

Europe's LV Powertrain Sector

Evolution or Revolution?



Engine Expo 2010

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Stuttgart

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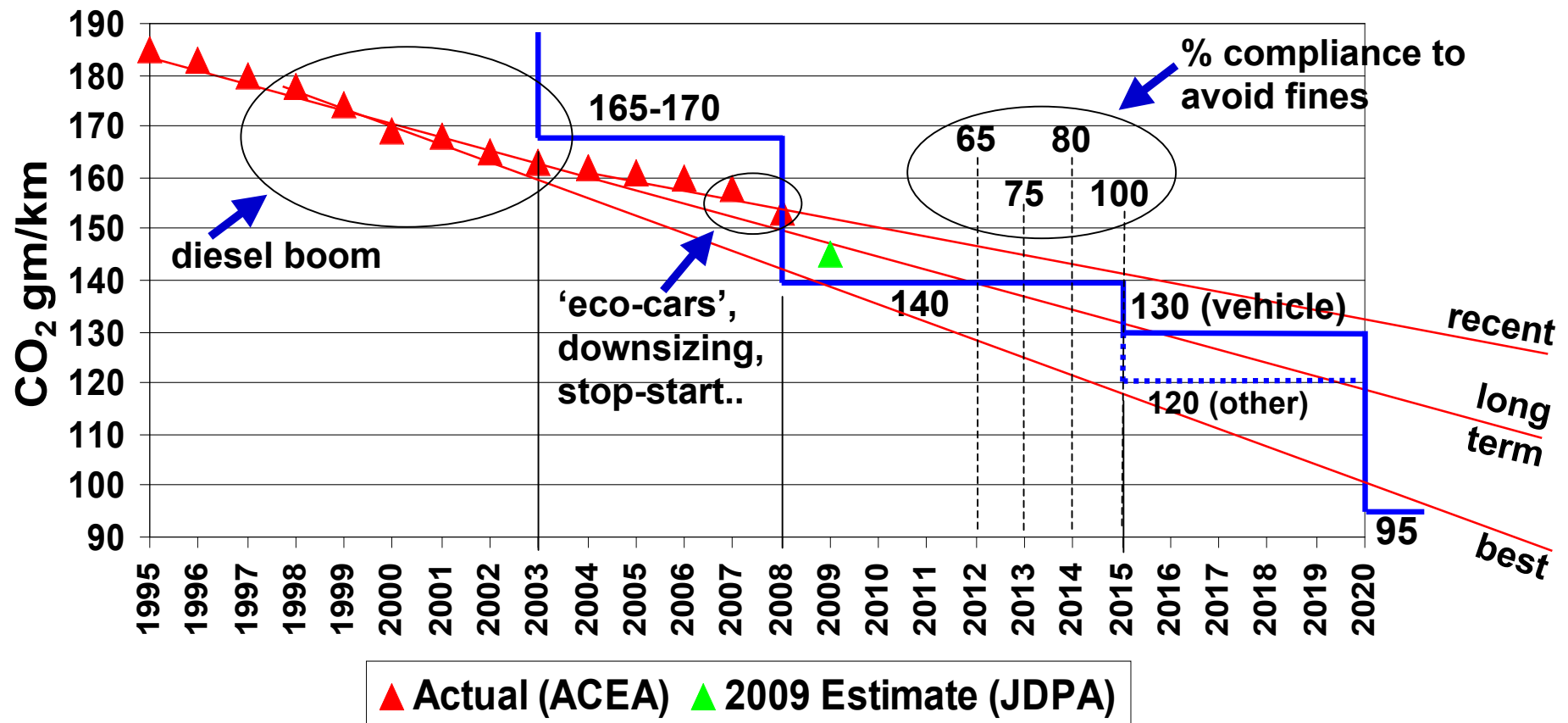
Outline

- Recap on CO₂ Targets
 - Recent progress
- Outlook for the diesel market
- Developments in the gasoline sector
 - Boosting, DI
 - Power & Torque
- Light vehicle transmissions
- Vehicle electrification
 - Hybrid
 - Battery electric vehicles
- Summary of roadmap to long-term CO₂ targets
- Conclusions

CO₂ Targets – A Long-Term Challenge

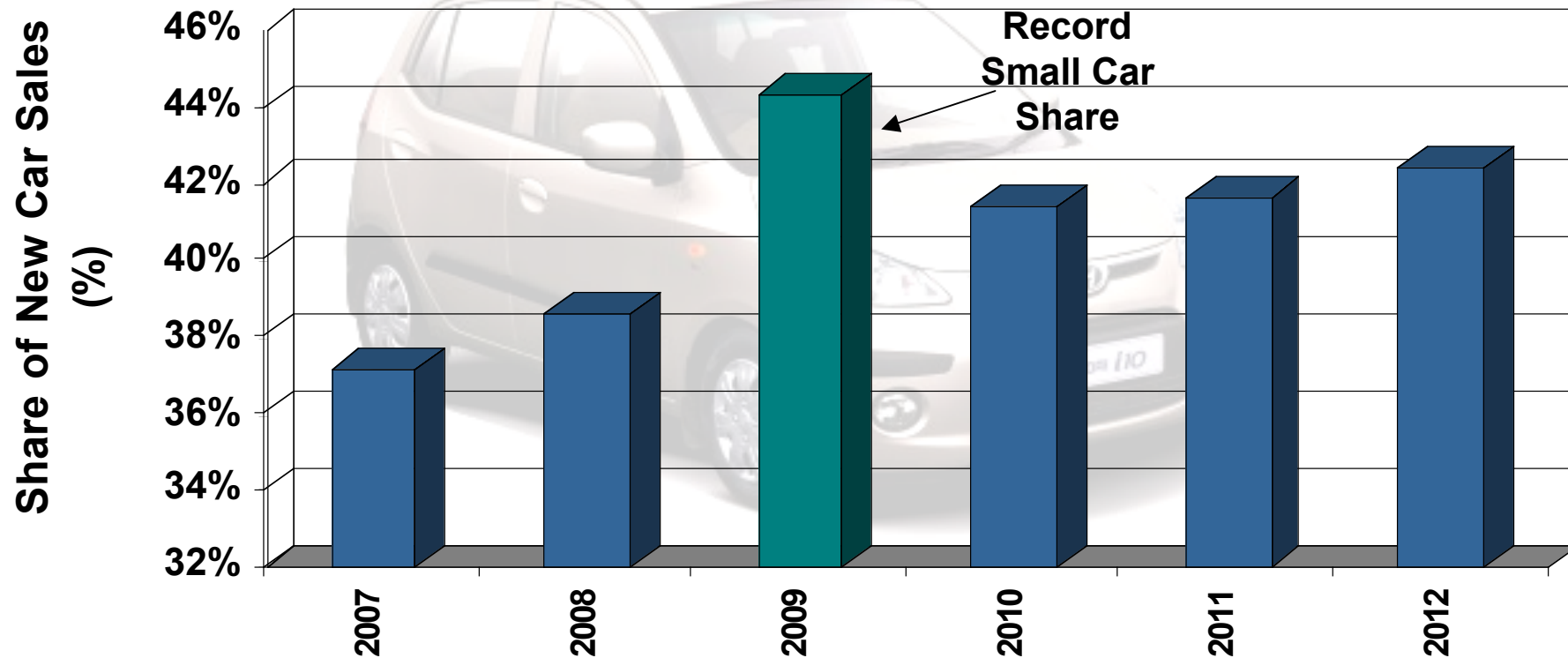
ACEA-EU25 CO₂ Passenger Car Targets

- 2008 voluntary target was missed by 13.5gm/km
- 130gm/km = 15.3% reduction on 2008, 95gm/km = 38.1% reduction

