

IHS AUTOMOTIVE

Presentation

European Engine Outlook – Potential of the Gasoline Engine

IHS Automotive Customer Briefing – Frankfurt | 17 June 2015

ihs.com

Pavan Potluri, Senior Powertrain Analyst
+44 (0) 208 544 7973, pavan.potluri@ihs.com

© 2015 IHS

IHS AUTOMOTIVE
driven by POLK



Contents

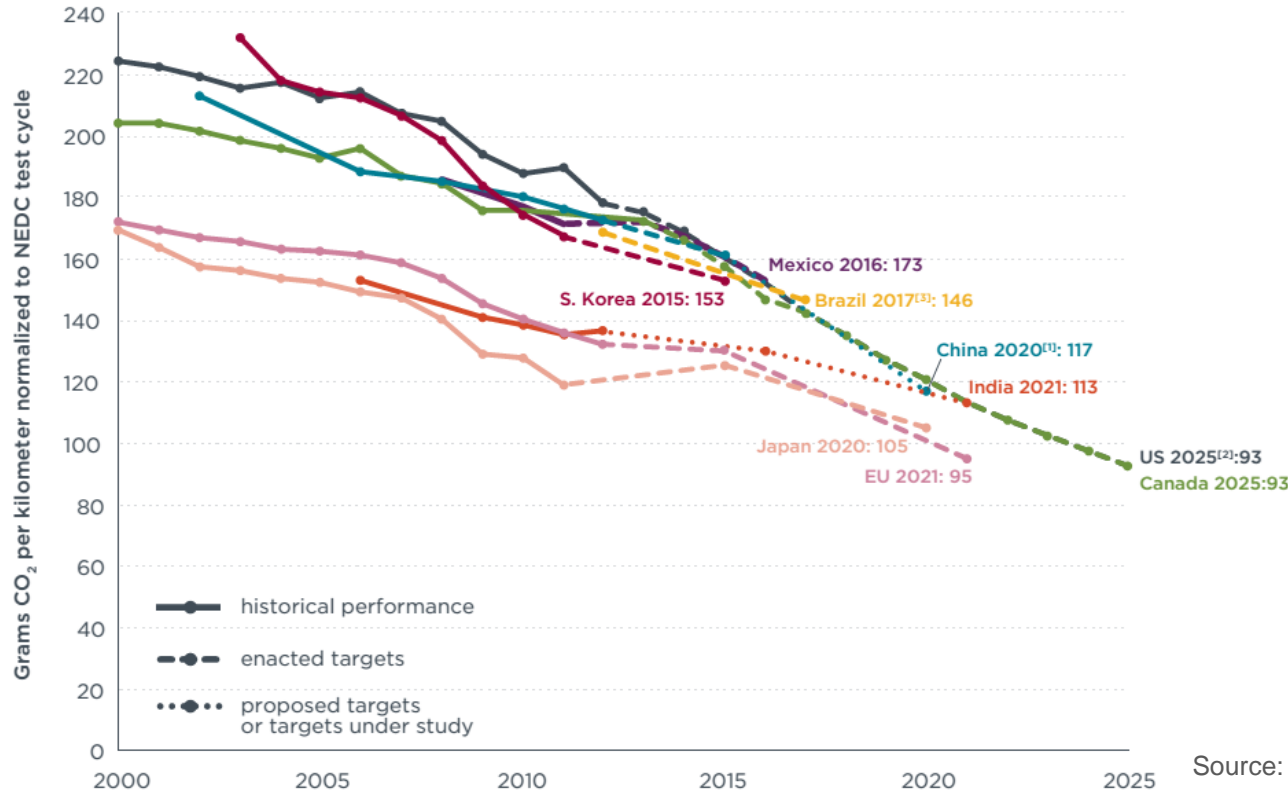
INTRODUCTION

DIESEL - THE RECENT DEBATE

GASOLINE ENGINE OUTLOOK

SUMMARY

Emissions Legislation: Global Overview



- Global CO₂ target number range now starting to converge
- ~4% and ~5% annual CO₂ reduction needed by EU and U.S. respectively
- Global non-CO₂ emission norms continue to tighten and converge
- Combined with the WLTP movement, the 'Global' engine becomes a reality

	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	
US	T II B8	Tier II Bin 5							Tier II Bin 4			
Europe	Euro 4					Euro 5				Euro 6		
Japan	Japan '05				Japan '09							
S. Korea	Euro 3	Euro 4				Euro 5				Euro 6		
China (Beijing)	Euro 3			Euro 4				Euro 5				

