



Global PVL Market Trends

Global CVL Market Trends

Lubricant Market Review

Automotive Trends

Global Market Trends

95.6 Million global light vehicle sales

VW Group 10.8 million

0.3-2.0% growth expected in 2019

Plug in sales up 72% on 2017

No1. Toyota Corolla >1.1 million

- Sold in 150 countries and regions



Top-Selling Vehicles Around the World in 2018



US: F-150 – 909,330



Europe: VW Golf – 502,752



Japan:

- Micro car: Honda N-Box – 241,870
- Standard: Nissan Note – 136,324



Russia:

- Lada Vesta -108,364



China:

- Sedan: VW Lavida – 503,800
- SUV: Haval H6 – 452,600



Ford F-150 retains the US top spot

2018 Snapshots of the 4 Biggest Markets



CHINA

- Decline 4.1%
- Sales >23 million
- VW No1: 4.1 m.
- Strong position for local OEMs in SUV market
- Gain for Geely +20% - 1.5 million
- BYD tops NEV >247,000 sales



U.S.

- Slow growth 0.6%
- Sales >17 million
- Ford No1. 2.46 m.
- Top 3 models all Pickups
- Biggest gains for Jeep +17.5% & Ram +7.3%
- Tesla enters top 20~190,000 sales



EUROPE

- Almost flat +0.1%
- >15 m. registrations
- VW No1. 3.7 m.
- Big gains: PSA Grp +32%, Jeep + 55%
- Diesel share down to 35% from 43%
- 2.1% cars can be electrically charged



JAPAN

- Almost flat +0.1%
- Sales >4.3 million
- Toyota >30% of the market
- Top 4 sellers are Micro-cars
- Top 3 models all hybrids
- >1 million hybrid sales >26% sales

2018 Snapshots of 4 Growth Markets



INDIA

- Growth slows to 5% ~3.4 million sales
- >70% sub. 1.0 liter models
- Maruti Suzuki holds >50% share
- Tata +18%
- Limited uptake of e-mobility



BRAZIL

- Sales up 14% ~2.5 million
- No 1: GM, then VW and Fiat
- >87% flex fuel
- ROTA 2030 focus on efficiency
- First flex hybrid in 2019



KOREA

- Demand up 1.1% >1.81 m. sales
- Sales of imported vehicles up
- Hyundai Motor Group ~70%
- Hybrid/Electric sales up 26.6%
- Fuel efficiency std. 23.5 km/l



RUSSIA

- Sales up 12.8%, 1.8 m. sales
- No 1: Lada then Kia and Hyundai
- Top 3 hold >42%
- 82 EVs sold in 2017
- More charging + Tesla 3 launch may spark demand

Passenger Car Powertrain Trends

Powertrain mix
continues to diversify

EV growth strong,
but still <10% by 2025

- Fuel Cell

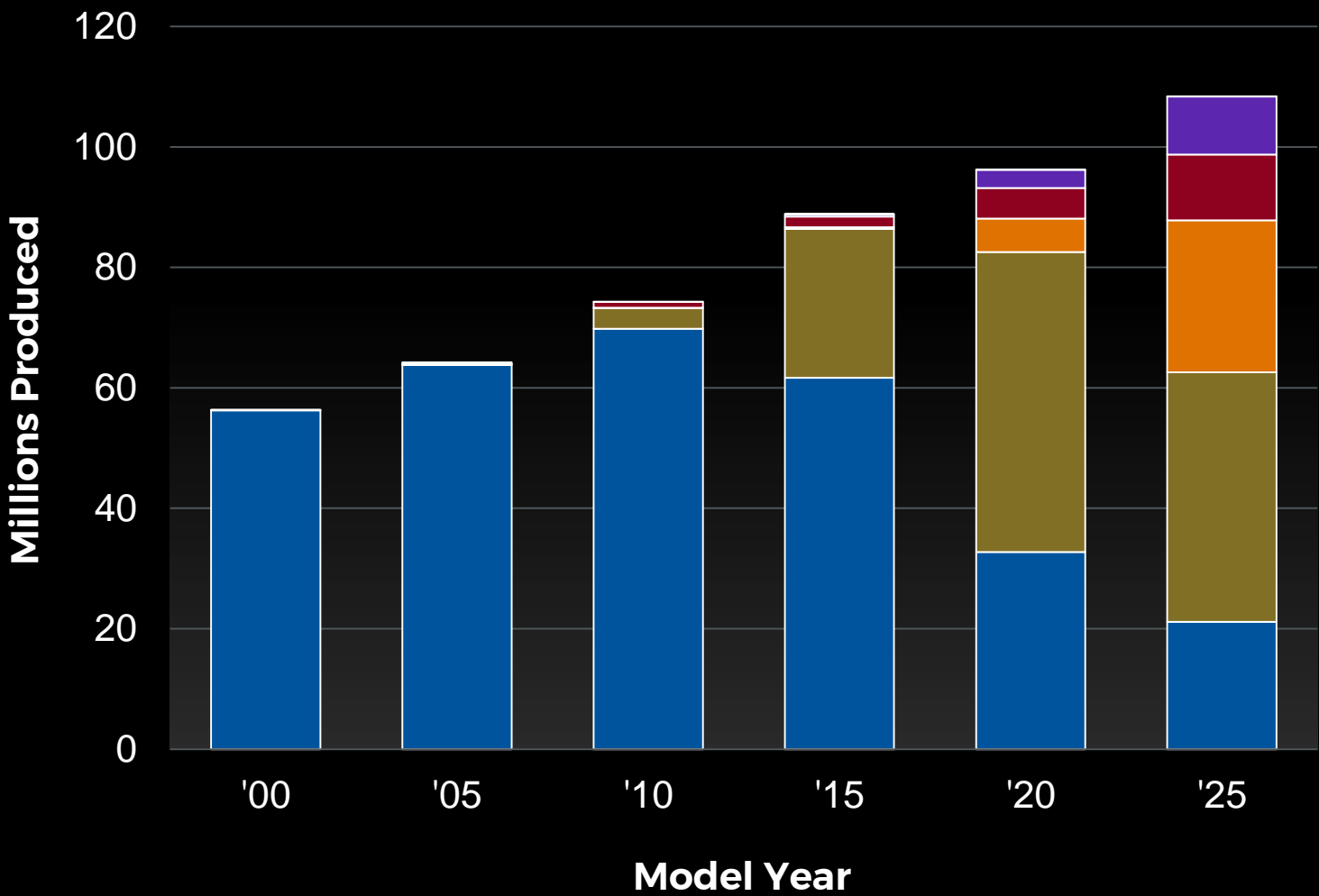
Hybrid-Full

ICE: Stop/Start
- Electric

Hybrid-Mild

ICE

Global Light-Duty Vehicle Production by Propulsion System



Air Quality Improvements Through Legislation

China 6 – tightening emissions limits in 2020 and 2023

US Tier 3 emissions phasing in to 2025

Euro 6 gets tougher on PM, PN & Nox for diesel and gasoline

India jumps straight to Bharat VI

**2016 Euro 5 implemented in Russia
– no timeline for Euro 6**

**TRENDS
2019**

Air Quality: Emissions reductions drive hardware innovation

China 6b close to zero:

NOx – 0.035 g/km

PM – 0.0030 g/km

PN – 6x10¹¹ #/km



CO₂ Reductions Targeted at Climate Change

US looks for 35% CO₂ reduction from light-duty

EU to cut CO₂ from cars by 30%

2020 could see 5 liter/100 km fleet average target in China

Japan to cut fuel consumption ~20% 2009-2020

India CAFE-style fuel economy norms tighten in 2022

**Ultimate goal is
“zero” emissions
for road transport**

**TRENDS
2019**

Climate Change: OEMs are looking
across the whole vehicle for solutions



Improvements in ICE Technology Continue

Mazda: SKYACTIVE-X Spark Controlled Compression Ignition

- 30% more torque, 20-30% better FE than current gasoline engine
- Available in 2019 in the Mazda3