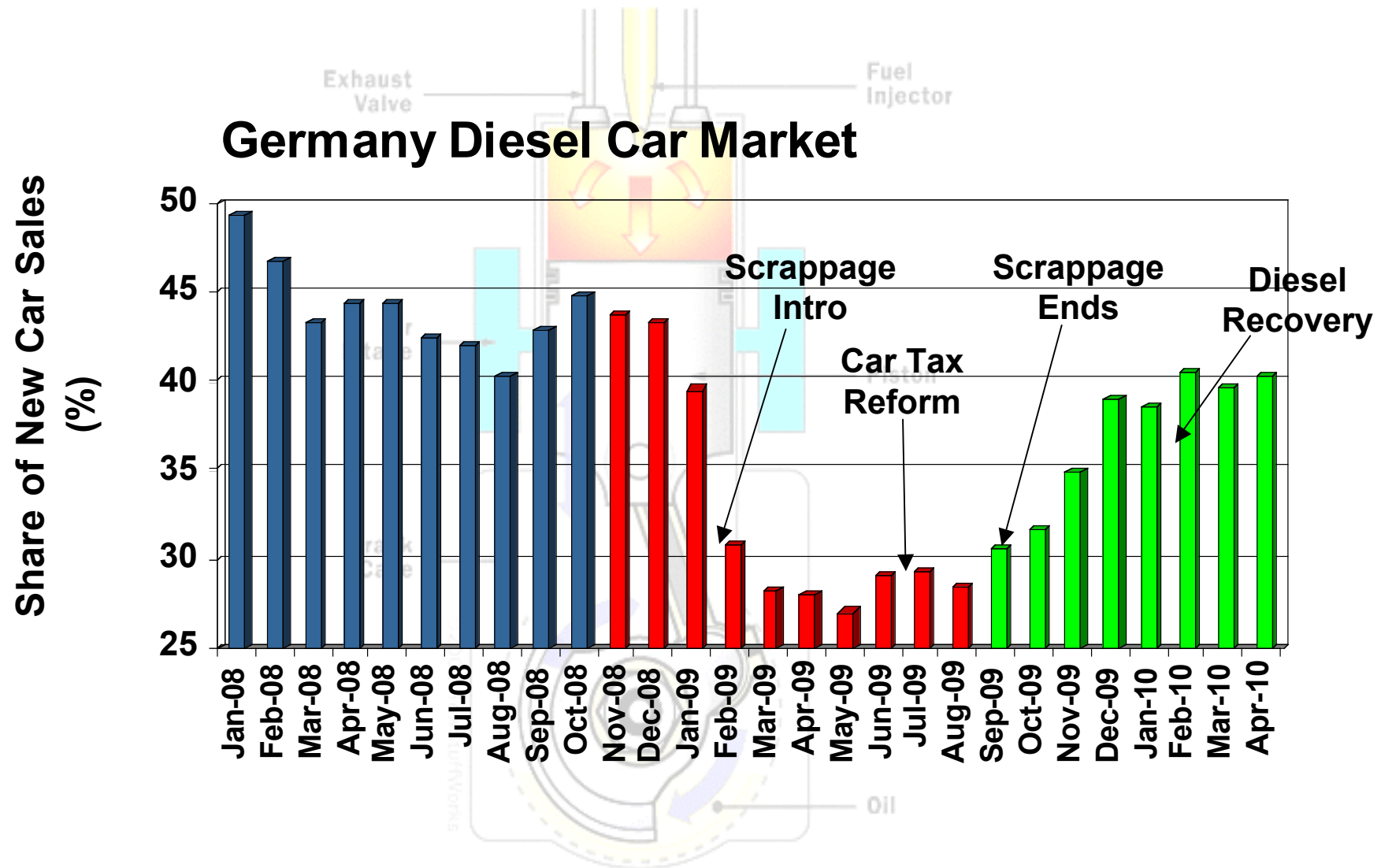


Influence of the Market on 2009 CO₂ Reduction

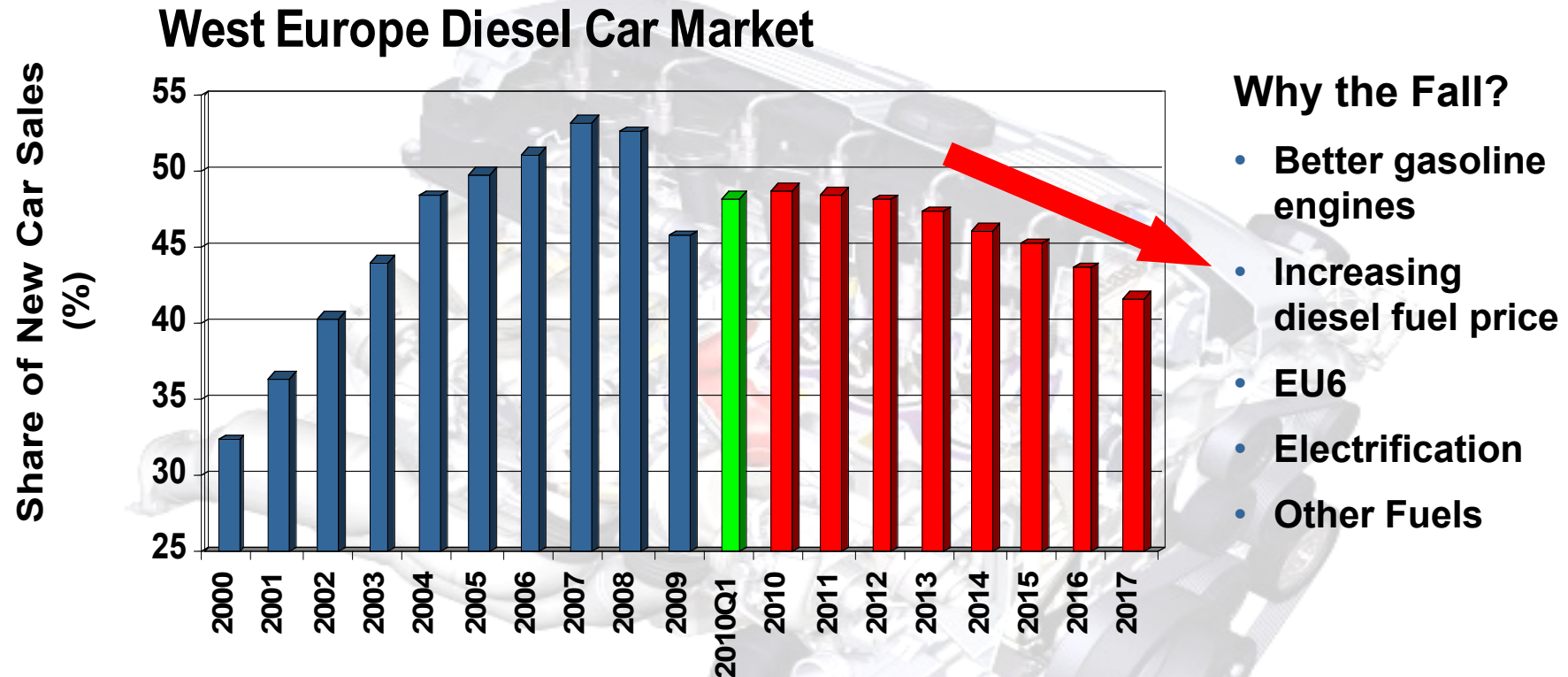
West Europe Small Car Mix



Diesel Market – Collapse in 2009, Recovery 2010?



Long Term Diesel Decline?



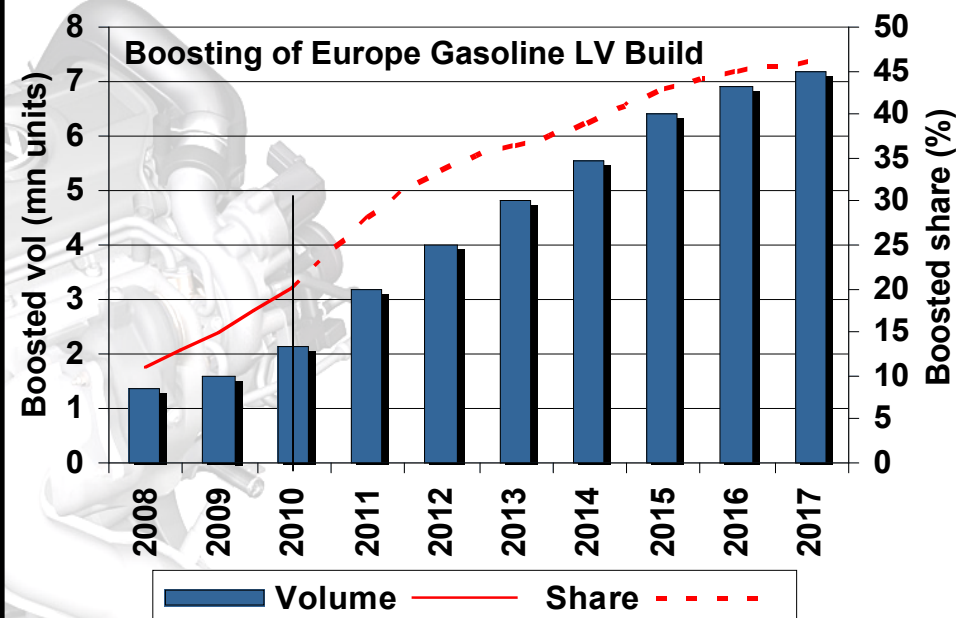
But Diesel Volumes will Recover and Remain Robust

Year	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Diesel Share (%)	53.4	52.7	45.8	48.9	48.6	48.2	47.4	46.3	45.3	43.7	41.8
Diesel Sales (mn units)	7.9	7.1	6.3	6.1	6.1	6.4	6.7	6.8	6.9	6.8	6.6