European Legislation Roadmap



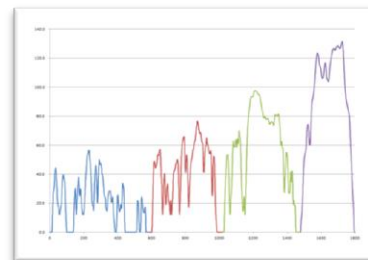
2015

- **130g/km** for all Pass.Cars
- Costly NOx reduction for Diesel - **EU6b**



2017

- PN regulations for GDI engines – **EU6c**
- LCV targets **178g/km**



2021

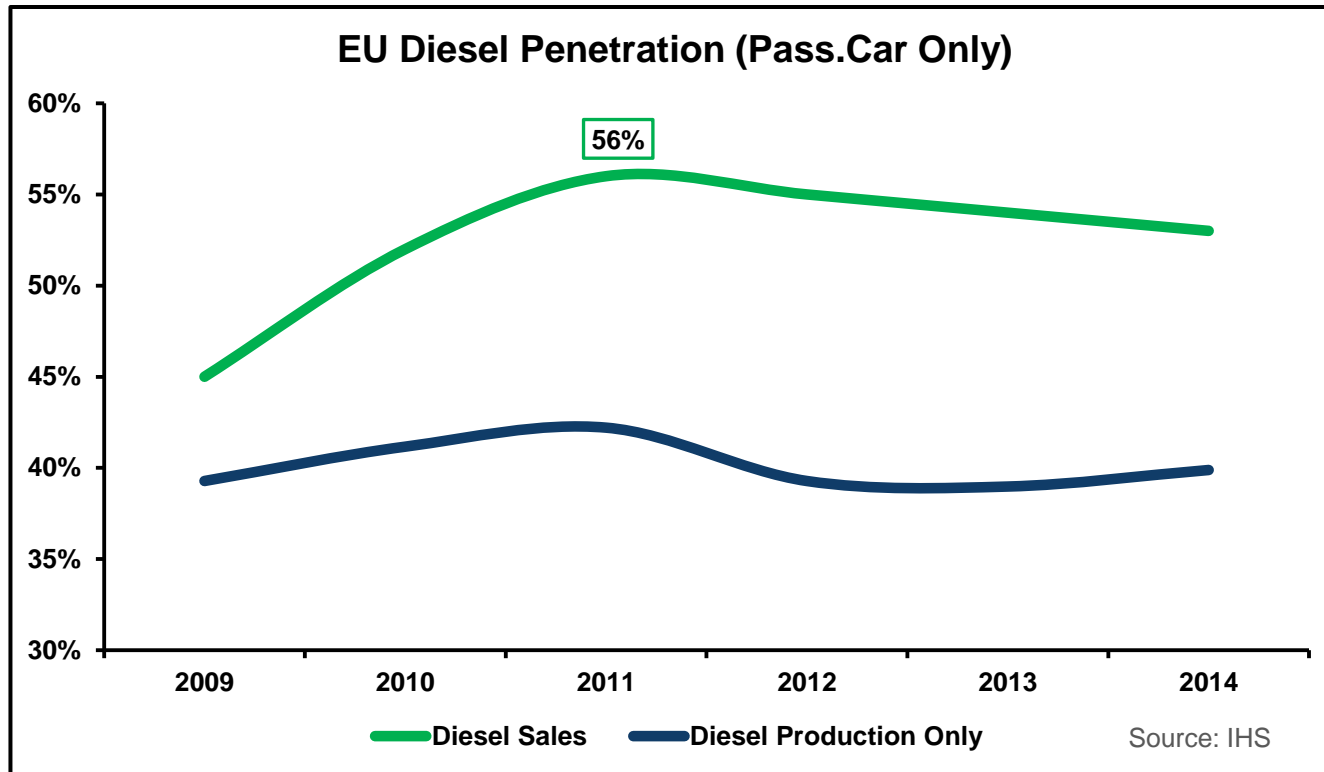
- **95g/km (NEDC)** – 27% reduction from all OEMs
- **WLTC + RDE** challenges
- LCV targets **147g/km**



2025?

- **78-68g/km?** vehicle fleet average target sets the bar high

How have OEMs achieved these targets in the EU?



- Diesel engines generally achieve better CO₂ values on NEDC
- Before Euro 5b (2011) the non-CO₂ limit values (NO_x, PM, PN..) for the diesel engines were relatively weak compared to some other markets like the USA