Toyota Dynamic Force Engine

- 40% thermal efficiency, higher torque, fuel efficient

Daimler: New inline 6-cylinder petrol engine

- Launches in 2019 in S-Class

Nissan: Variable compression turbo

- Available in the 2019 Altima

GM: 2019 Silverado can run on 2-cylinders



ICE Innovations for Hybrids

INFINITI energy recovery system

- Instant electric torque & lag-free acceleration
- Scavenges & recycles heat and kinetic energy

EQ Boost EQ Power

- 48V system powers components & boosts engine improved efficiency and drivability
- Plug-in Hybrid with 50km electric only range

Mazda brings back the rotary engine

- Paired with battery as range extender

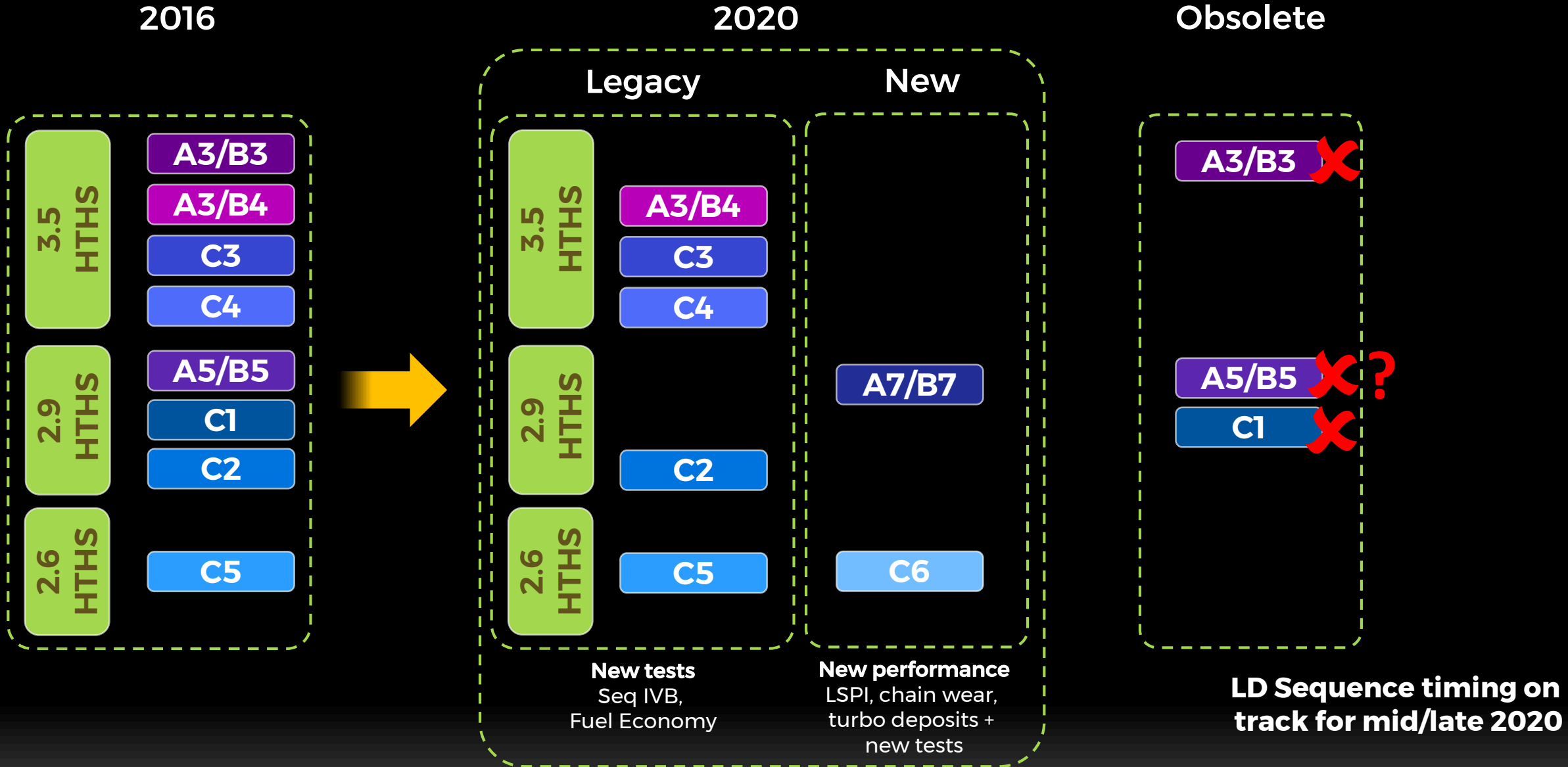


PASSENGER VEHICLES

How will light-duty
lubricant specifications
for EMEA evolve?



ACEA LD Sequence Outlook



ACEA LD Sequence Outlook

	A3/B3	A5/B5	C1	Obsolete
	A3/B4			
SAPS	Full			
Application	Gasoline and diesel			
HTHS	High			
Sludge	M271 EVO			
VTW	Seq. IVB (M271SL Grandfathering under discussion)			
FE				
Others	Seq. VH, DV6, EP6, VW TDI, OM646 wear, OM646 Bio			
Turbo deposits	Not required for continuing categories			
LSPI				
Chain wear				

+ bench tests, viscosity and chemical limits carried over from ACEA-16

LD Sequence timing on track for mid/late 2020

ACEA LD Sequence Outlook

	A3/B3	A5/B5	C1	Obsolete
	A3/B4	A7/B7		
SAPS	Full			
Application	Gasoline and diesel			
HTHS	High	Mid		
Sludge	M271 EVO			
VTW	Seq. IVB (M271SL Grandfathering under discussion)			
FE		JASO FE (M111FE Grandfathering under discussion)		
Others	Seq. VH, DV6, EP6, VW TDI, OM646 wear, OM646 Bio			
Turbo deposits	Not required for continuing categories	L-114		
LSPI		Seq. IX		
Chain wear		Seq. X		

+ bench tests, viscosity and chemical limits carried over from ACEA-16

**LD Sequence timing on
track for mid/late 2020**

ACEA LD Sequence Outlook

	A3/B3	A5/B5	C1	Obsolete		
	A3/B4	A7/B7	C2	C3	C4	C5
SAPS	Full		Reduced (Mid)			
Application	Gasoline and diesel					
HTHS	High	Mid	Mid	High	High	Low
Sludge	M271 EVO					
VTW	Seq. IVB (M271SL Grandfathering under discussion)					
FE		JASO FE (M111FE Grandfathering under discussion)				
Others	Seq. VH, DV6, EP6, VW TDI, OM646 wear, OM646 Bio					
Turbo deposits	Not required for continuing categories	L-114	Not required for continuing categories			
LSPI		Seq. IX				
Chain wear		Seq. X				

+ bench tests, viscosity and chemical limits carried over from ACEA-16

**LD Sequence timing on
track for mid/late 2020**

ACEA LD Sequence Outlook

	A3/B3	A5/B5	C1	Obsolete			
	A3/B4	A7/B7	C2	C3	C4	C5	C6
SAPS	Full		Reduced (Mid)				
Application	Gasoline and diesel						
HTHS	High	Mid	Mid	High	High	Low	Low
Sludge	M271 EVO						
VTW	Seq. IVB (M271SL Grandfathering under discussion)						
FE		JASO FE (M111FE Grandfathering under discussion)					
Others	Seq. VH, DV6, EP6, VW TDI, OM646 wear, OM646 Bio						
Turbo deposits	Not required for continuing categories	L-114	Not required for continuing categories				L-114
LSPI		Seq. IX					Seq. IX
Chain wear		Seq. X					Seq. X