Update on the Gasoline Sector

Group	Engine Family	Detail
BMW	N38, N18	1.5T, 1.6T
	N2X	2.0T
	N54, N55	3.0T
Daimler	M270	1.6T
	M271 EVO	1.8T
	M276, M278	3.5, 4.7T
Fiat	SGE	0.9T
	FIRE	1.4T
	Family B	1.8T
Ford	Fox	1.0T
	EcoBoost	1.6T, 2.0T
Opel	Family Zero	1.0, 1.4T
	Family One	1.6T
PSA	EB0/EB2	1.0T, 1.2T
Ren-Niss	S Series	0.9T, 1.2T
	D Series	1.2T
	HR	1.4T, 1.6T
VW Group	EA111/211	1.0T, 1.2T 1.4TS, 1.6T?
	EA888	1.8T
	EA837	3.0S

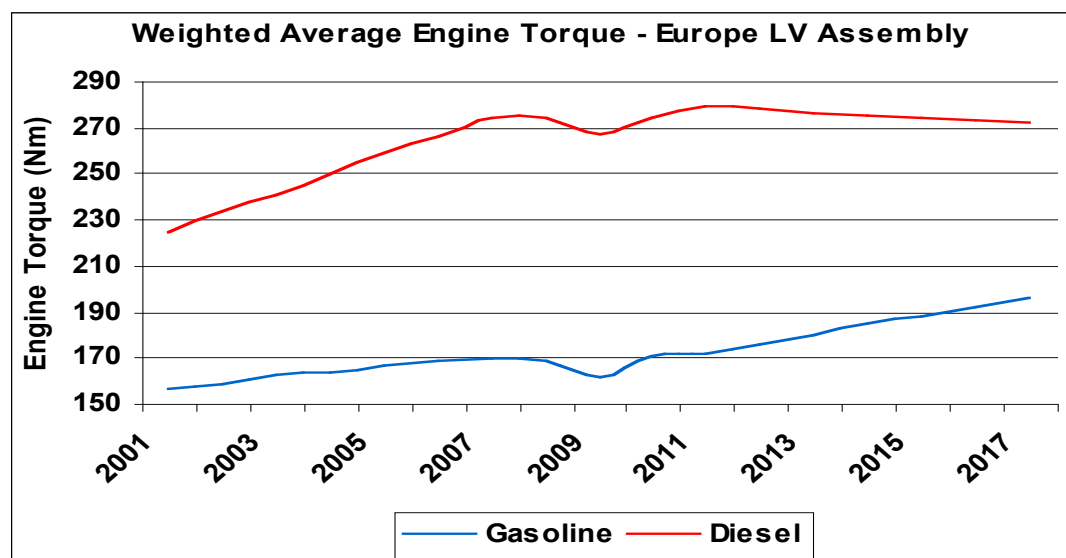
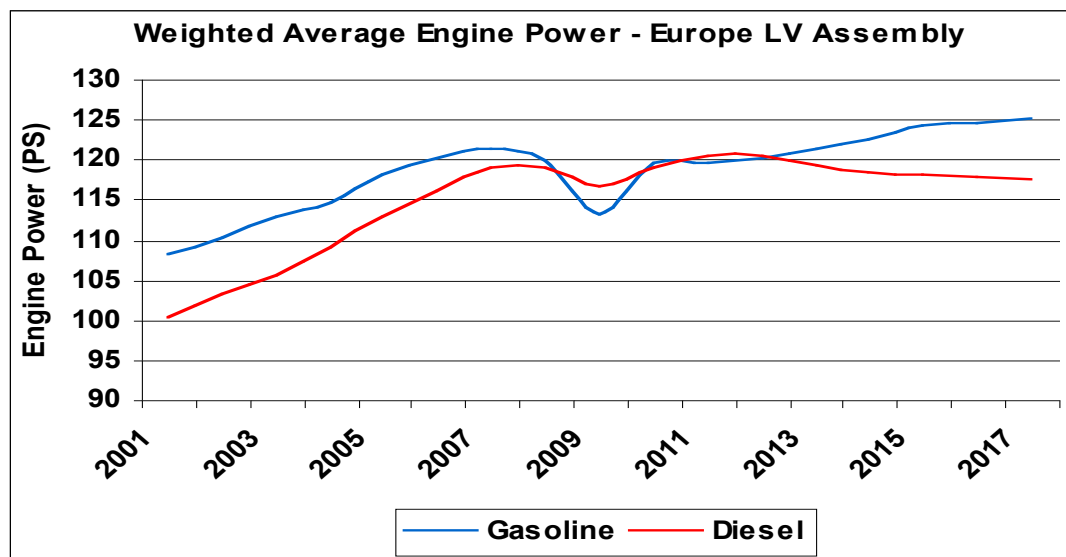
Key Gasoline Sector FE Technologies