Contents

INTRODUCTION

DIESEL - THE RECENT DEBATE

GASOLINE ENGINE OUTLOOK

SUMMARY

Diesel - The Recent Debate

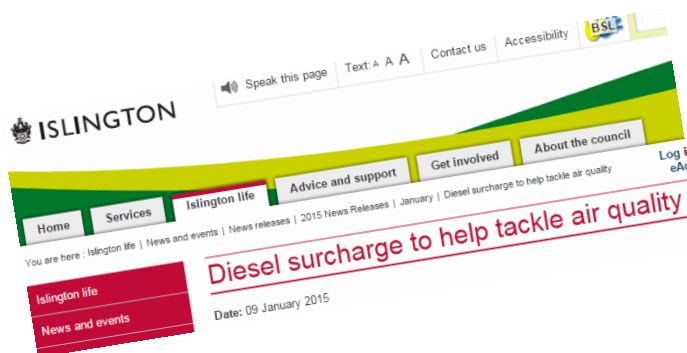


THE TIMES

Environment

News | Opinion | Business | Money | Sport | Life | Arts | Puzzles | Papers

Diesel drivers face £24-a-day London charge



11 March 2015 Last updated at 11:01

1.1K Share

Diesel car 'demonisation' condemned by industry group

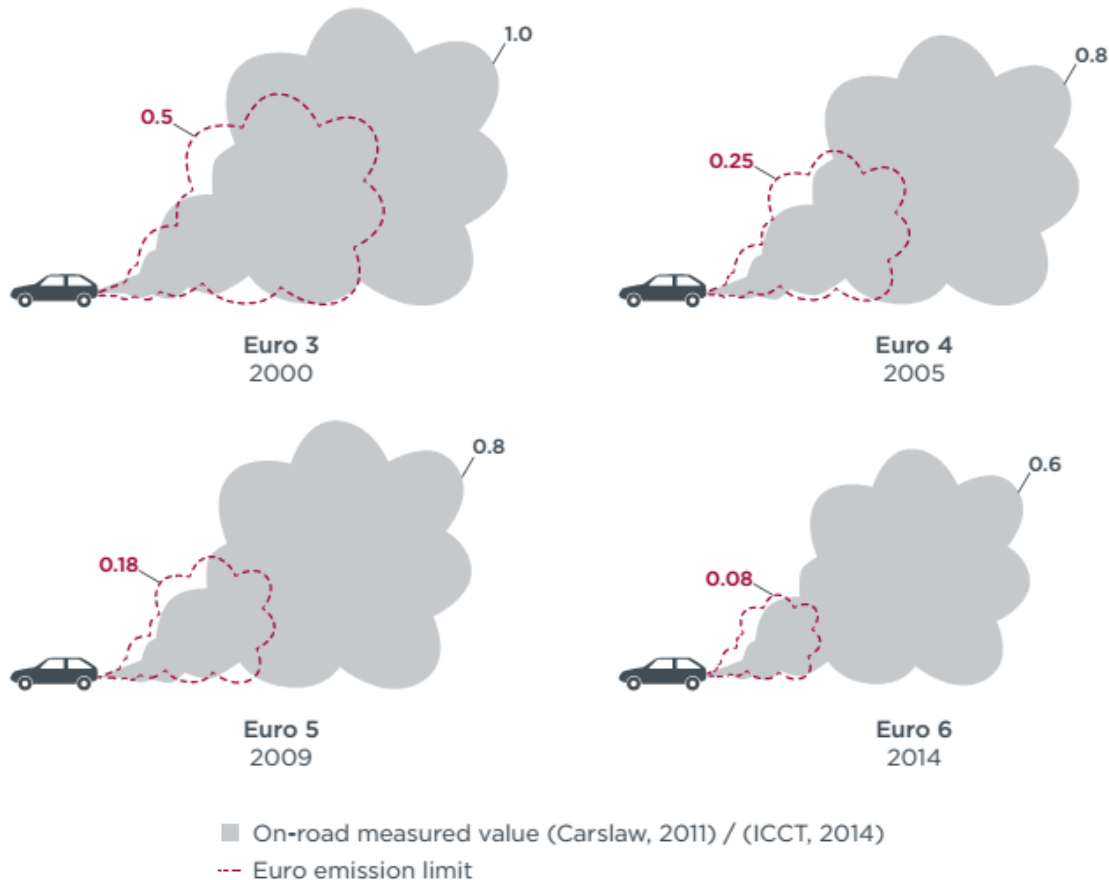


Diesel - The Recent Debate

- Focus on CO₂ in Europe incentivized consumer behaviour towards diesel
- Increased Particulate Matter(PM), Nitrous Oxides(NOx) in cities as a result – Health issues, visual pollution
- Increased pressure on city authorities to limit entry of diesel vehicles – creation of zero/ low emission zones, higher congestion charges, out right-ban on diesel vehicles

Certified Emissions vs. Reality

Diesel cars: Nitrogen oxides (NO_x) emissions (in g/km)



- NOx emission limits lowered by 85% between 2000 and 2014
- On-road emission levels decreased only by ~45%
- Upcoming test procedure changes (WLTC, RDE) should improve this situation

Source: REAL-WORLD EXHAUST EMISSIONS FROM MODERN DIESEL CARS, ICCT, October 2014

Real Driving Emissions (RDE)

- Real driving emissions have not decreased as fast as expected
- New RDE procedure will complement NEDC/ WLTC
- Expected to be phased in ~ 2017/18 (likely pushed to 2020) starting with Euro6c
- “Random” drive cycle or PEMS
- Measurement Targets:
 - NO_x (main target for Diesel)
 - CO
 - PN (main target for GDI)
 - HC (optional)



Source: TUV Nord

Contents

INTRODUCTION

DIESEL - THE RECENT DEBATE

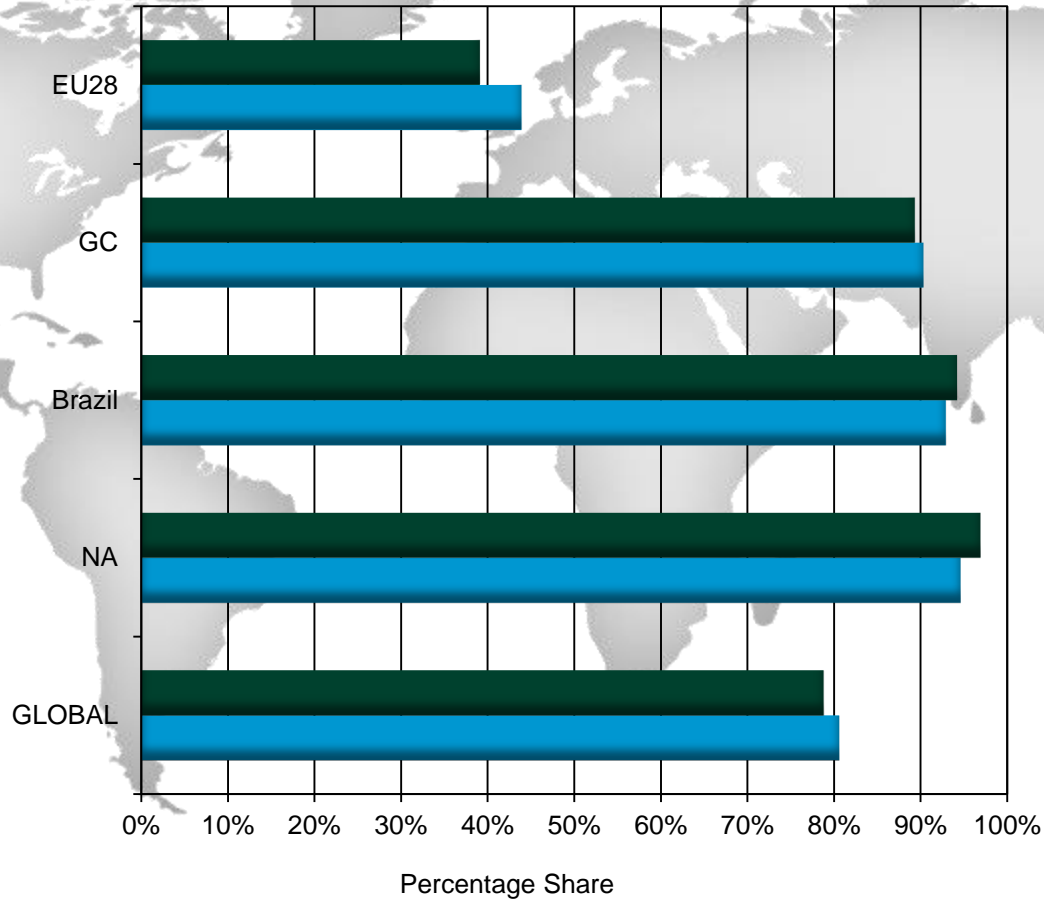
GASOLINE ENGINE OUTLOOK

SUMMARY

Gasoline Engine Outlook

Gasoline around the World

Light Vehicle Gasoline Sales (incl. LCVs)