+ bench tests, viscosity and chemical limits carried over from ACEA-16

**LD Sequence timing on
track for mid/late 2020**

COMMERCIAL VEHICLES

Global Trends

Global sales (Class 4-8) >3.3 million

Decline in demand expected in 2019

Alternative power vehicles +29%

TRENDS
2019

**Fuel costs and emissions legislation
drive demand for greener vehicles**



Global Trends – Growth Markets



BRAZIL

- Strong growth as economy recovers
- Bus & Heavy Truck Sales up 44%
- PROCONVE P8 (Euro VI) in 2022
- Growing ULSD B10 is B15 by 2023
- Extending Oil Drain Intervals



RUSSIA

- Economy up 2.3%
- Sanctions cost \$6.3 billion
- CV sales up 2.7%
- KAMAZ 30% market share
- Euro V emissions
- Shift from GOST oil grades to API CI-4



INDIA

- Strong economic growth
- ~1 Million CV Sales up 27%
- Bharat Stage VI emissions in 2020
- Fuel economy tightens in 2021
- Potential for lubricant upgrade



CHINA

- Economy growth slowest in 30 years
- Production +1.7%
- CV Sales +5.1%
- Over 213K NEV CV sold, 80% BEV
- China VI phases in 2019-2023
- Oil Q-up expected

Global Trends – Emissions Regulations Drive Change

US. GHG Phase 2: MY 2021-2027

- Cut CO₂ emissions ~ 1.1 billion metric tons
- Save owners fuel costs of about \$170 billion

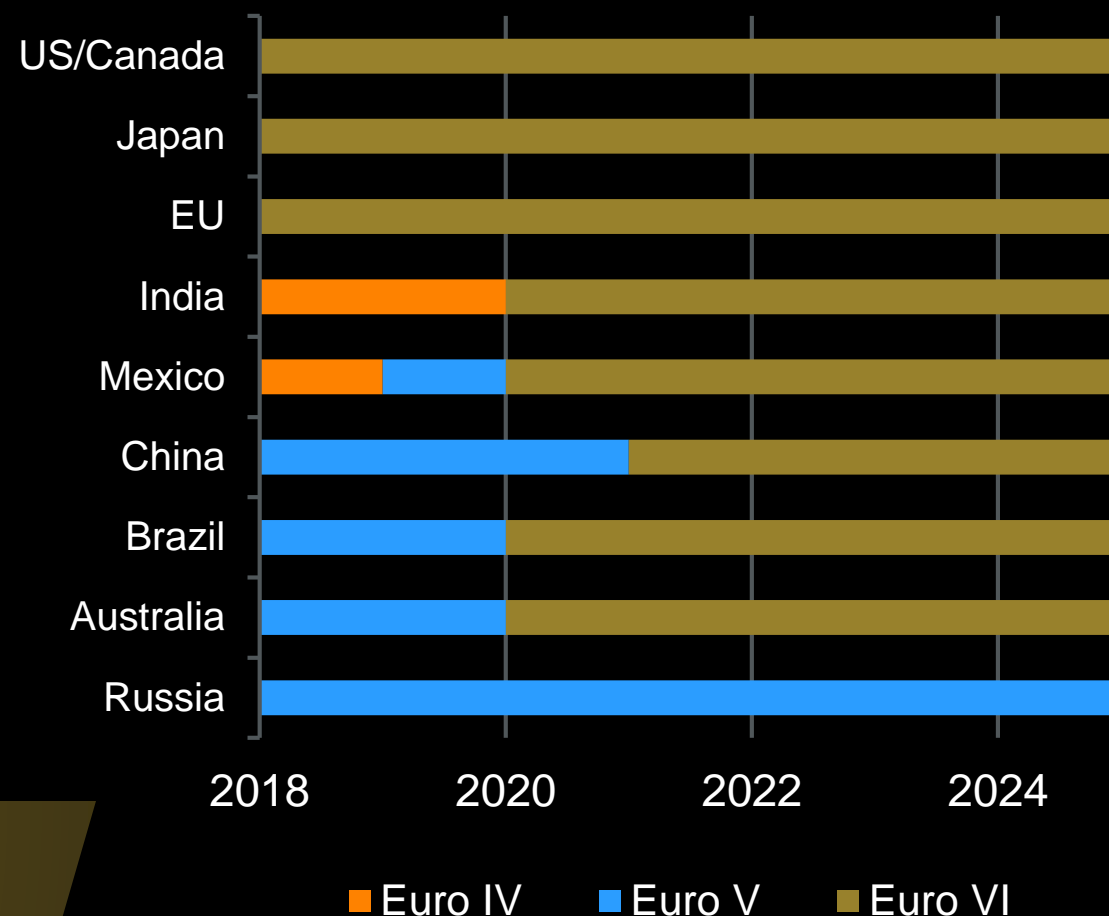
Europe new proposals in May 2018

- 15% CO₂ reduction from 2019 levels by 2025
- 30% CO₂ reduction from 2019 levels by 2030

Euro VI equivalent emissions growing

- Wider use of EGR and SCR will prompt oil upgrades and lower SAPS formulations

Euro Equivalent Emission Regulations Implementation



Global Trends – Natural Gas for Transport

China - Most medium/heavy NGV growth

Russia – Ministry of Energy Program

- \$2.6bn\$ subsidies for gas producers, OEMs and regional authorities
- Target 700K gas vehicles and 1400 new gas stations by 2024

Europe - Volvo latest FH/FM LNG trucks

- Diesel pilot injection ignites gas
- Fuel consumption 15 – 25% lower than conventional Otto cycle gas engines

US - Cummins Westport ISX12N

- 400 hp / 1,450 lb-ft torque
- >1,000 produced since Feb. 2018



Global Trends – Modern NGV Lubrication

Latest mobile gas engine oils must deliver extra performance

- Cummins launches CES 20092 for improved oxidation and wear protection

Fleets with NGVs often have diesel and gasoline vehicles

Performance Heavy-Duty Gas Engine Oils

- CES 20092 requirements
- Oxidation/Nitration control
- Emulsion handling
- Fuel quality
- Extended drain protection

Performance Heavy-Duty Diesel Engine Oils

- Exceed CK-4 & OEM specs
- Oxidation control
- Soot handling capability
- TBN retention
- Extended drain protection