Source: J.D.Power European Engine & Transmission Forecast

- Gasoline boosting: 20% now, 46% by 2017
 - Two thirds of all LV engines will be boosted
- Gasoline DI: 14% now, 50%+ by 2017
- Weighted average CC: 1.7L now, 1.5L 2017
- Weighted average cylinders: fewer than 4 by 2017

Gasoline Engine Performance

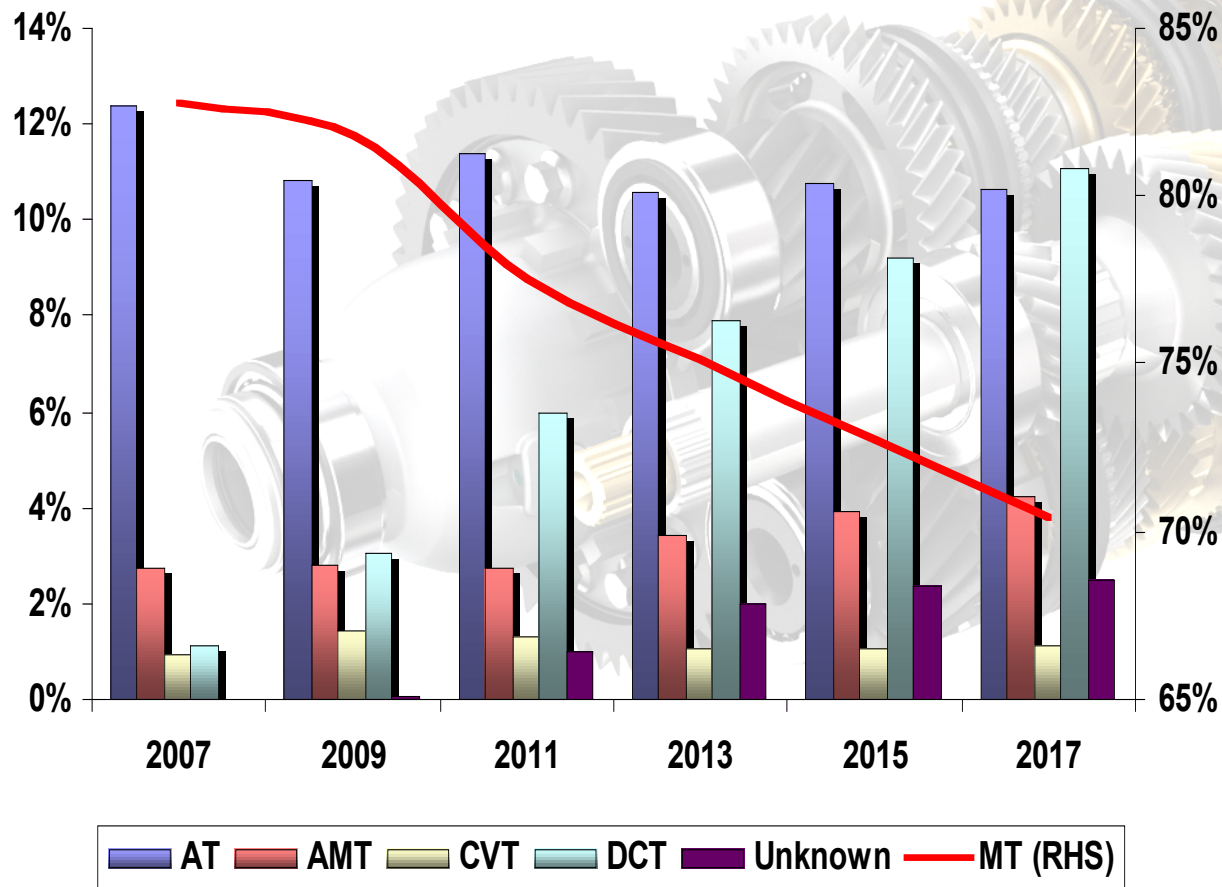


Positive Outlook for Gasoline:

- Gasoline will re-assert power advantage over diesel as boosting improves specific outputs
- Diesel sector output will be constrained by emissions requirements and cost of further development
- 2001-2017 growth in power:
 - Gasoline 21%
 - Diesel 24%
- 'Driveability' of gasoline sector will improve substantially this decade
- Diesel retains significant torque advantage, but average values will not increase much more
- Gasoline will narrow the FE gap, but diesel maintains an advantage of circa 20% in like-for-like performance

Trends in Transmission Type

Transmission Fitment to European LV Assembly



- Major change is the increase in demand for DCTs
- Near-manual efficiency but lower cost than planetary auto
- Will impact most on the MT sector
- Premium sector will stick with AT for ultimate comfort
- AMT will be used for gasoline medium and small cars
- CVT restricted to Japanese brands
- Number of speeds will grow in AT sector – up to 9 speeds by 2020
- MT sector to be dominated by 6-speed
- Auto (all types) 18% in 2009, 27% in 2017

Source: J.D.Power European Engine & Transmission Forecast

Vehicle Electrification

Now

- 1mn global hybrid vehicle sales in 2010 (100k in Europe)
- Equivalent to 2.0% of global car sales
- 10.5% share in Japan, 2.8% in US, 0.7% in Europe
- Toyota Prius became best selling car in Japan in 2009
- 40% increase in global hybrid demand in 2009, 25% expected 2010

Looking ahead...