Note: Includes Gas-E85/E100 bi-fuel vehicles

■ 2012 ■ 2021

Source: IHS

Gasoline Engine Outlook

EU28 – LCV Sales by Fuel Type



- Diesel is the dominant fuel in the LCV segment, expected to stay strong in long term

- Gasoline shows some growth, especially in smaller LCVs

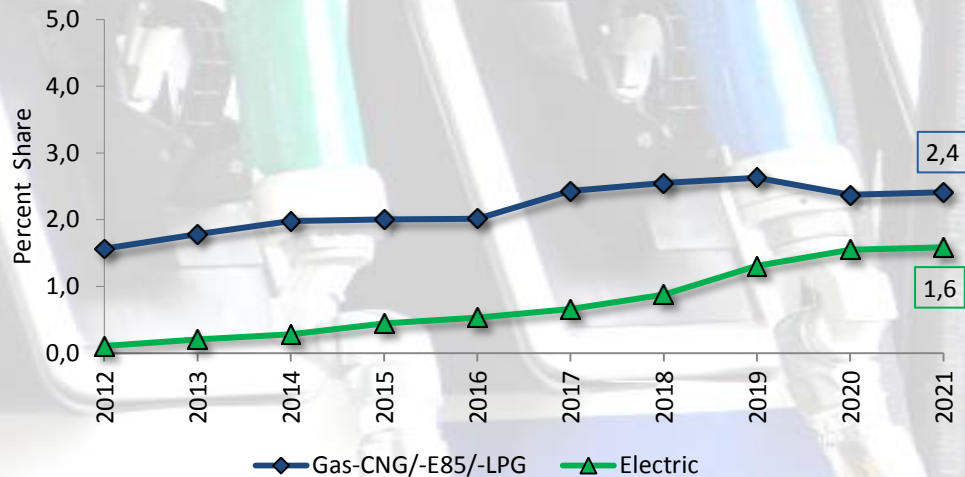
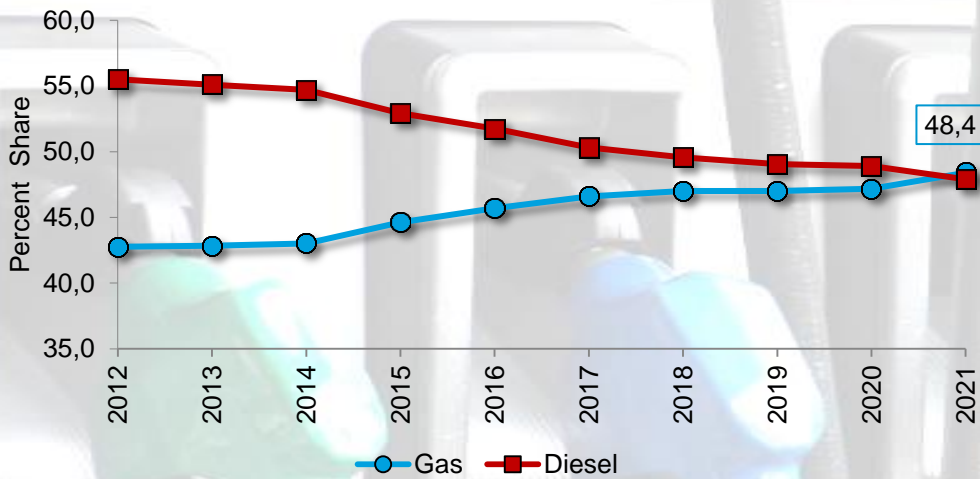
- Modest growth for CNG/E85/LPG fuels

