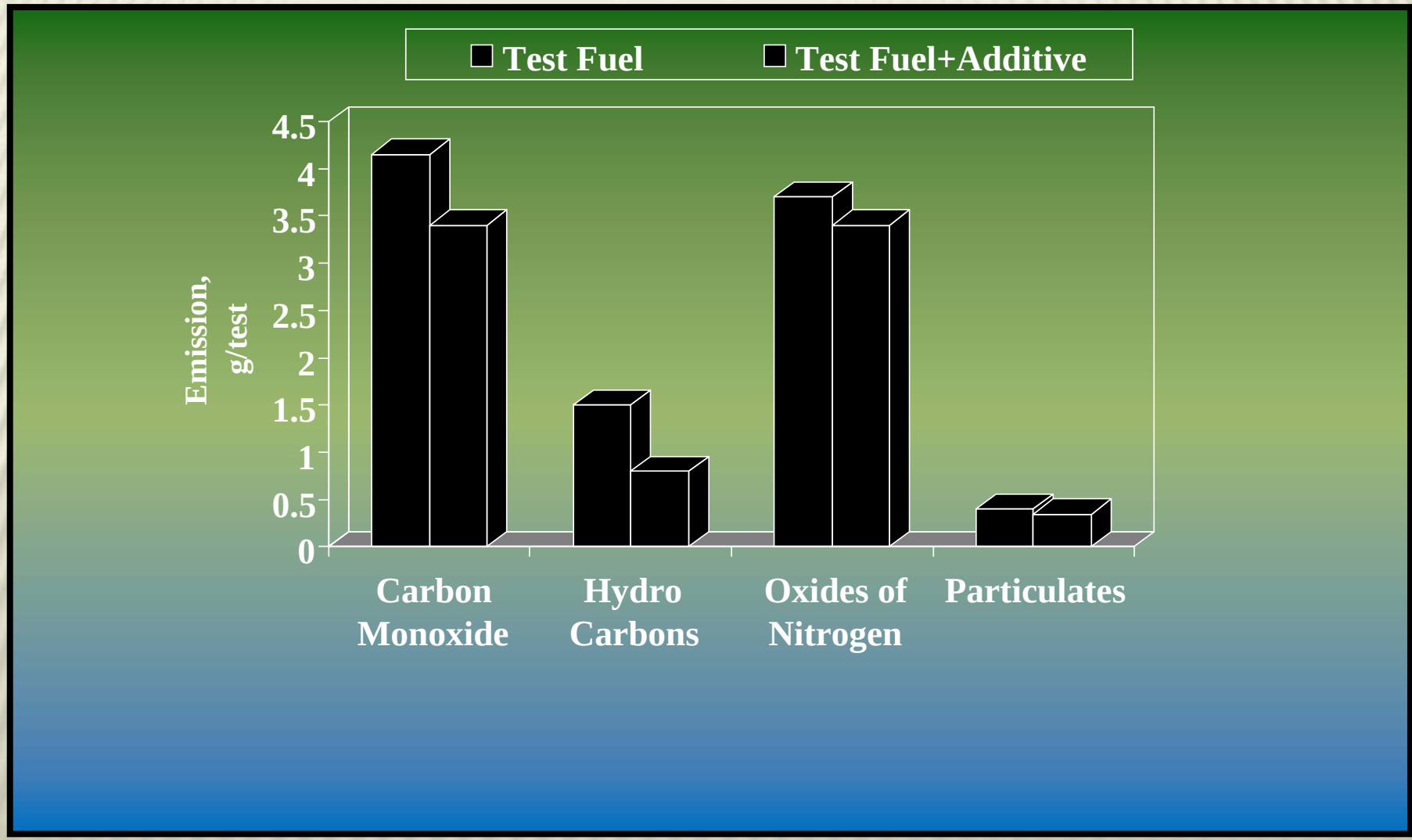
Normal Spray



Injection Hole Clogging