- Regulators pushing hard for low carbon solutions
- Europe EV build – circa 150k by 2015 (OEMs say more)
- EV incentives, subsidies, bonuses: €15bn globally over 5 years
- Over 130 hybrid / EV models identified for Europe by 2020
- Oil price is trending up again

EVs

- Big subsidies & cheap fuel = ownership cost similar to alternatives?
- Fuel costs are less than 20% of gasoline equivalent
- Zero powertrain maintenance
- High residual values anticipated – better leasing costs
- Good launch performance
- Range - less of a problem than thought?
- Growth dictated by charging point availability
- Lack of common charging standards a barrier at present
- In some markets, electricity generation may come under strain
- EVs only make sense if using 'clean' fuel
- Track record of EV projects is not good
- Will it be 'different this time'?

EV Incentives – Europe Big 5

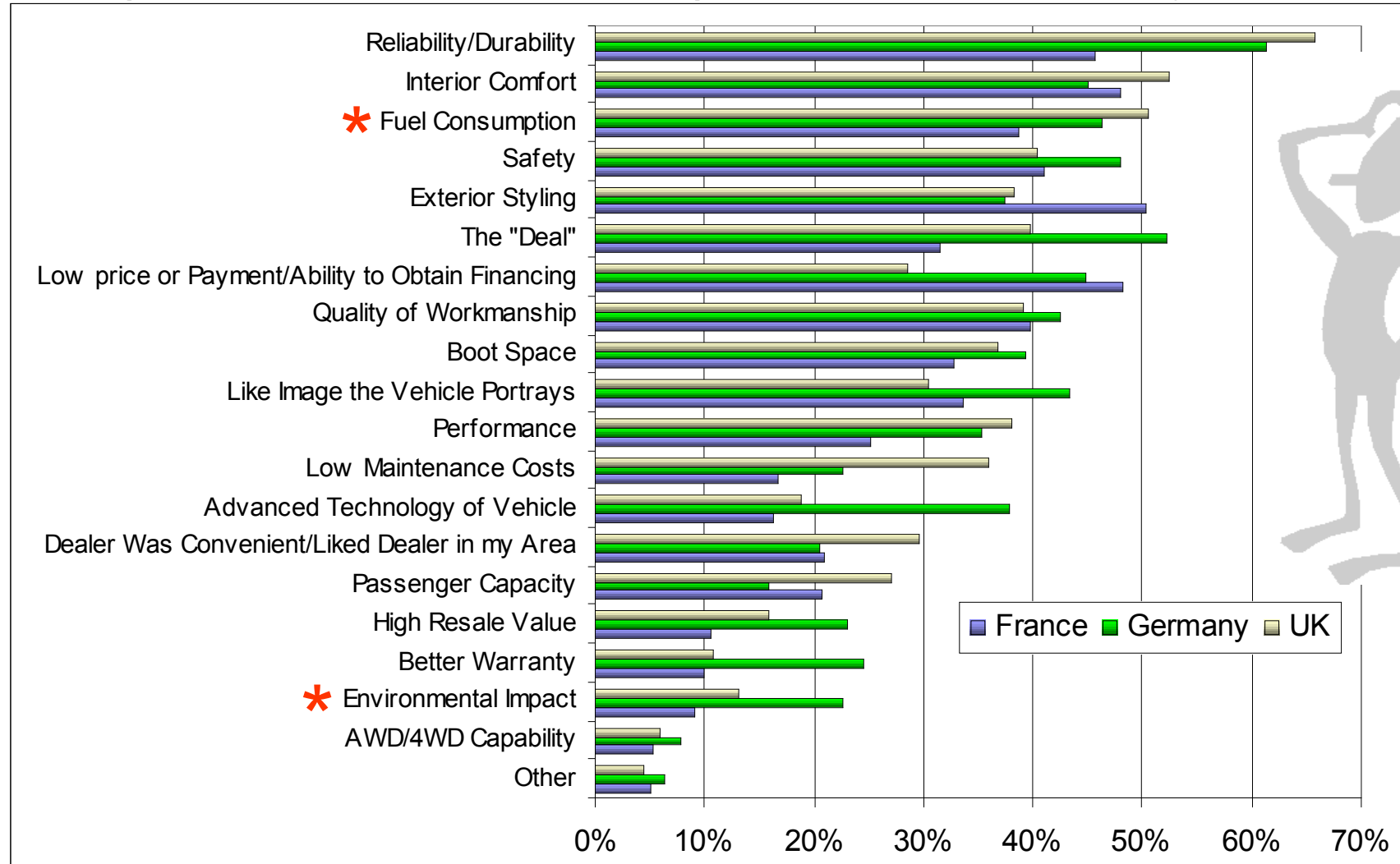
Stimulus / Target	Country	Action
EV Target	France Germany Italy Spain UK	100k 2011/2012 1mn by 2020 No targets announced 1mn hybrid / EV (of which 250k plug-in) by 2014 London: 100k 'soon'
Sales Incentive	France Germany Italy Spain UK	Up to €5k Exempt from road tax for 5 years €3.5K Up to €6k Up to €5k
Support Package	France Germany Italy Spain UK	€1.5bn €500mn No specific package announced €590mn to 2012 €290mn (from 2011)
Help for OEMs	France Germany Italy Spain UK	Government to buy 50k EVs, mostly Renault and PSA Research incentives Has 'Plans to support' No specific package announced €810mn loan to UK OEMs
Infrastructure Target	France Germany Italy Spain UK	500k in 3 years Local projects only Local schemes No target; Part of €590mn fund used €23mn for 4 regional pilots; London: target 25k by 2015

Hybrids

- 75k sales in Europe in 2009, circa 100k expected 2010
- 70% full hybrid, 30% mild hybrid
- Incentives are there, but lower than for EVs
- Choice of 7 mainstream models in 2009, up to 75 by 2015
- Full hybrids likely to dominate due to greater FE
- Reasons for purchase differ according to segment:
 - FE for non-premium midsize cars
 - Performance for premium and SUV segment
- 2011 will bring the diesel hybrid
- Plug-in versions to follow when hybrids are established
- But let's not forget the conventional diesel sector