- Electric LCVs expected to reach ~1.4% in 2021

Source: IHS

Gasoline Engine Outlook

EU28 - Passenger Vehicle Sales by Fuel Type

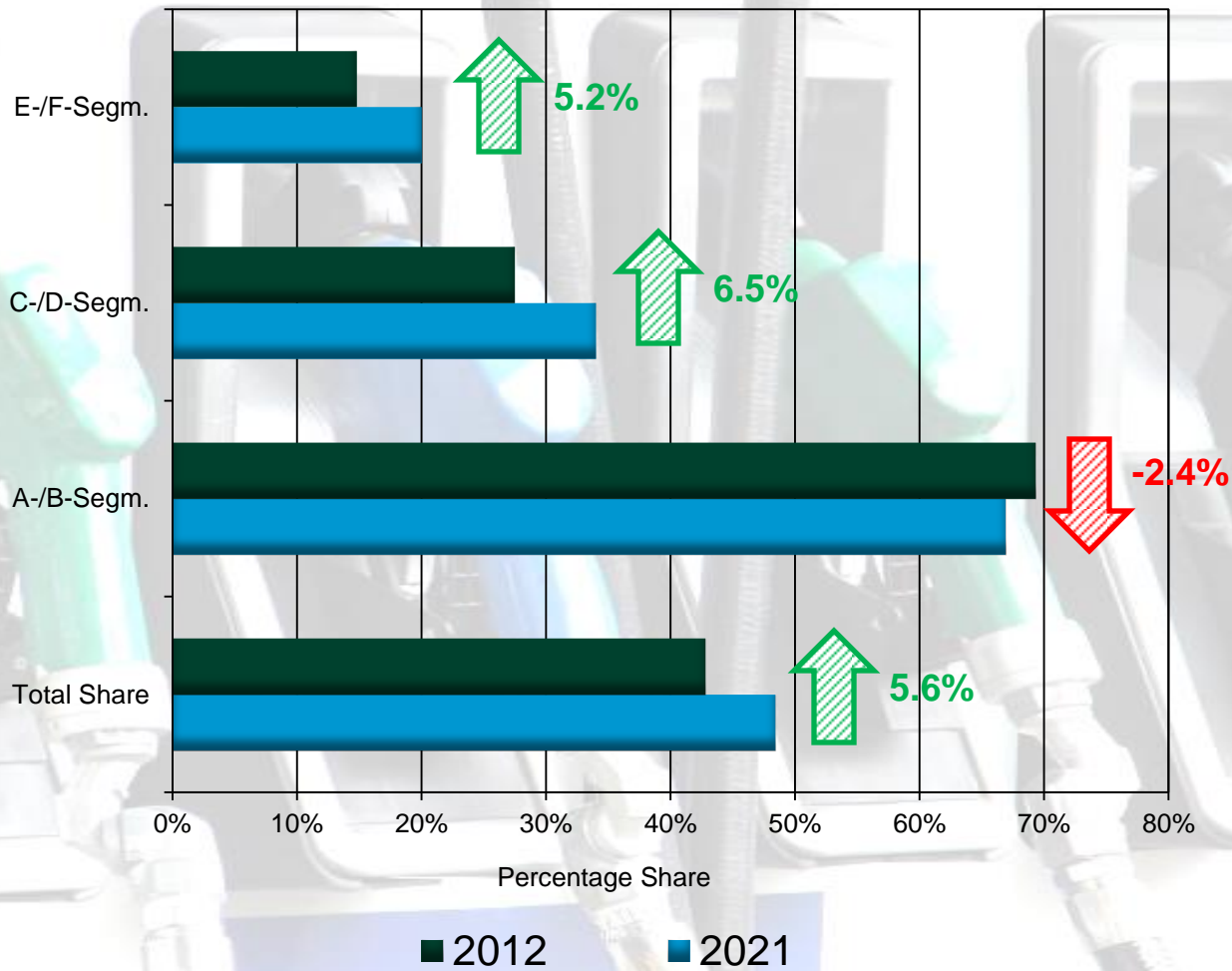


- Gasoline set to overtake diesel as the dominant fuel
- The “crossover” from diesel to gasoline expected to happen around 2021 (*might even happen slightly earlier*)
- Modest growth for CNG/E85/LPG fuels
- Electricity as a propulsion source is expected to reach ~1.6% by 2021

Source: IHS

Gasoline Engine Outlook

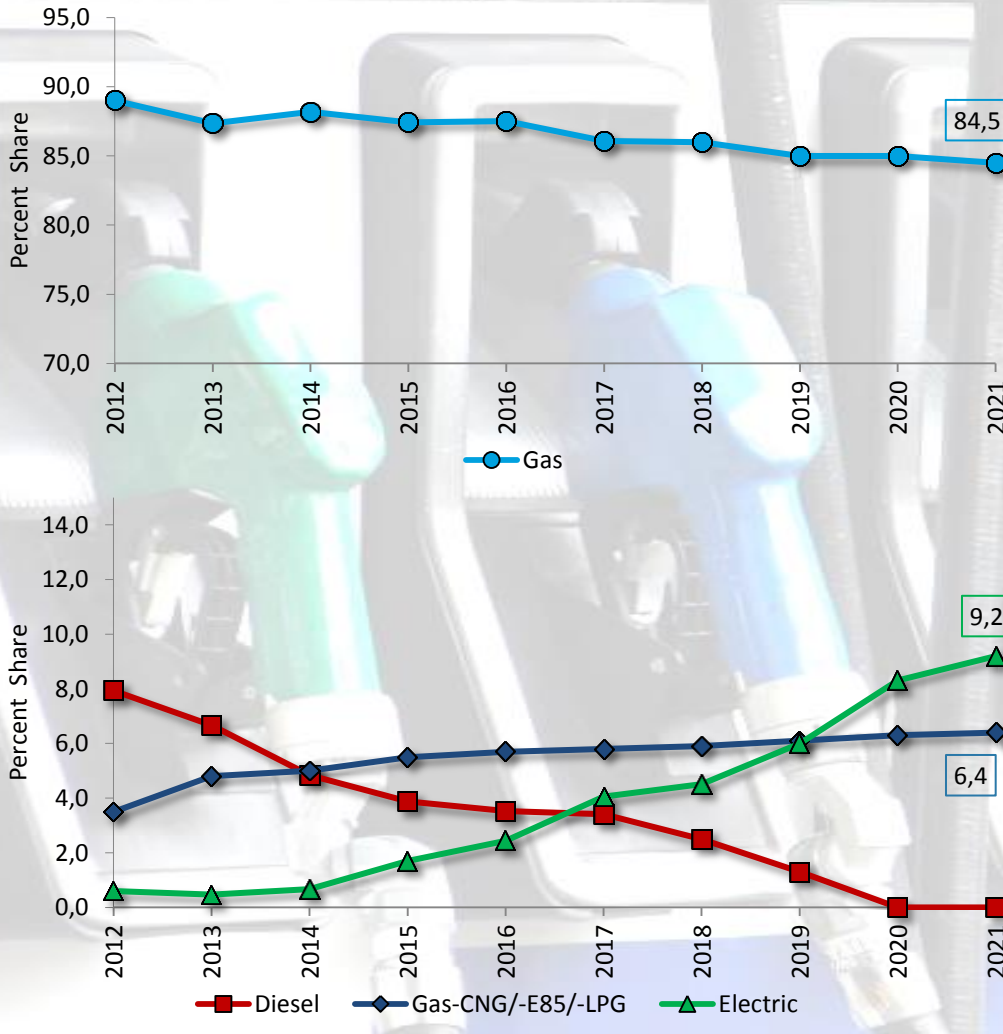
EU28 – Gasoline Market Share by Veh. Segment