Performance Gasoline Engine Oils

- API SN requirements
- Catalyst compatibility

Global Trends – ICE Continues to Improve

Turbo compounding – waste heat recovery

- Volvo – Improves FE by up to 6.5%

Uptake depends on fuel economy gains vs. various costs



Global Trends – Green Tech Market Barriers Remain

Higher vehicle purchase price

Higher vehicle weight

Lack of recharging or
refueling infrastructure

Battery service life and
recycling

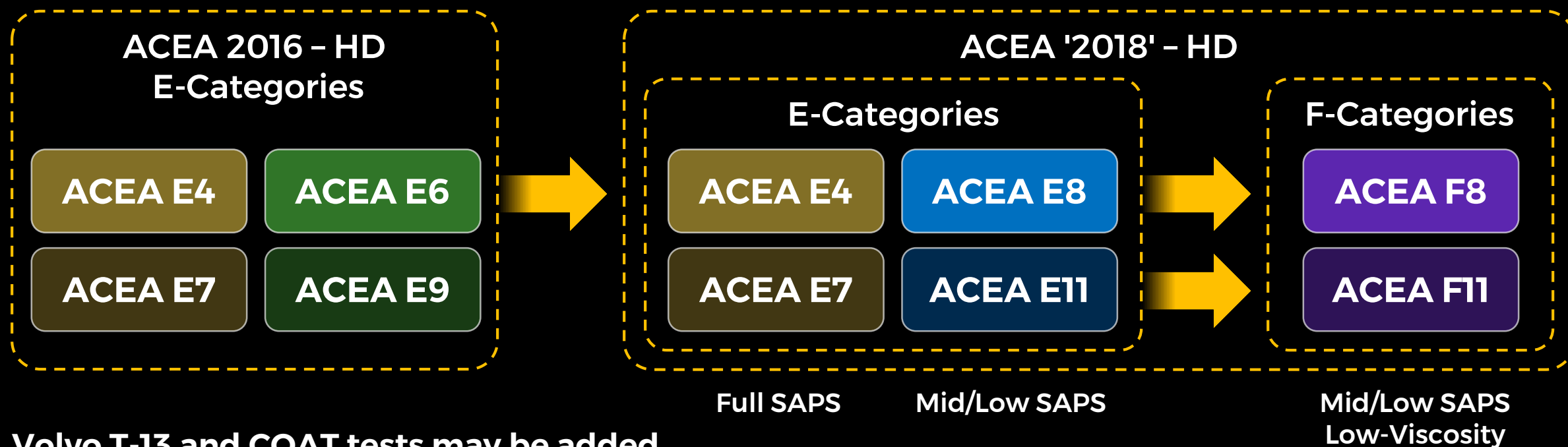
Poor ROI



COMMERCIAL VEHICLES

How will
heavy-duty
lubricant specifications for
EMEA evolve?

ACEA Update – Efficiency Improvements



Volvo T-13 and COAT tests may be added

New low viscosity F categories: HTHS from 2.9 to 3.2

- Two new tests for wear protection in low viscosity and low soot: CEC TDG-L-115 Bearing Wear and CEC TDG-L-116 Ring – Liner Wear

OM501 & OM646 test replacements

Tighter limits for some existing tests

Timing uncertain, but ACEA revisions may slip into 2020

A close-up photograph of a grey plastic oil can being poured. A thick, golden-yellow stream of oil is falling from the spout. The background is blurred, showing mechanical parts.