Reasons for Vehicle Purchase

Most Important Factors in Owners' Choice of Specific Make/Model – 2009 Survey

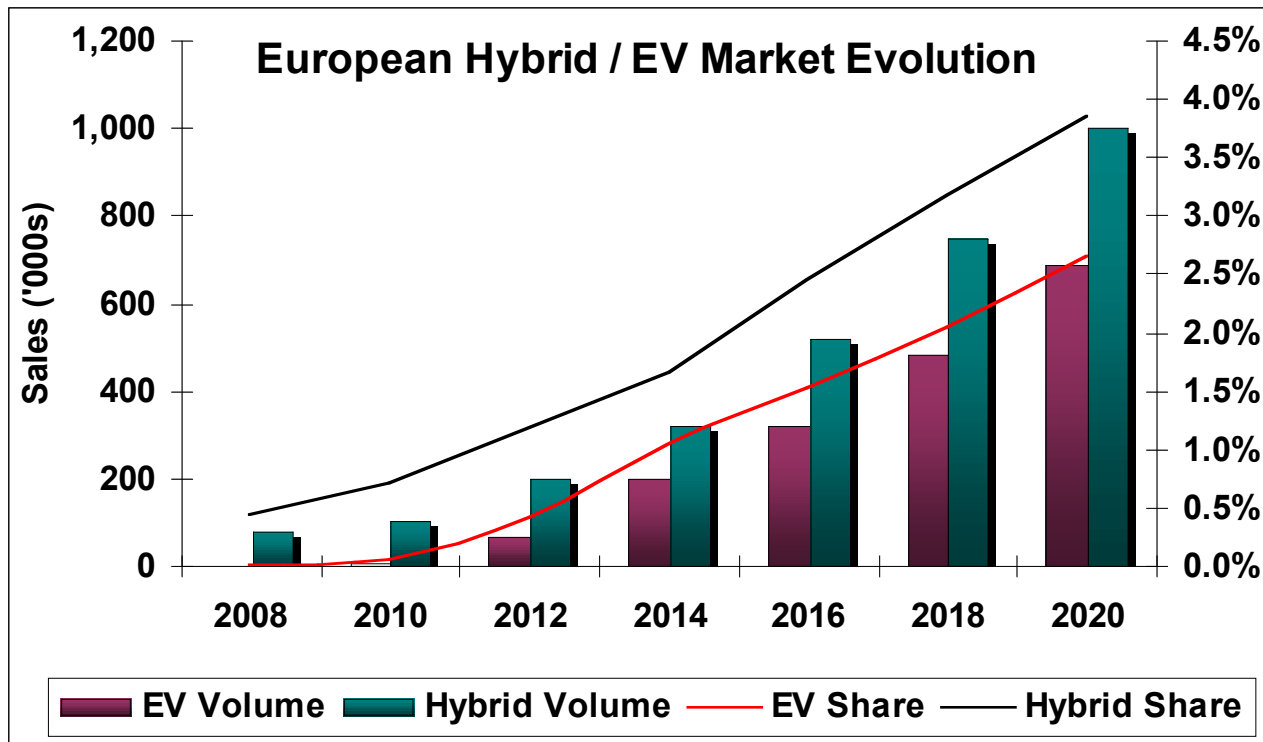
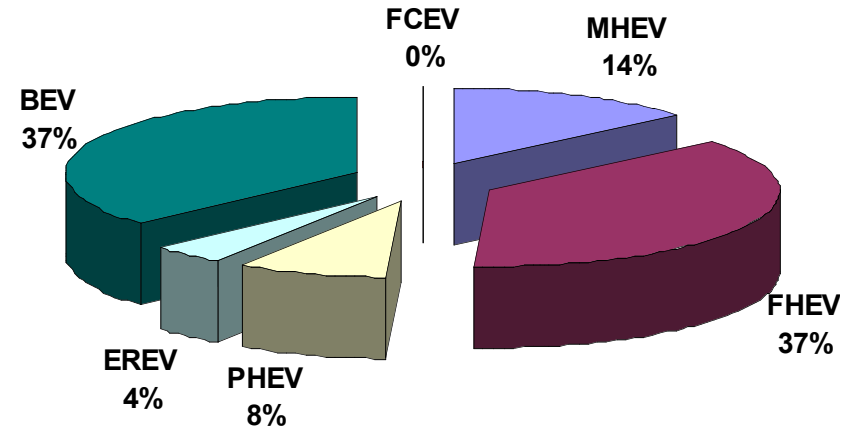


Source: J.D.Power 2009 European Vehicle Ownership Satisfaction Studies (VOSS). Annual survey of owners of vehicles after an average of two years of ownership.

Hybrid / EV Outlook

- 1.7mn sales by 2020
- 8.5mn hybrid / EV on the road
- Hybrids will dominate for many years
- EV growth likely to accelerate post-2020

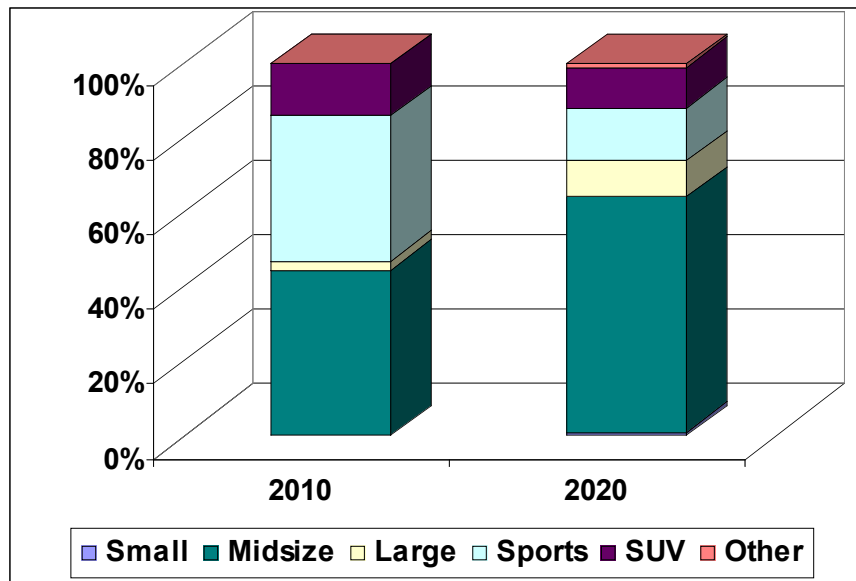
Hybrid / EV Market by Type 2020



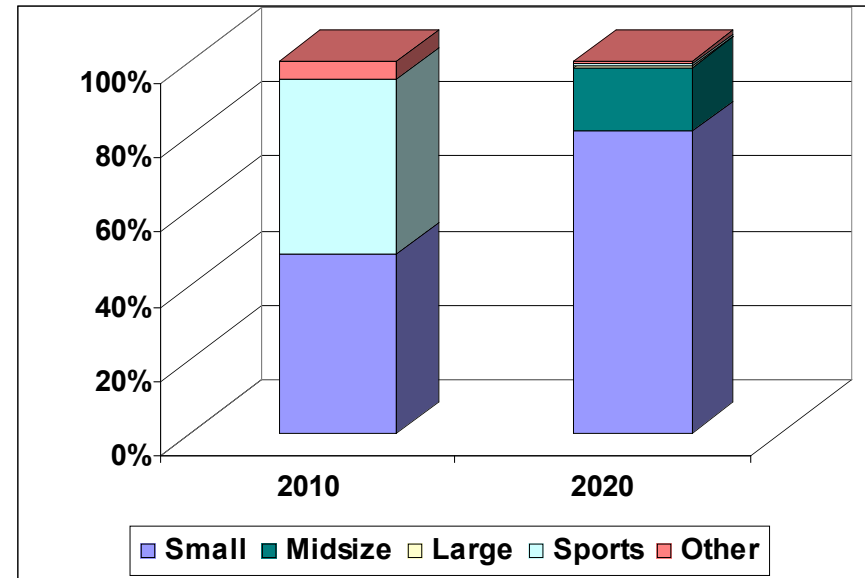
- Plug-in will lag conventional hybrid
- Range extenders good idea, but limited investment so far
- Gasoline hybrid may not give sufficient FE gain to compete with diesel
- Fuel cell as range extender may emerge circa 2017