Source: IHS

Gasoline Engine Outlook

EU28 Gasoline Extremes– A Segment

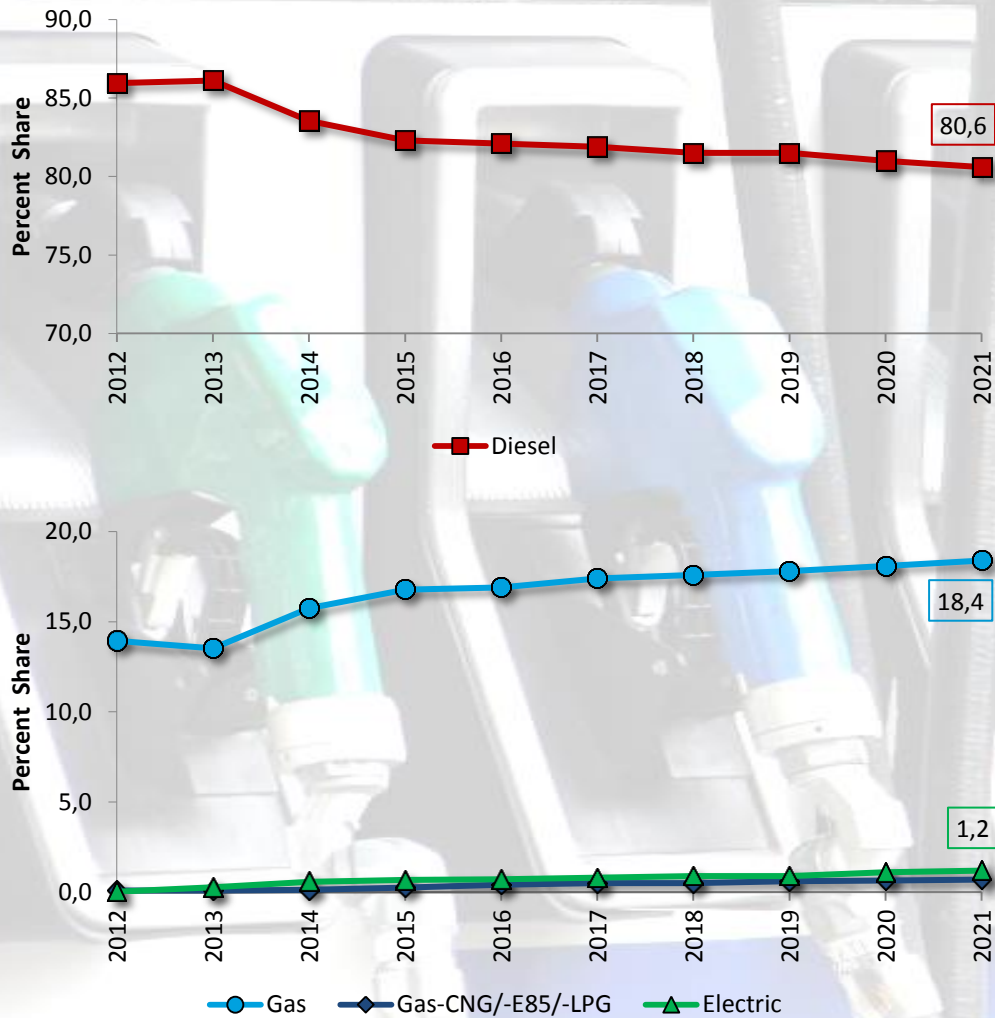


- Gasoline remains the dominant fuel in A-segment
- Diesel share drops to zero after 2019
- Electric Vehicles expected to gain a significant share going forwards
- Some growth in CNG/E85/LPG fuels