Lubricant Trends

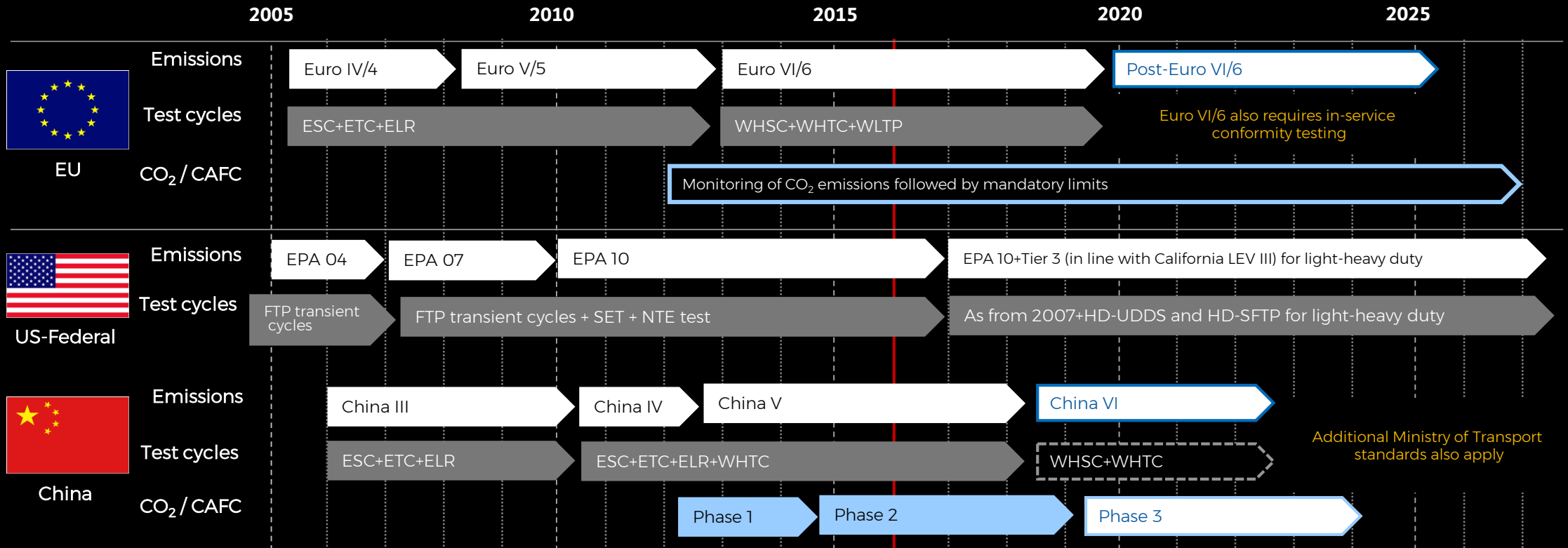
Lubricant Demand Drivers

Lower Viscosity Grades

Quality Upgrades

Globalisation of Oils

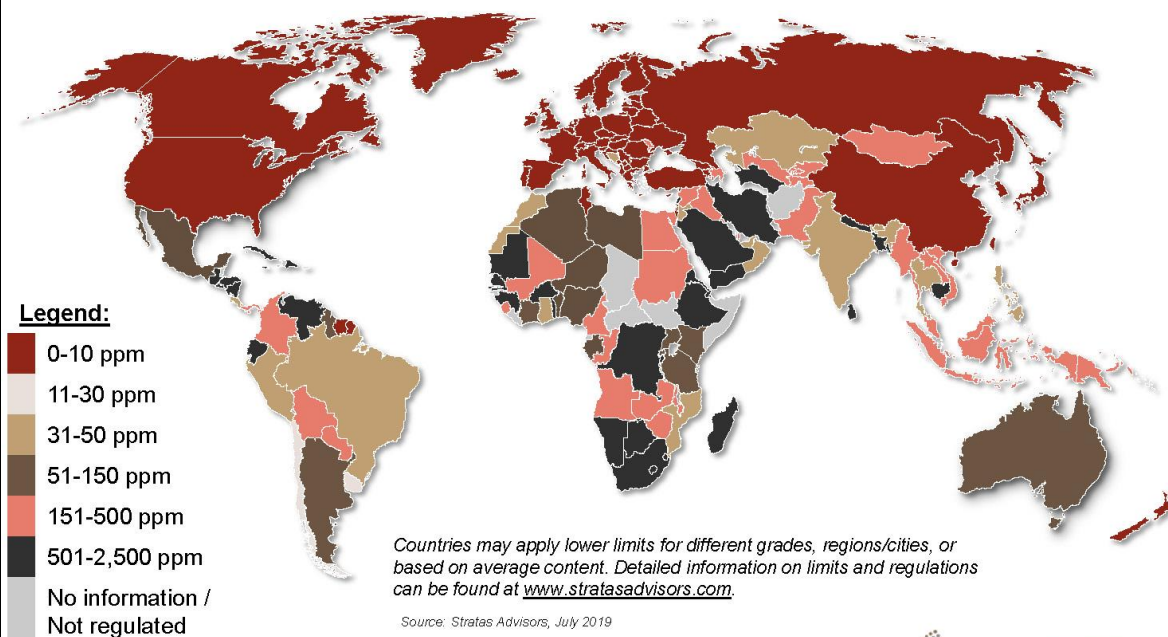
Emission Regulation is the Key Driver



Fuel Quality still varies globally

Maximum Sulfur Limits in Gasoline, 2019

Fiji implemented 50 ppm since January

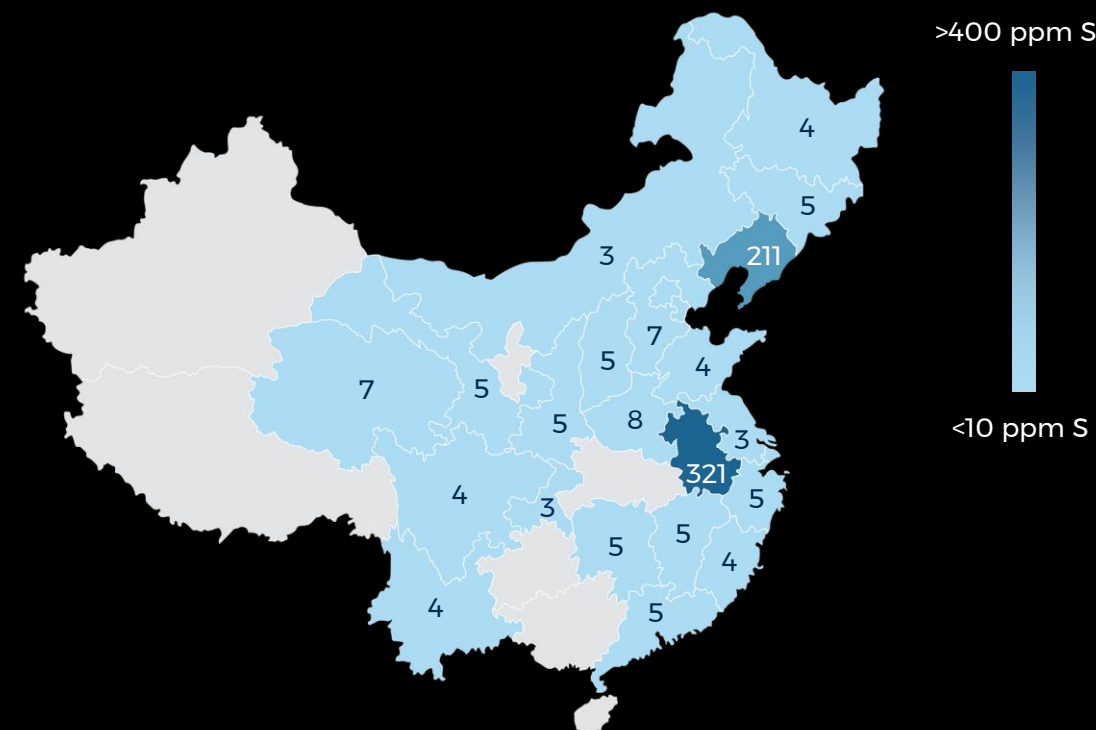


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Average sulphur levels in diesel in China



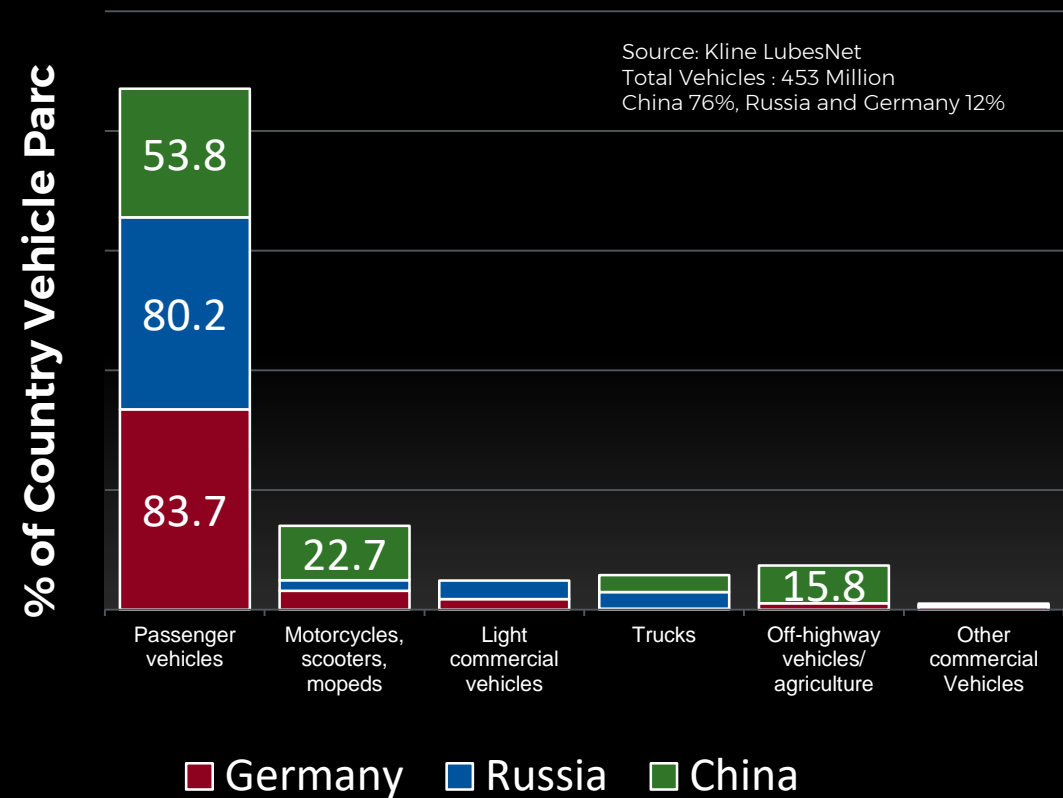
More than 91% of samples from China contained less than 10 ppm sulphur



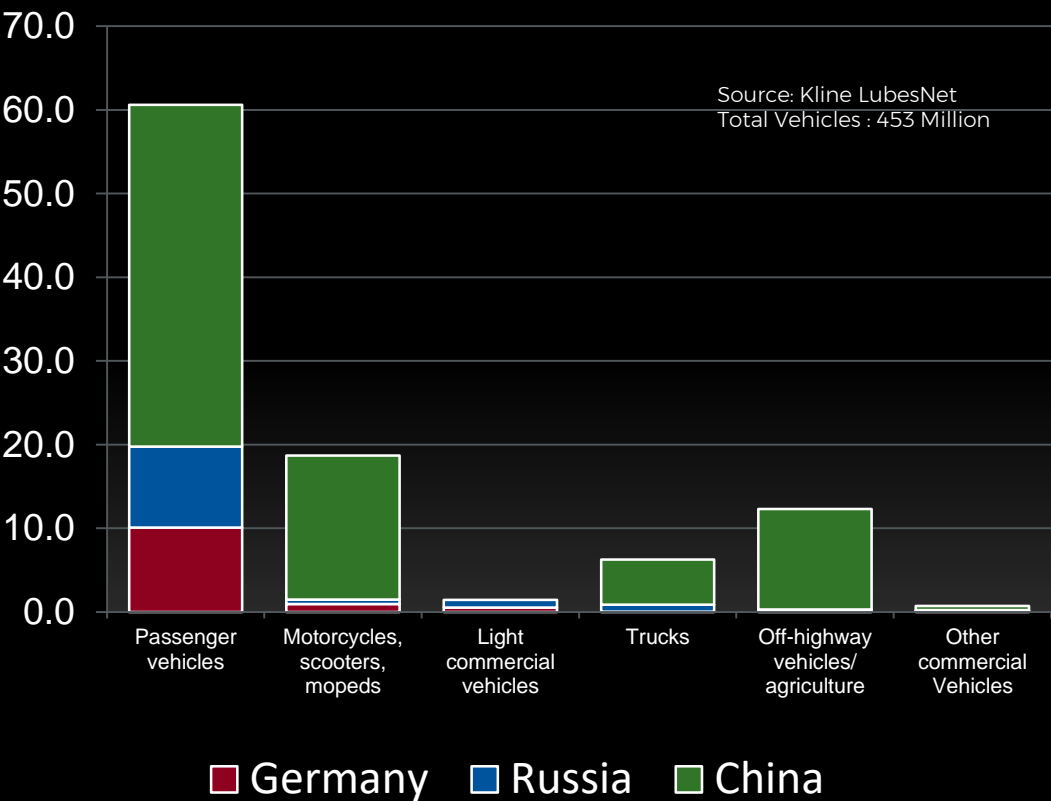
**So how does
lubricant quality
evolve across
different regions**