Segment Distribution

Hybrid



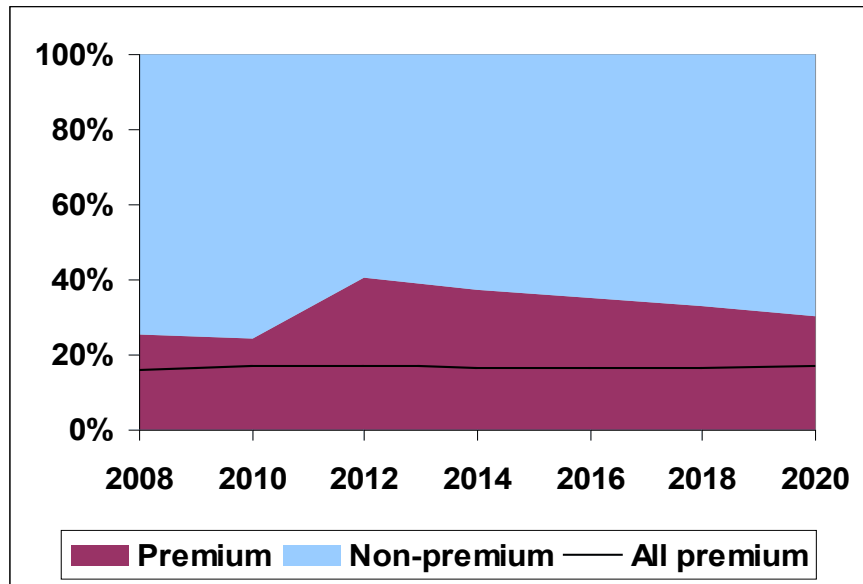
EV



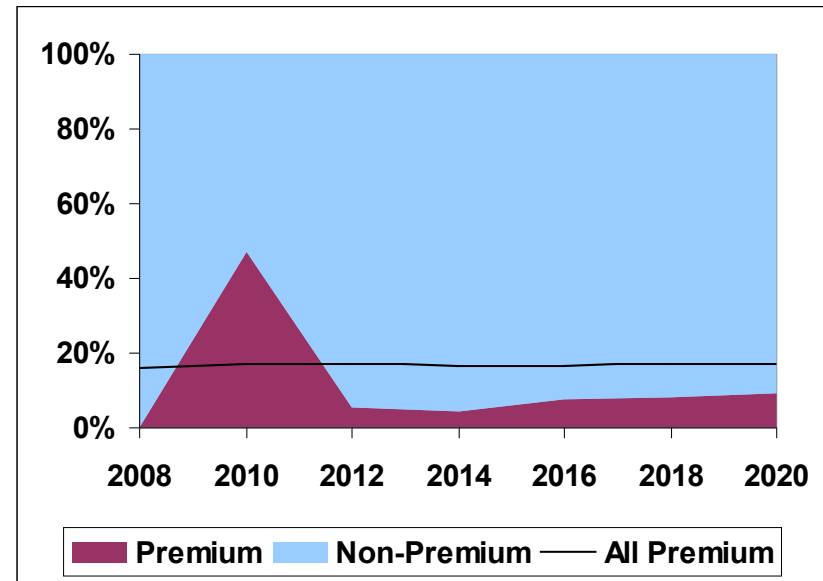
- By 2020 midsize hybrids will dominate as the technology spreads into mainstream cars
- SUVs are strong candidates for hybridisation and volumes will grow
- EV numbers are low at present, market is dominated by a few city cars and Sports cars
- Moving forward, small cars will come to dominate the sector over this period