Source: IHS

Gasoline Engine Outlook

EU28 Gasoline Extremes– E Segment

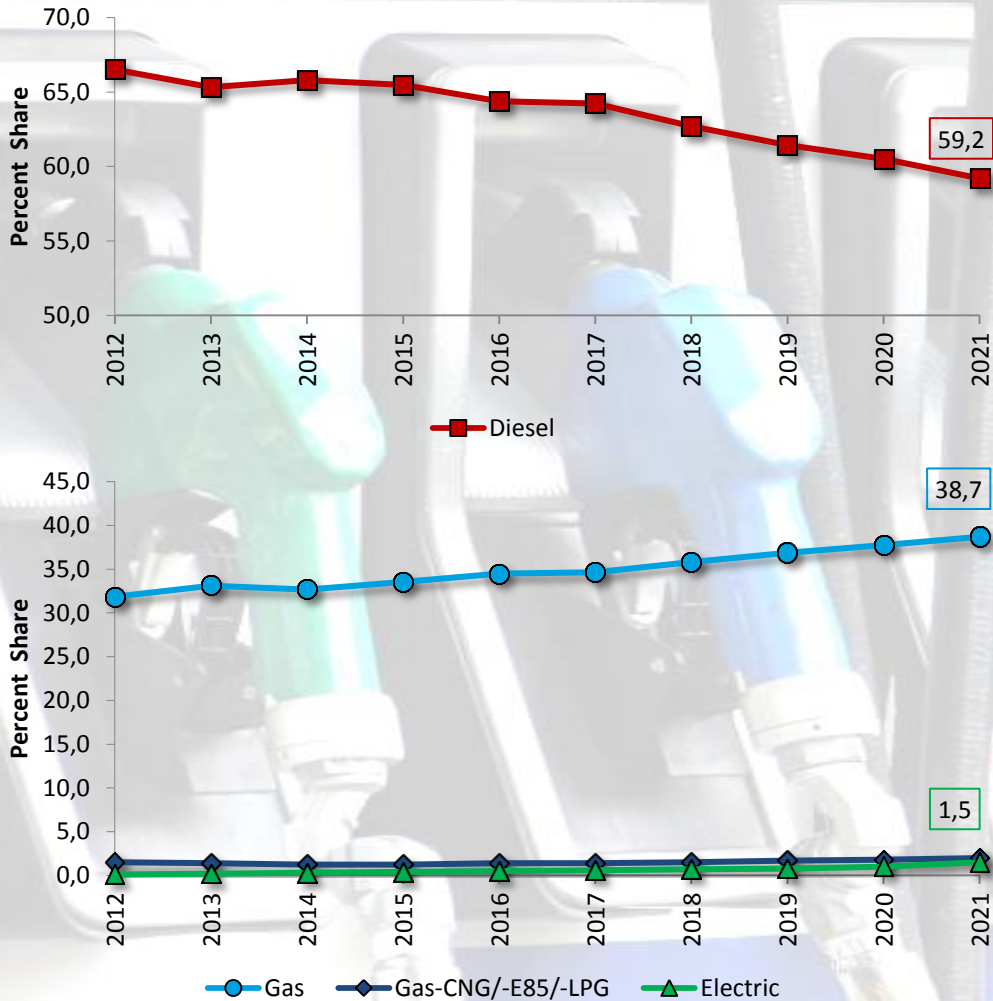


- Diesel is the dominant fuel in E-segment and will stay strong in the long term
- Gasoline increases driven by plug-in hybrid vehicles
- Very modest growth in EVs, mainly driven by Tesla
- CNG/E85/LPG fuels stay flat

Source: IHS

Gasoline Engine Outlook

EU28 Gasoline – High Volume C Segment



- Diesel market share expected to drop by ~ 7% by 2021
- Gasoline growth (~6.8%) driven by downsized GDI-T engines, 48V mild hybrids post 2019
- EV market expected to grow from 0.1% to 1.5% (15 times!)
- CNG/E85/LPG fuels stay relatively flat

Source: IHS

New Platforms Coming Online – Volvo Example



Source: Volvo

Will play a key role in Volvo's Drive-E efficiency strategy

- New VEP/GEP gasoline engines being developed as part of the modular VEA platform
- Will replace the current range of SI6, SIGMA and Volvo INLINE engines
- Avg. annual volumes ~200k

Volvo VEP/ GEP Engine Range (estimated)		
Fuel Type	Gasoline	
# of cylinders	3	4
Expected SOP	2018/19	2015
Displacement	1.5L	2.0L
Power Range [kW]	75 - 135	85 - 240
Torque Range [N.m]	140 - 260	240 - 420

Gasoline Engine Outlook

Volvo VEP Triple Boost Development



2.0L 4-Cylinder 335kW (168kW/L) , 500N.m
[Daimler M133 engine – 133kW/L]



Source: Volvo

New Platforms Coming Online – JLR Example



Source: JLR

- New AJ20-P engine range being developed as part of the modular AJ20 (*Ingenium*) platform
- Will be a range of 3, 4 and 6 cyl inline engines. A V8 engine is also likely at some point
- Avg. annual volumes ~180k

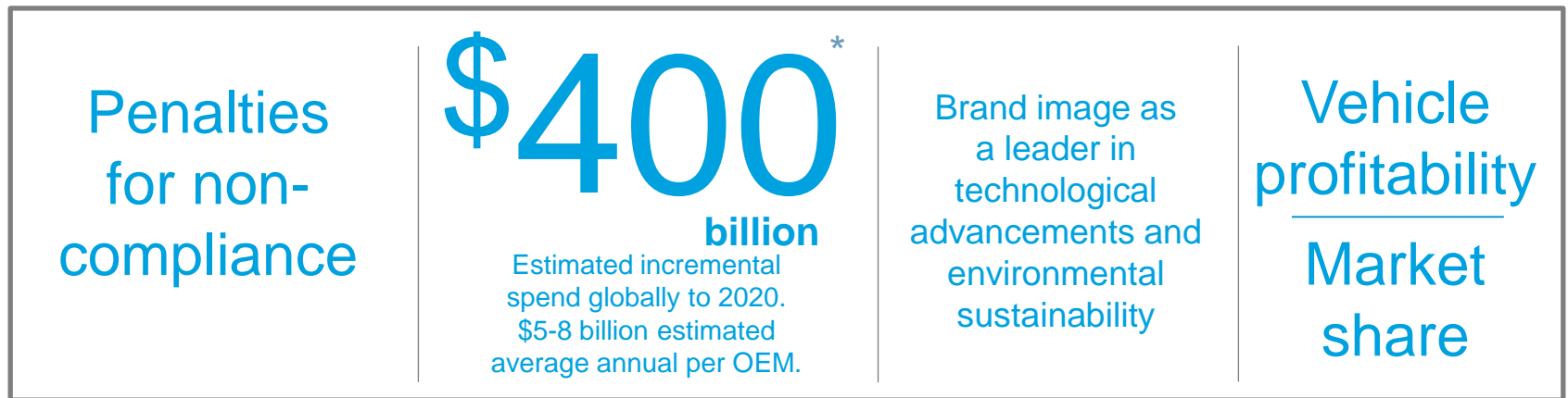
Will be the main engine platform for JLR

JLR AJ20-P Engine Range (estimated)				
Fuel Type	Gasoline			
# of cylinders	3	4	6	8
Expected SOP	2017/18	2015/16	2020/21	2022?
Displacement	1.5L	2.0L	3.0L	4.0L
Power Range [kW]	110 - 140	150 - 220	230 - 320	350 - 450
Torque Range [N.m]	140 - 260	300 - 380	400 - 500	550 - 700

THE CHANGING LANDSCAPE

Global vehicle CO₂ and fuel consumption regulations are continually tightening; resulting in significant increases in R&D spending and planning complexity.

What's at stake?



* IEA *World Energy Investment Outlook* (International Energy Agency, *World Energy Investment Outlook*, OECD/IEA, Paris).

What is IHS Doing to Help?