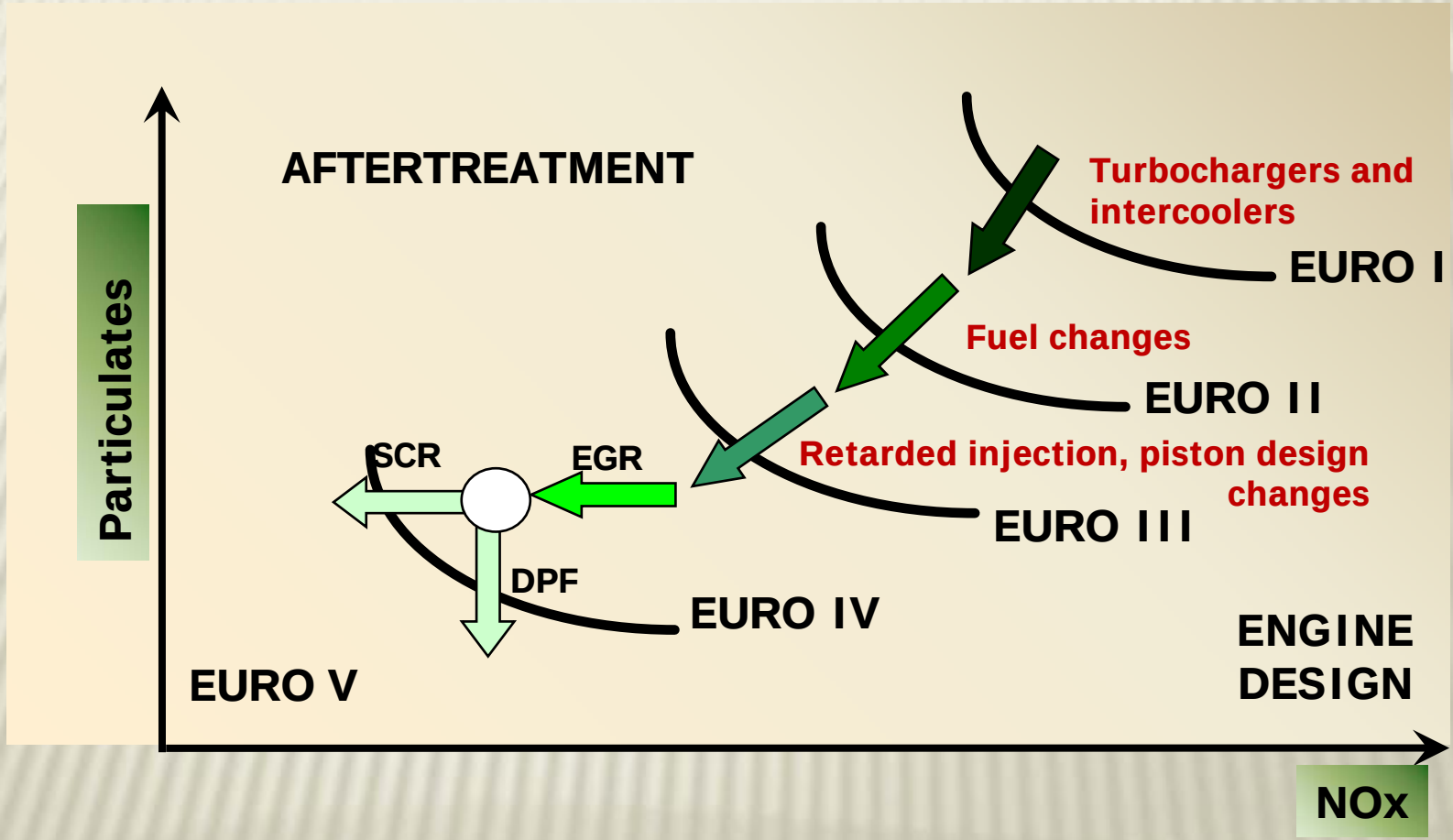


EFFECT OF MFA ON DIESEL EXHAUST EMISSIONS



Source: Lubrizol