What Does the Fleet Look Like

Vehicle Type by Country
% of total fleet in that country



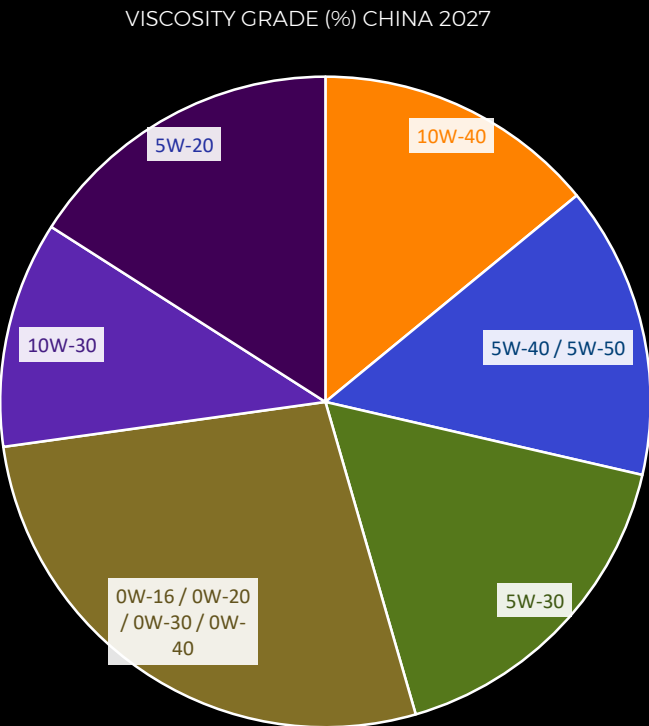
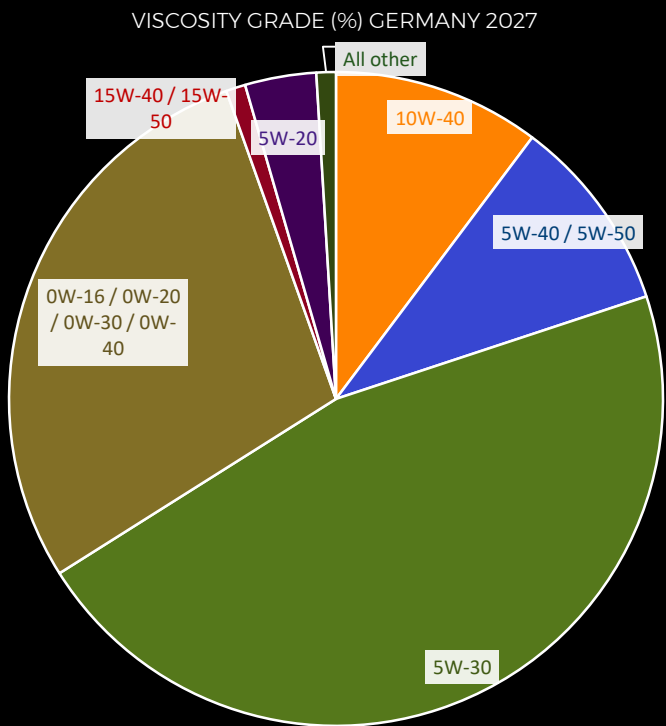
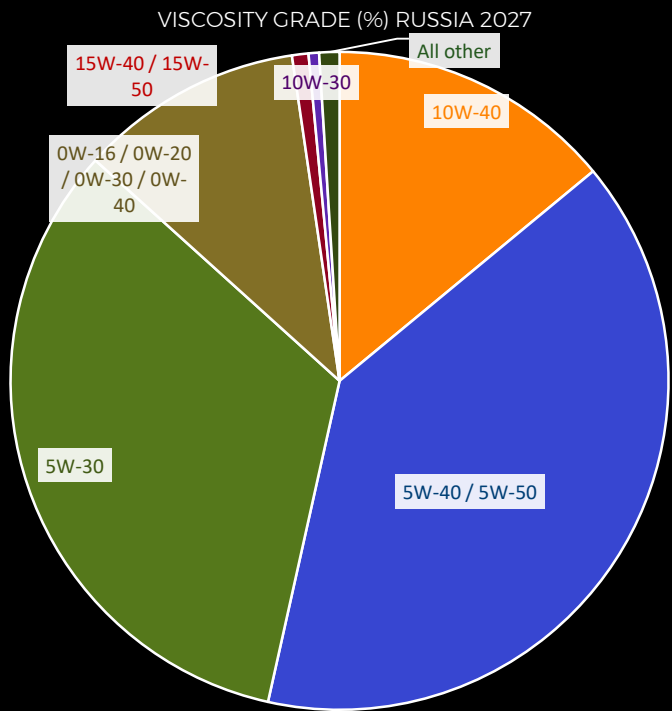
Vehicle Type by Country 2018
% relative total vehicle of combined China, Russia & German Fleet



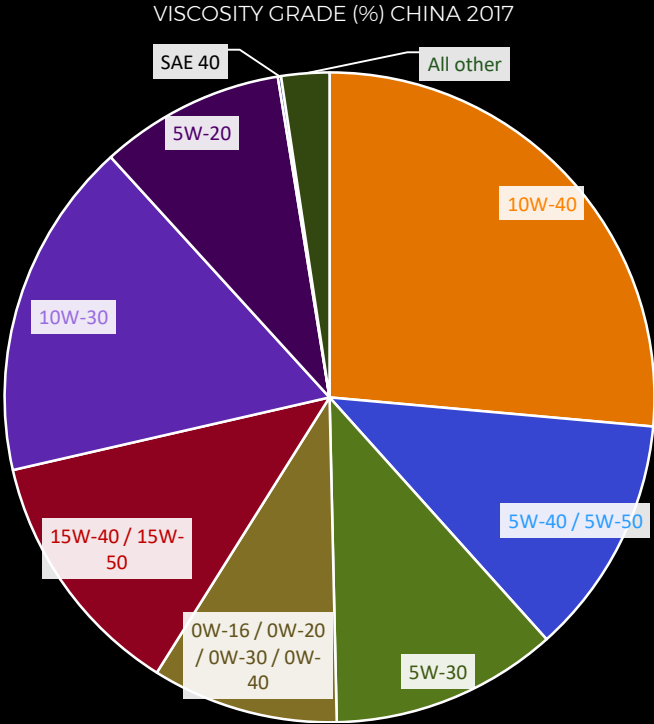
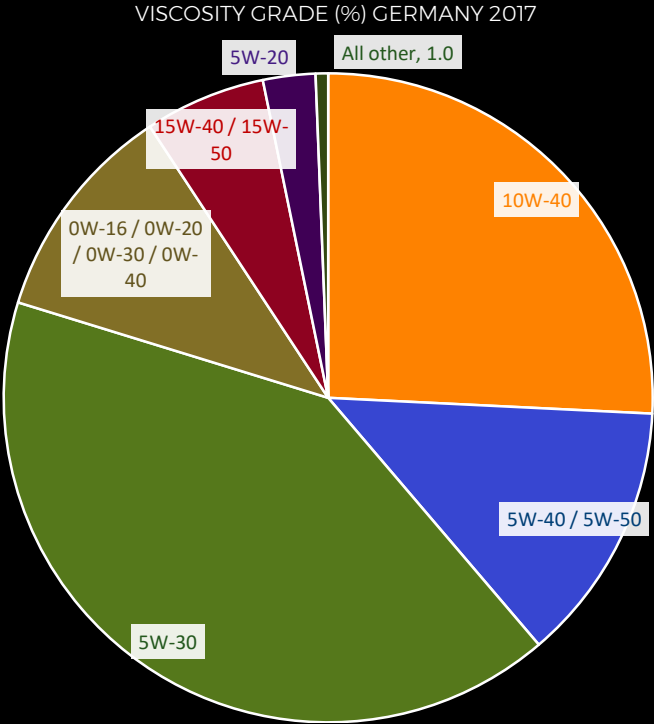
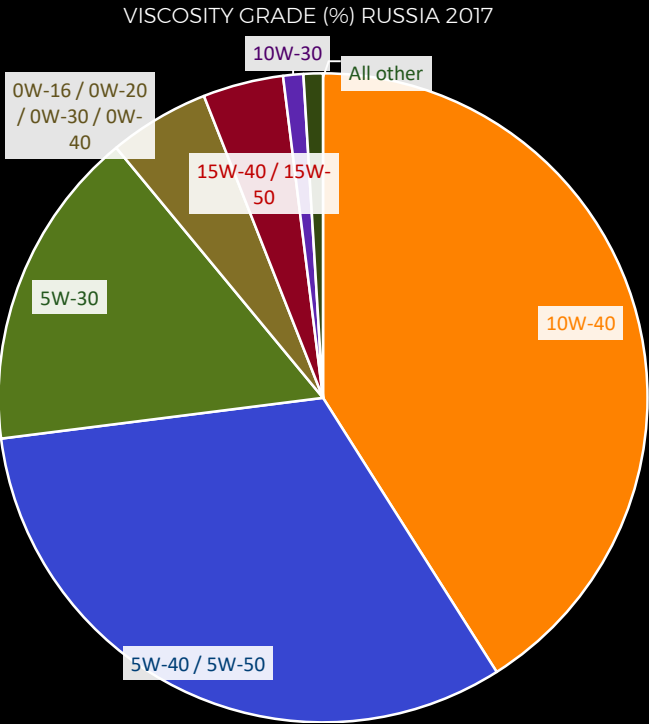
How does this play out
in lubricant
requirements?