V-PaC

CO₂ & Fuel Efficiency Forecasts

3 years of history, 6 years of forecast by body type

Enables planning and provides insight into competitive powertrain efficiency expectations

Vehicle Performance Module (optional add-on)

The augmentation of theoretical performance forecast with trade-off metrics

Enables insight into competitive positioning on the important blend of performance and efficiency

Vehicle Compliance Module (optional add-on)

Displays distance to target

Enables an unbiased, physics based independent outlook on potential OEM compliance gaps

Introducing V-PaC, the IHS Automotive Vehicle Performance and Compliance Monitor

This One-of-a-kind solution helps automakers and suppliers adjust their strategies for the most critically regulated markets by providing 6 year forecasts for:

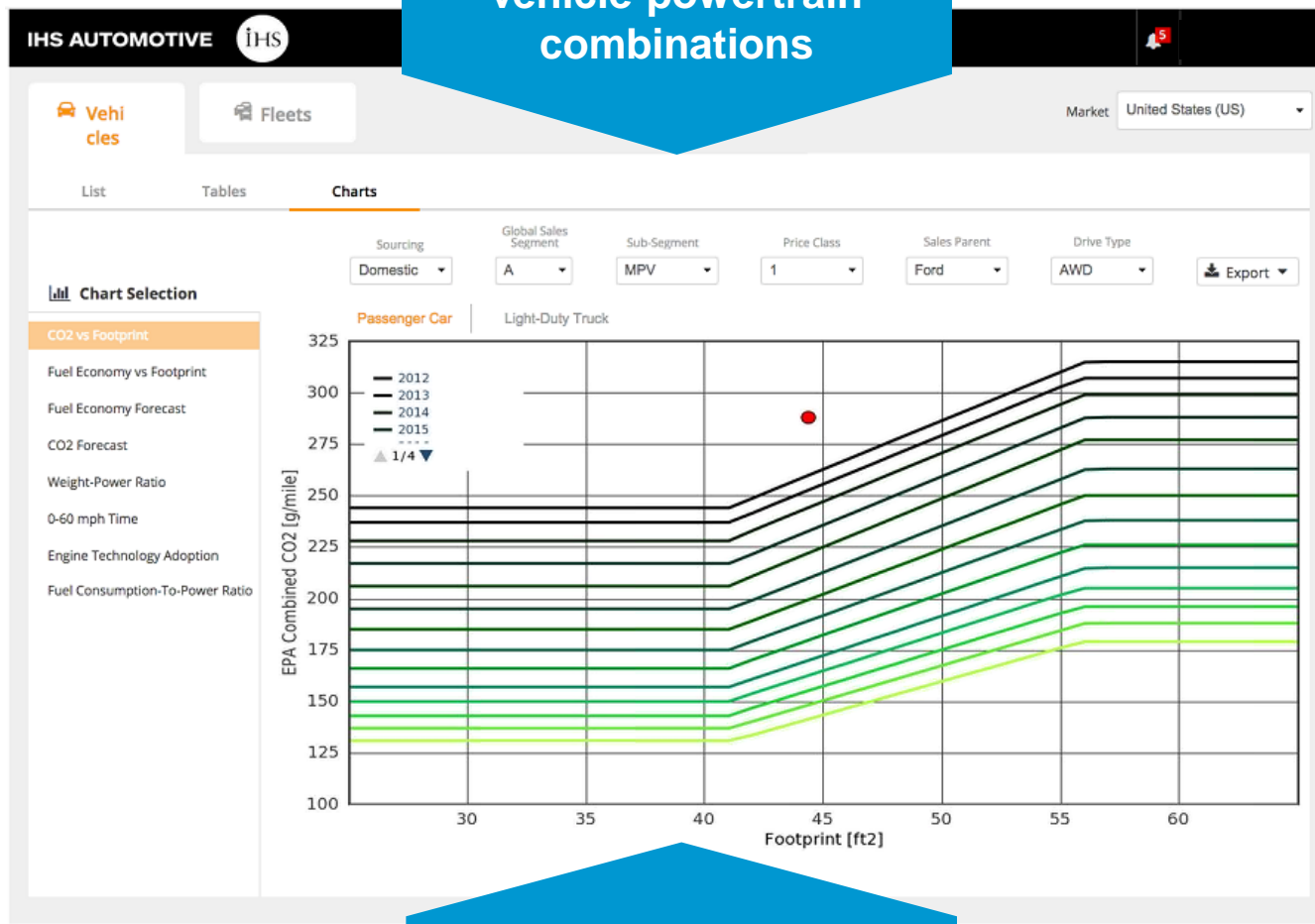
- Projected fuel consumption, tailpipe CO₂ emissions, and acceleration performance
- Over 36,000 vehicle-powertrain combinations
- Connected to over 160 attributes
- The United States, EU28, Brazil & China

What is this New Capability?

- Cloud based web-portal – easy access from anywhere
- Offers full vehicle performance and compliance analysis
- Designed for strategy planning and competitive vehicle analysis
- Integration of IHS' SBPT forecast and our partner's big data powertrain & engineering software prowess
- Leverages fuel consumption and CO₂ regulatory parameters to provide vehicle and fleet-level compliance
- Introduces performance and compliance data into the competitive context
- Expands the appeal beyond traditional engineering tools
- Depth of coverage includes U.S., EU28, Brazil & China

What is this New Capability?

Forecasts for 36,000
vehicle-powertrain
combinations



Over 160 technical
attributes
per vehicle

Contents

INTRODUCTION

DIESEL - THE RECENT DEBATE

GASOLINE ENGINE OUTLOOK

SUMMARY

Summary

- Gasoline set to overtake diesel and become the dominant fuel for passenger vehicles in the EU28 in coming years
- Market share of gasoline is segment dependent, with diesel remaining strong in the larger vehicle segments (C+)
- Growth of gasoline driven by increased installation of efficient downsized GDI-T engines and increasing powertrain electrification (48V, E-Superchargers, plug-in hybrids etc.)
- Diesel has been a fundamental contributor to the CO₂ performance in Europe, but is facing a number of challenges (cost, air quality issues, political pressure etc.) - the market share will undoubtedly soften, but this is not the end for diesel
- The upcoming WLTC, RDE drive cycle changes will minimize the discrepancy between homologation and real world emissions – both for diesel and gasoline
- Auto OEMs, supported by suppliers need to strike the perfect compromise of efficiency, performance, utility, compliance and **V-PaC** is now here to provide that critical insight