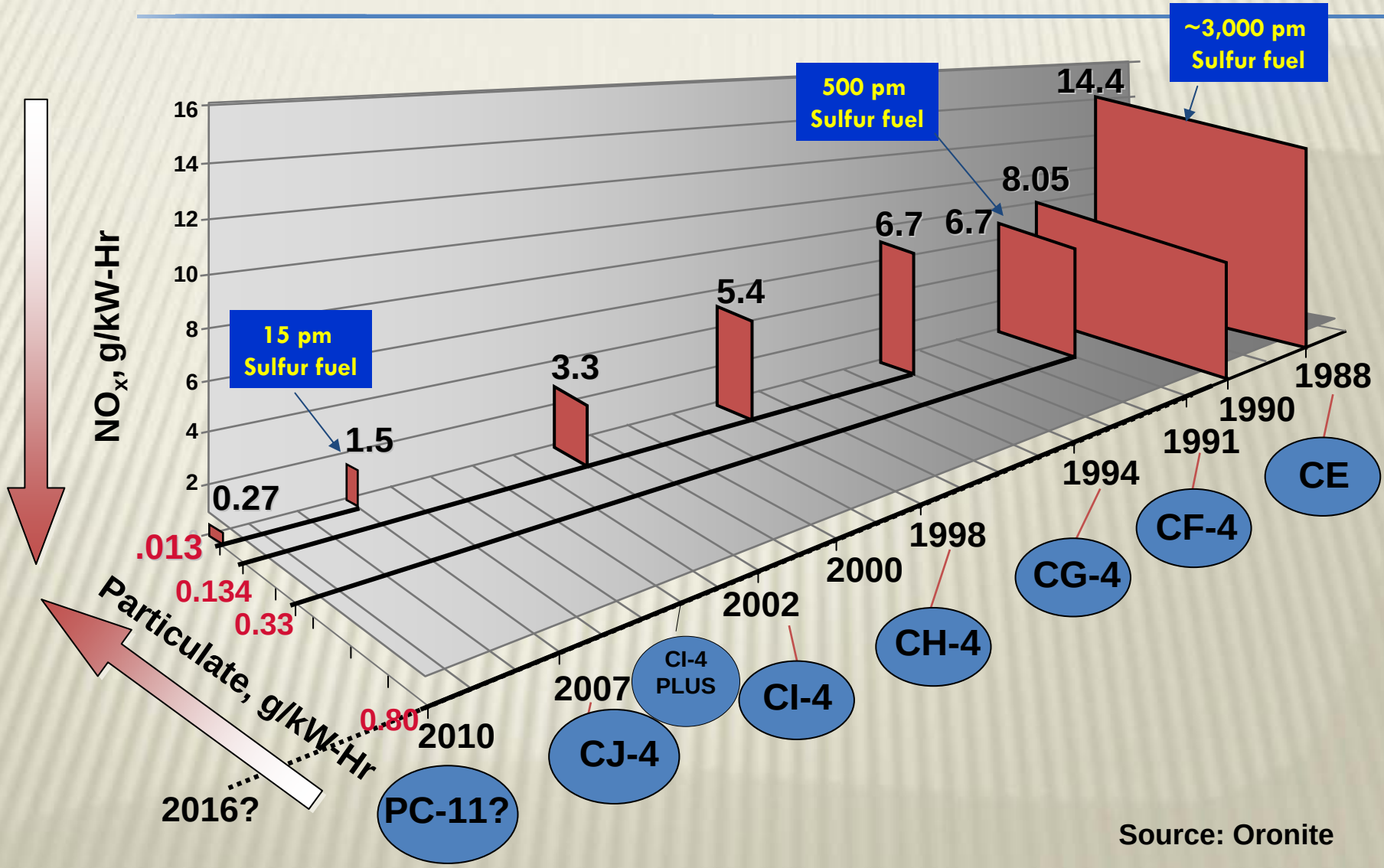
TECHNOLOGIES FOR EMISSION CONTROL IN HEAVY DUTY DIESEL ENGINES