Passenger Car Lubricant Demand Viscosity Grade Evolution

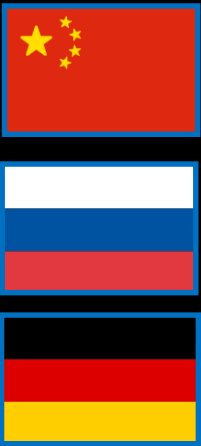


Passenger Car Lubricant Demand Viscosity Grade Evolution



Lubricant Quality Upgrade

CHEMICAL LIMITS



C3/C2/(C5)
SAE 5W-40/30
SAE0W-30

MB229.52
MB229.51
MB229.31



MB
SAE 0W-20/30

BMW
SAE 0W-20/30

VW
SAE 0W-20

JLR
SAE 0W-20

PSA
SAE 0W-20/30

FORD
SAE 5W-20/30

C4/C1
SAE 5W-40/30

Renault
JLR

FUEL ECONOMY
HTHSV ≥ 2.6, 2.75, 2.9



NON CHEMICAL LIMITS

A3/B3, A3/B4, A3/B5
SAE 5W-40/30
SAE 0W-40/30

MB229.5



BMW LL-14FE+
SAE 0W-20

MB 229.6
SAE 5W-30

FORD
SAE 5W-30

A3/B3, A3/B4
SAE 5W-40/30

MB229.3

A3/B3, A3/B4
SAE 10W-40

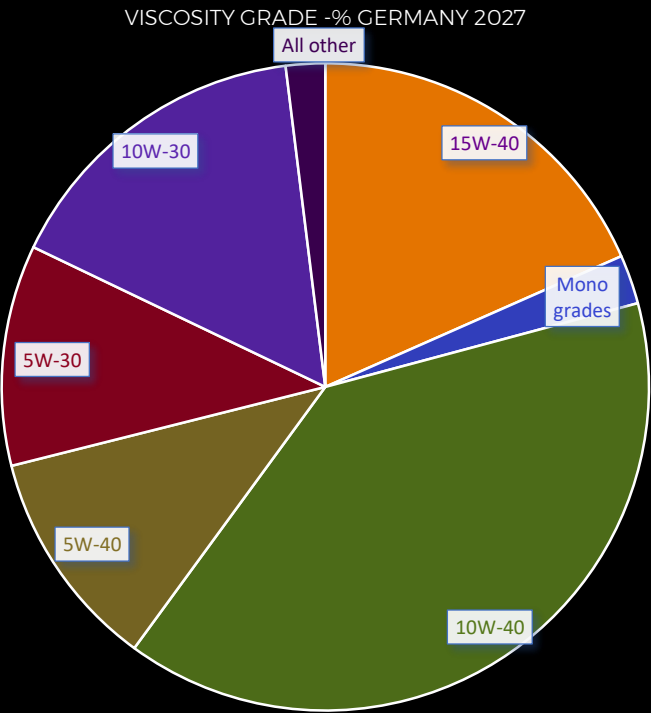
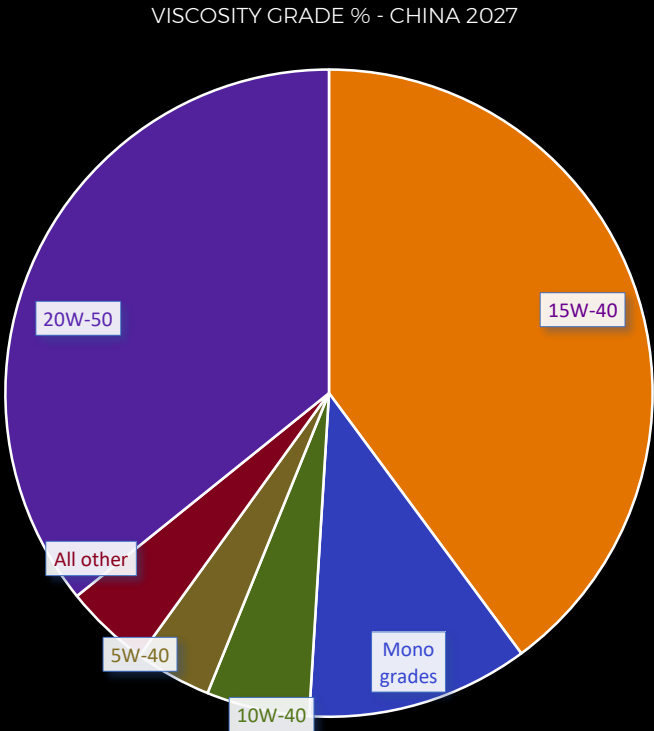
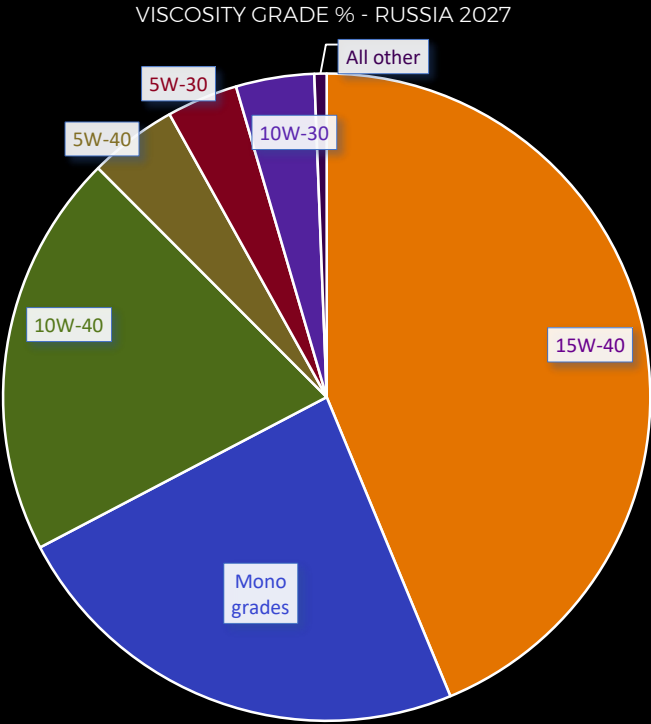
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A3/B3, A3/B4
SAE 15W-40