IMPACT OF LOW EMISSION ENGINE TECHNOLOGIES ON LUBRICANT QUALITY

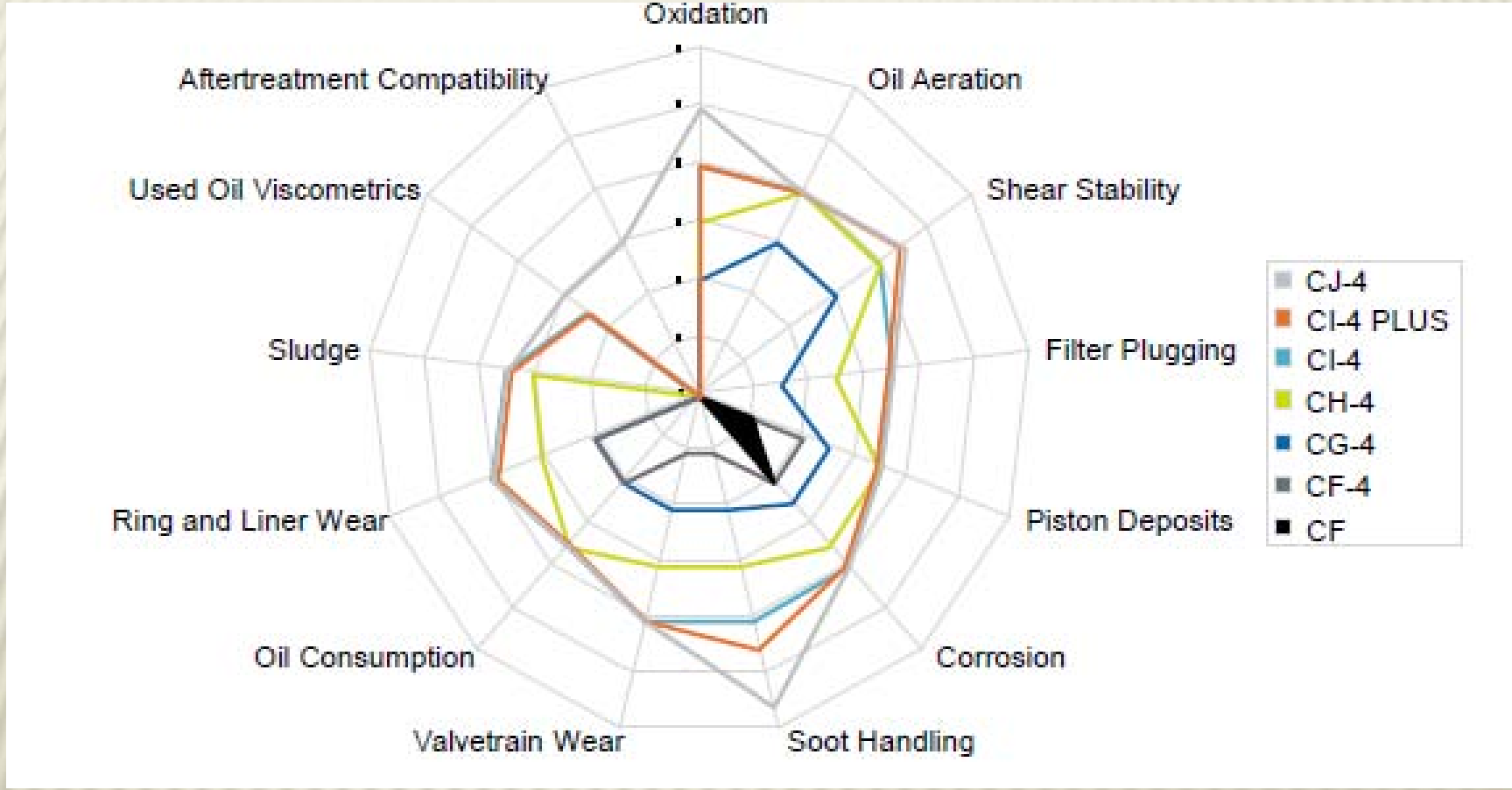
PARAMETER	CONSEQUENCES	LUBRICANT STRESS
Oil Cons. Reduction	Ring / Liner wear	More eff. antiwear additives
	Low Oil renewal	Performance Durability
		Volatility reduction
Raised top ring	Ring/Liner thermal Loading	High Temp detergency
	Liner polishing tendency	Crown land deposit control
Retarded Inj. Timing	Soot Loading	Suitable anti wear
	Thickening	Increased dispersancy
E G R	Liner corrosive wear	Alkalinity reserve increase
	Soot loading	Increased dispersancy
After treatment Catalyst	P & Zn limitation	Alternative antiwear additive
Alternate Fuel	Specific needs	New Technology
New AT Devices	Low S, Ash, Ph	New Low SAPS technology