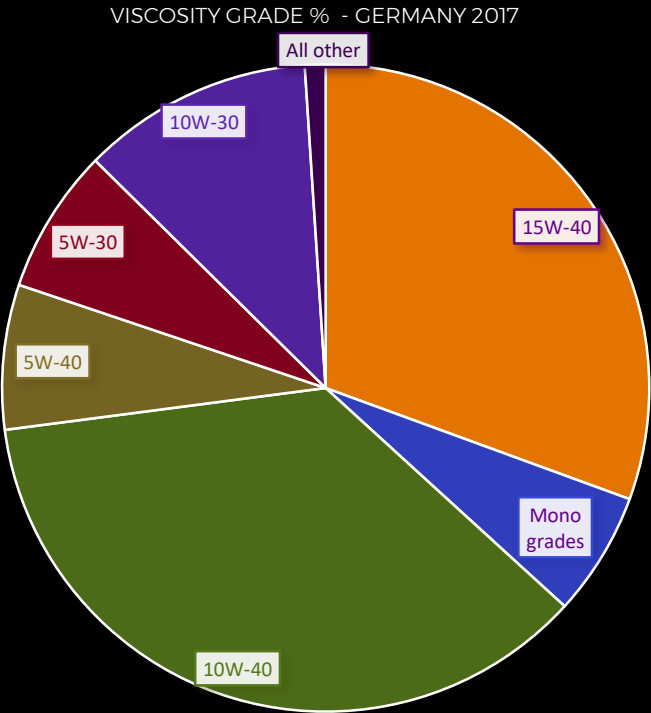
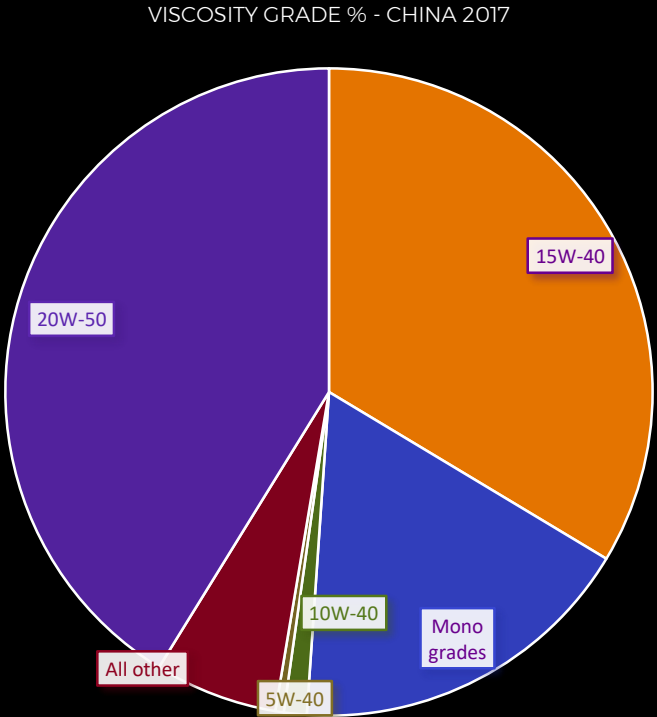
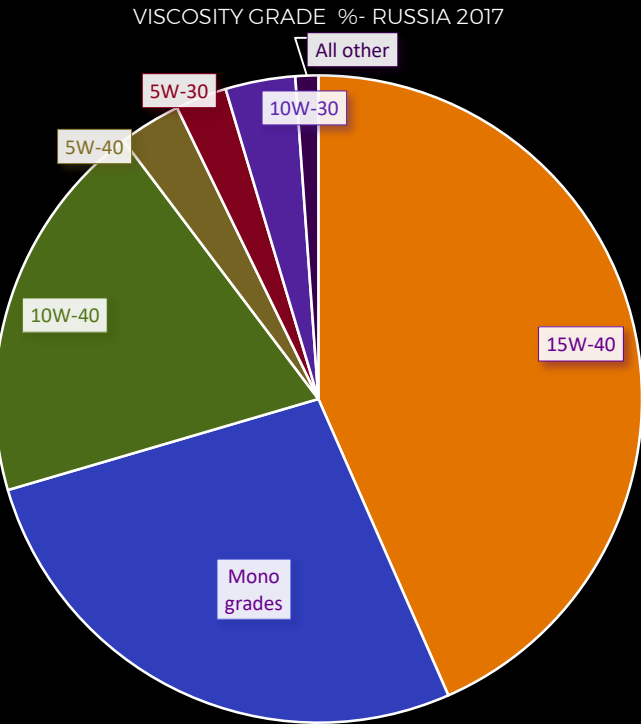
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Heavy Duty Diesel Lubricant Demand Viscosity Grade Evolution

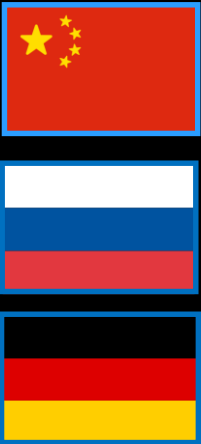


Heavy Duty Diesel Lubricant Demand Viscosity Grade Evolution



Lubricant Quality Upgrade

CHEMICAL LIMITS



E6/E9/CK-4
Cummins 20083
VDS-4 / 4.5
SAE 10W-40

E6/E9/CK-4
Cummins 20081
MAN M3677, LDF-4
VDS- 4/4.5
SAE 5W-30

E6/E9/CJ-4
Cummins 20081
VDS-4 / 4.5
SAE 10W-40

E6/E9/CJ-4
Cummins 20081
MAN M3677, LDF-4
VDS- 4/4.5
SAE 5W-30

E6-CI-4-VDS-3
SAE 10W-40
SAE 10W-30

MB229.51

E9-CJ-4-VDS-4.5
SAE 10W-40
SAE 10W-30
"SAE 15W-40"

MB229.31

MB229.51



OEMs
HTHSV ≥ 2.9
HTHSV ≥ 2.6

HTHSV ≥ 2.9
API FA4 – ACEA F

MB229.61

NON CHEMICAL LIMITS

E4 Scania LDF-3
SAE 10W-40

E4 Scania LDF-3
SAE 5W-30

MB229.5

E7/CI-4
SAE 15W-40

E7/CI-4
SAE 10W-40

MB228.3

E5/CH-4
SAE 15W-40

MB228.3
MB228.1

CF-4-CG-4
SAE 15W-40

MB228.1



What have we seen so far?

Industry and Markets

Lubricant Impacts

OEMs leveraging fuel-efficient engine oils

Lower viscosity oils in factory and service

New materials and contact surfaces for improved FE

Oils compatible with new materials

Down-sized Direct Injection Gasoline

Oils capable of controlling / reducing LSPI

Steel Pistons enabling higher BMEP

Higher thermal oil stress

Thermal management

Higher average temperature of operation

Hybridisation / Stop Start

Cold start response and water handling

EGR and SCR

Potential for greater nitration and oxidation

Push for lower cost of ownership

Increased oil drain intervals challenge oil life