EMISSIONS STANDARDS DRIVING DIESEL ENGINE OIL QUALITY STANDARDS



Source: Oronite

US DIESEL ENGINE LUBRICANT SPECIFICATIONS- RELATIVE MERITS

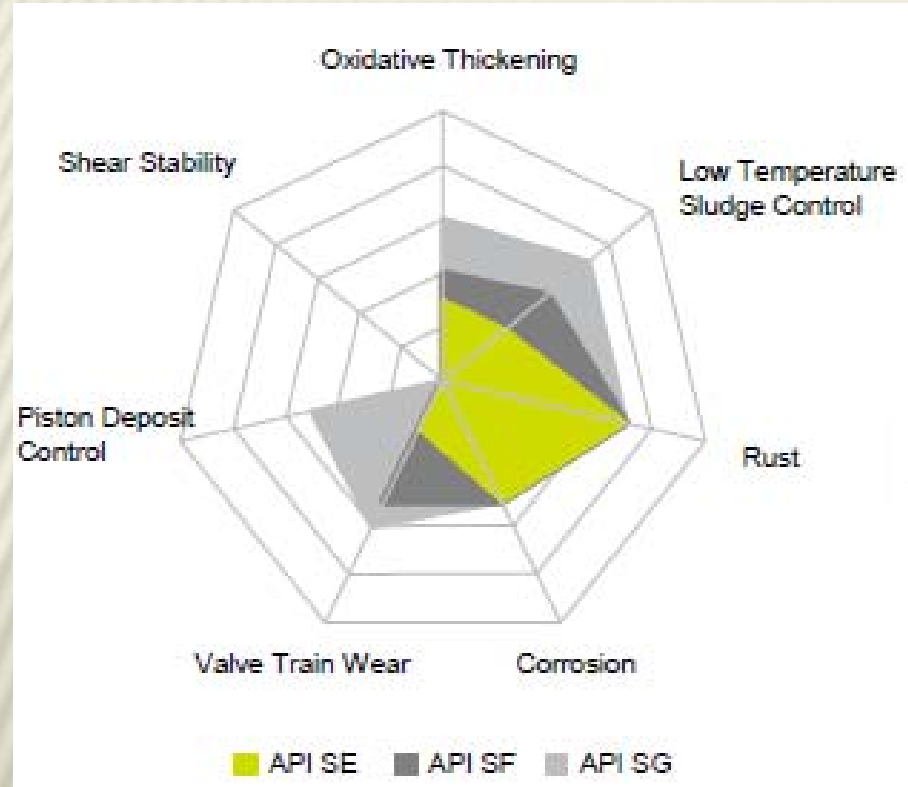


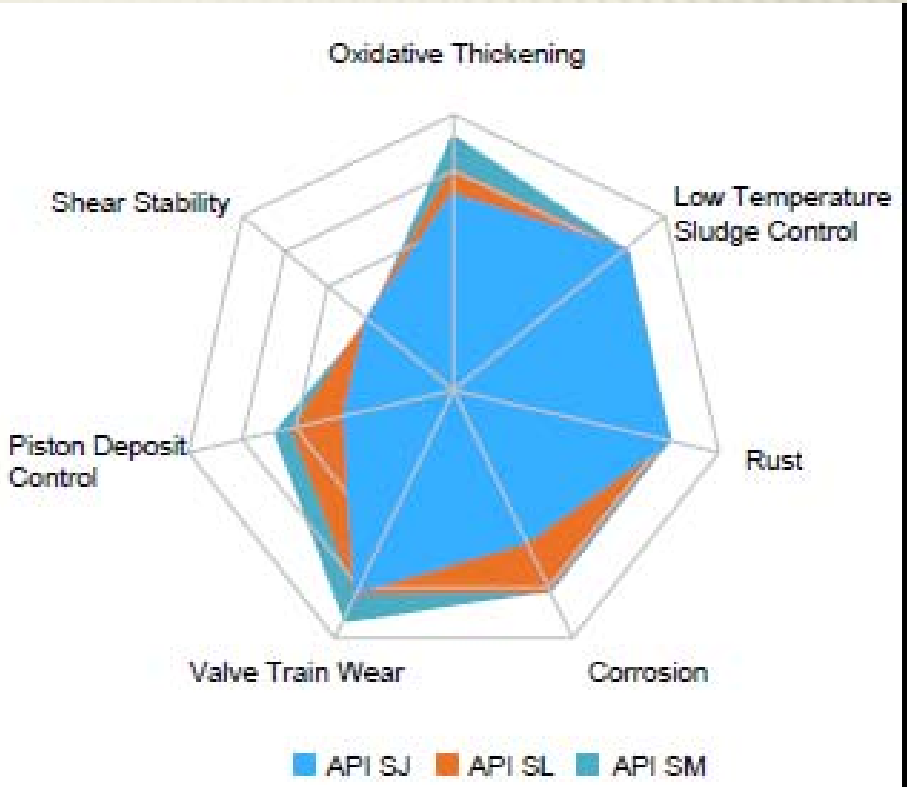
Source: Lubrizol

LOW SAPS DEFINED

Element	High SAPS Engine Oils	Low SAPS Engine Oils
Sulphated Ash	• Detergent systems • Antiwear systems	New approaches to achieve piston cleanliness requirements
Phosphorus	• Antiwear systems • Antioxidant systems	New approaches to achieve wear protection and maintain oxidative stability
Sulphur	• Detergent Systems • Antiwear systems • Base oils (API Group I & II)	New technology to reduce or remove sulfur from antiwear systems, detergents and antioxidants. Increased use of sulfur-free base oils.

US PASSENGER CAR MOTOR OIL SPECIFICATIONS-RELATIVE MERITS





- **API SN builds on the strong VTW, piston cleanliness and oxidative performance of API SM**

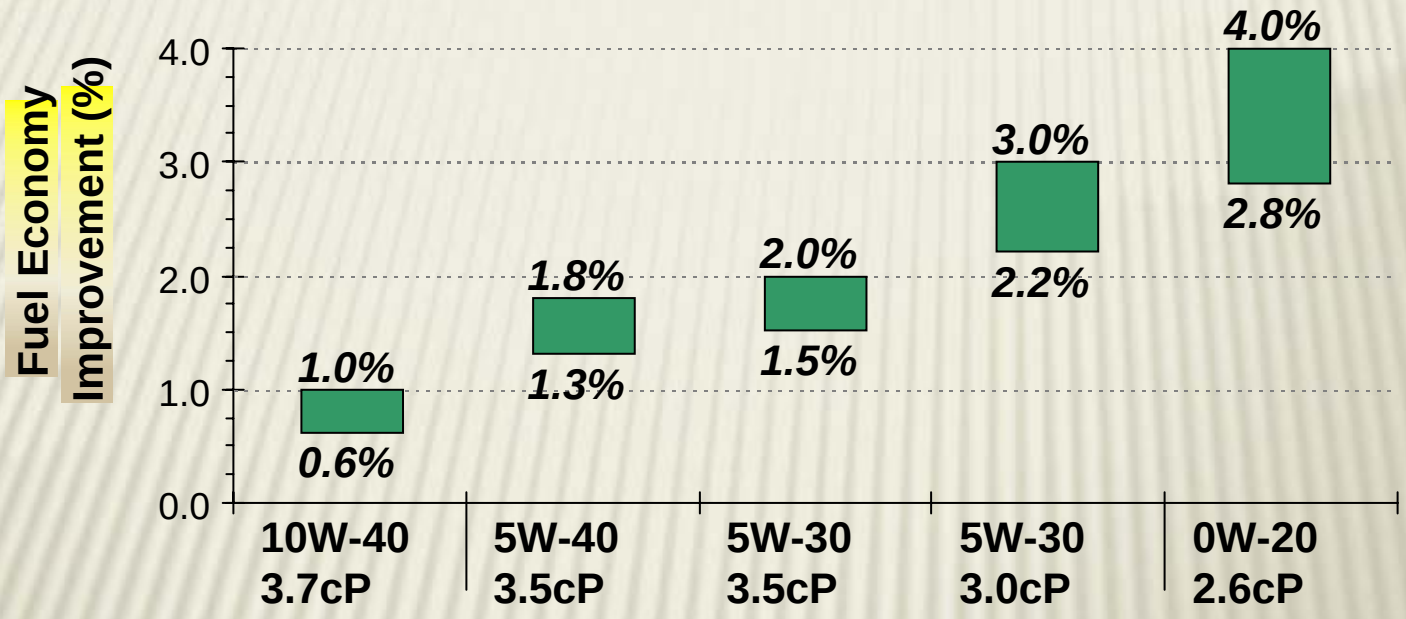
API SM VS ILSAC-GF-5

- API SN delivers improved piston deposit control versus API SM
- API SN Resource Conserving is equivalent to ILSAC GF-5
  - In contrast, API SN does *NOT* require
    - Sequence VID Fuel Economy
    - Sequence IIIGB Phosphorous Retention
    - TEOST 33C
    - Emulsion Retention
- ILSAC GF-4 and ILSAC GF-5 require a demonstration of fuel economy performance, measured by the Sequence VID
- ILSAC GF-5 delivers additional performance benefits vs. GF-4:
  - Improved fuel economy and fuel economy retention
  - Engine oil robustness
  - Protection of emission control systems

Source: API

EFFECT OF VISCOSITY

Typical ranges for M111E fuel economy improvement



Baseline:
15W-40 RL191
Reference Oil

Source : Lubrizol

- **Viscometrics can affect the level of fuel economy improvement**
- **Viscometrics are affected by many factors, including high temperature-high shear viscosity (HTHS), kinematic viscosity, shear stability, cold crank viscosity, base oil viscosity index**

NEW ULTRA LOW VISCOSITY GRADES

- Driven by Japanese Passenger Car Makers- Honda & Toyota's demand for better fuel economy for new generation cars; SAE Engine Oil viscosity Classification Task force working on new low viscosity grades
- Ballot was successfully conducted on inclusion of SAE 16 (?) grade in the recently held ASTM D-02 committee half yearly meeting in June 2012

Proposed SAE Grade	HTHS min	KV min	KV max
20 (existing grade)	2.6	5.6	<9.3
15	2.3	5.6	<9.3
10	2.0	5.6	<9.3
5	1.7	5.6	<9.3

Ref.: SAE EOVC TC Publication, 2011

Hardware durability concerns with low HTHS value?

FUTURE ILSAC CATEGORIES

GF-6

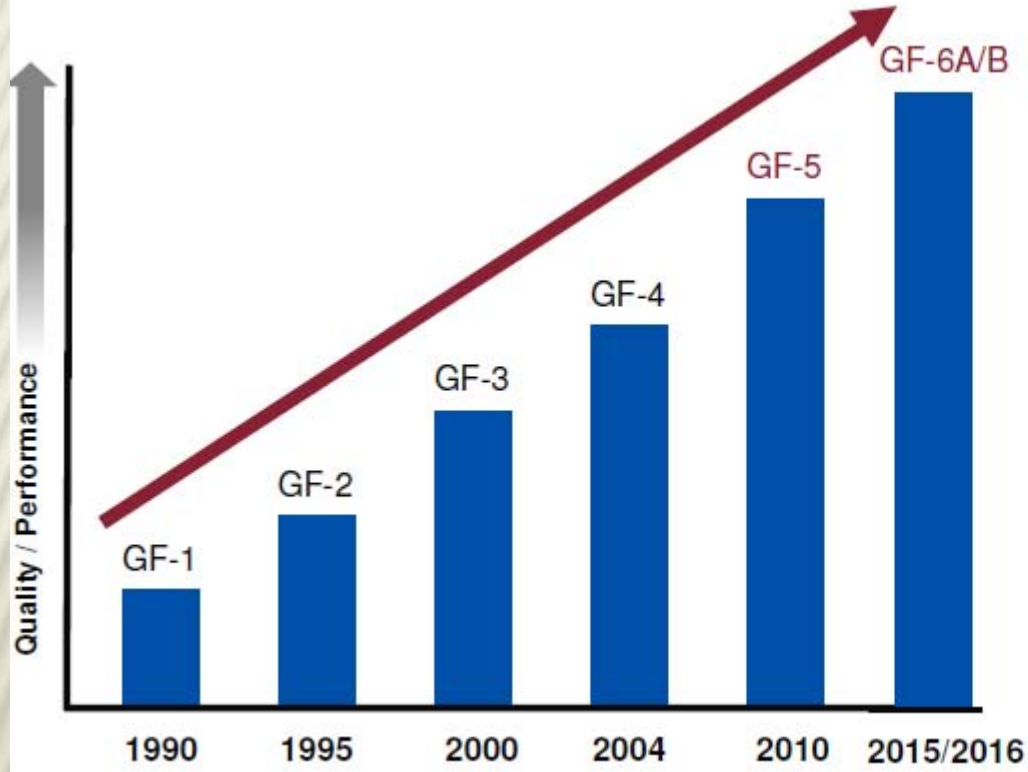
- Current debate over ***two*** GF-6 grades

	GF-6A	GF-6B
HTHS @ 150C	≥ 2.6 mPa•sec	< 2.6 mPa•sec
Certification Mark	Traditional "Starburst"	TBC
Backwards compatible with previous GF categories	Yes	No

- Current timeline first license Sept 2016 (GF-6A)
- Hot topics:
  - Low speed pre-ignition (LSPI) phenomena
  - Wear protection for stop-start engines
  - Increased fuel economy

Source: ILSAC, USA

CHRONOLOGY OF GASOLINE ENGINE LUBRICANT SPECIFICATIONS.- US



- Fuel Economy and Fuel Economy Retention
- Obsolescence of Seq IIIG and Seq IVB Engine Tests
- Protection of Emissions Control Systems
- Overall Engine Oil Robustness
- New Lower Viscosity Grade

Proposed first licensing date for GF-6 by ILSAC is January 2015

Source: Oronite

Thank You

malhotrark@indianoil.in