Premium, non-Premium Mix

Hybrid

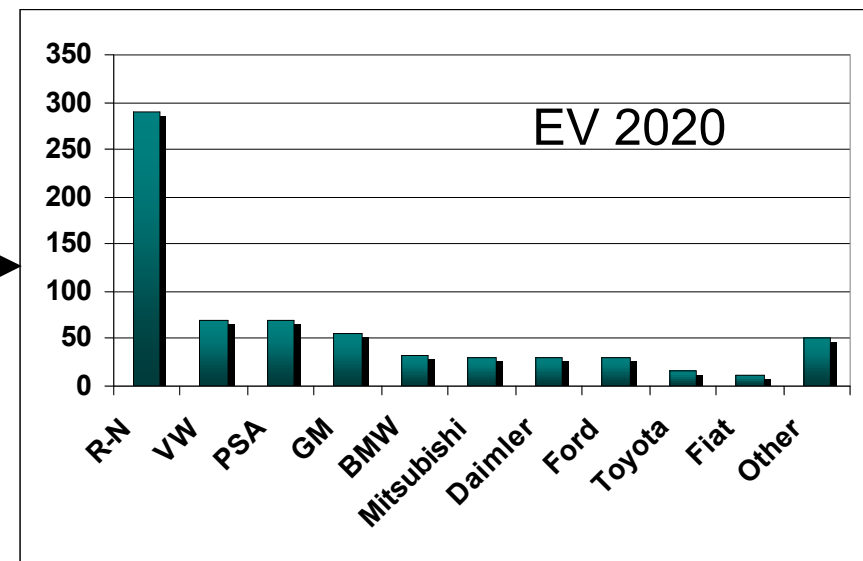
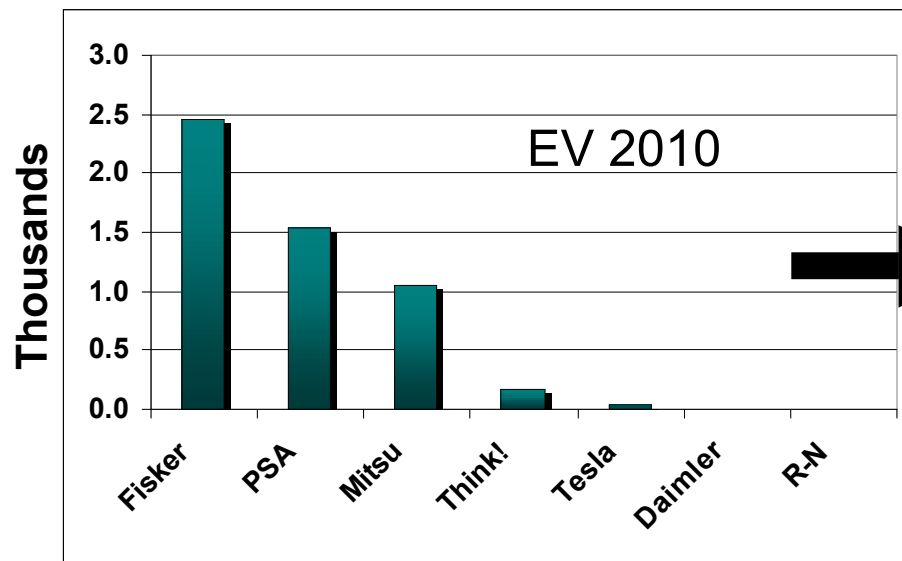
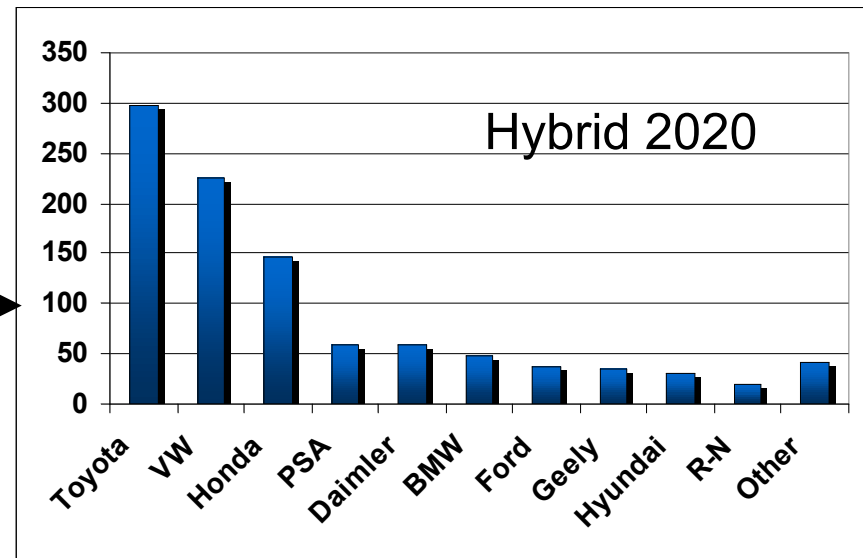
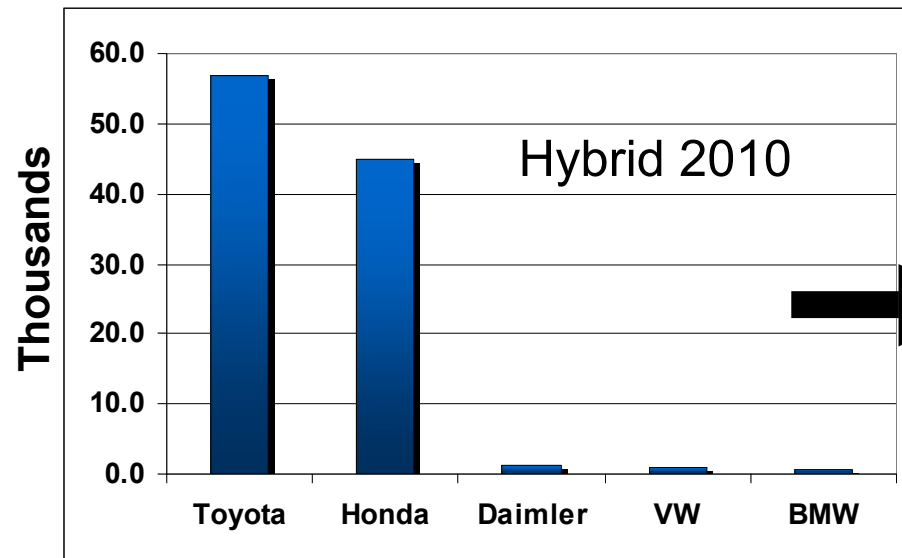


EV

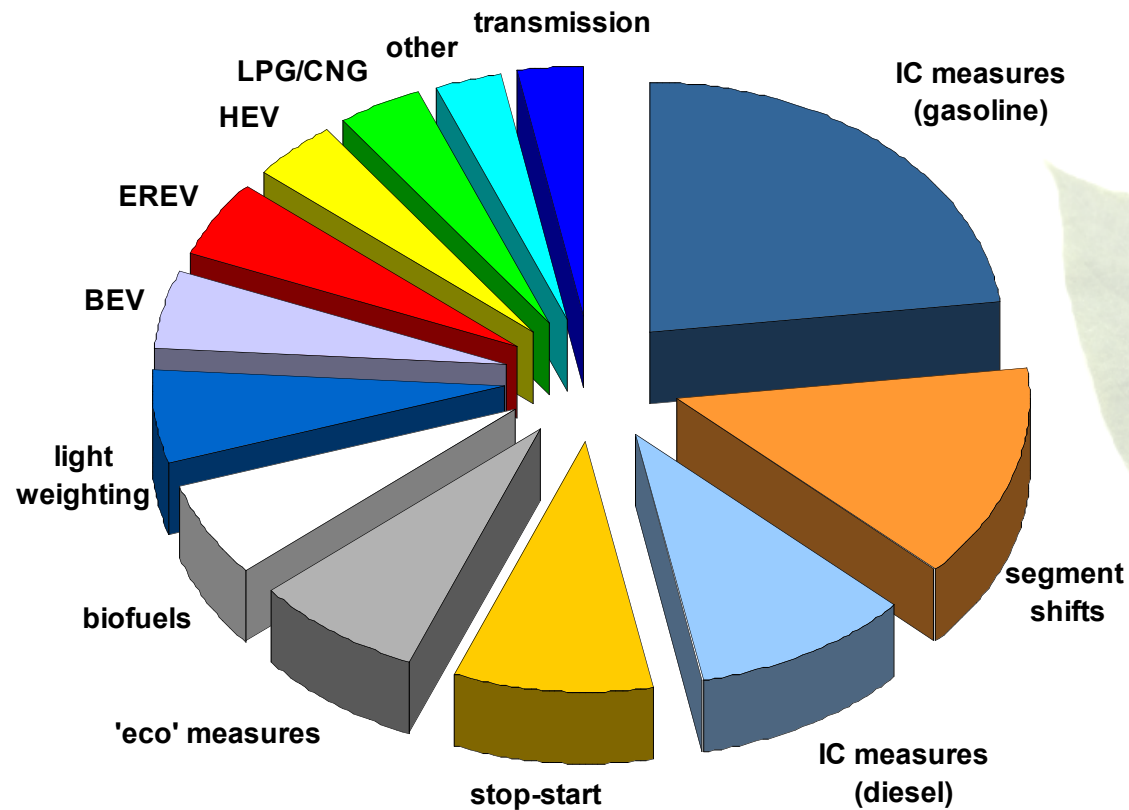


- Early hybrid growth will be in the large car and SUV segments, mostly premium
- As hybrids become more mainstream, non-premium will grow faster
- Many current EVs are premium sports cars
- Market will quickly move to small, mostly non-premium conventional cars

OEM Distribution



Inputs to CO₂ Reduction 2008 to 2020



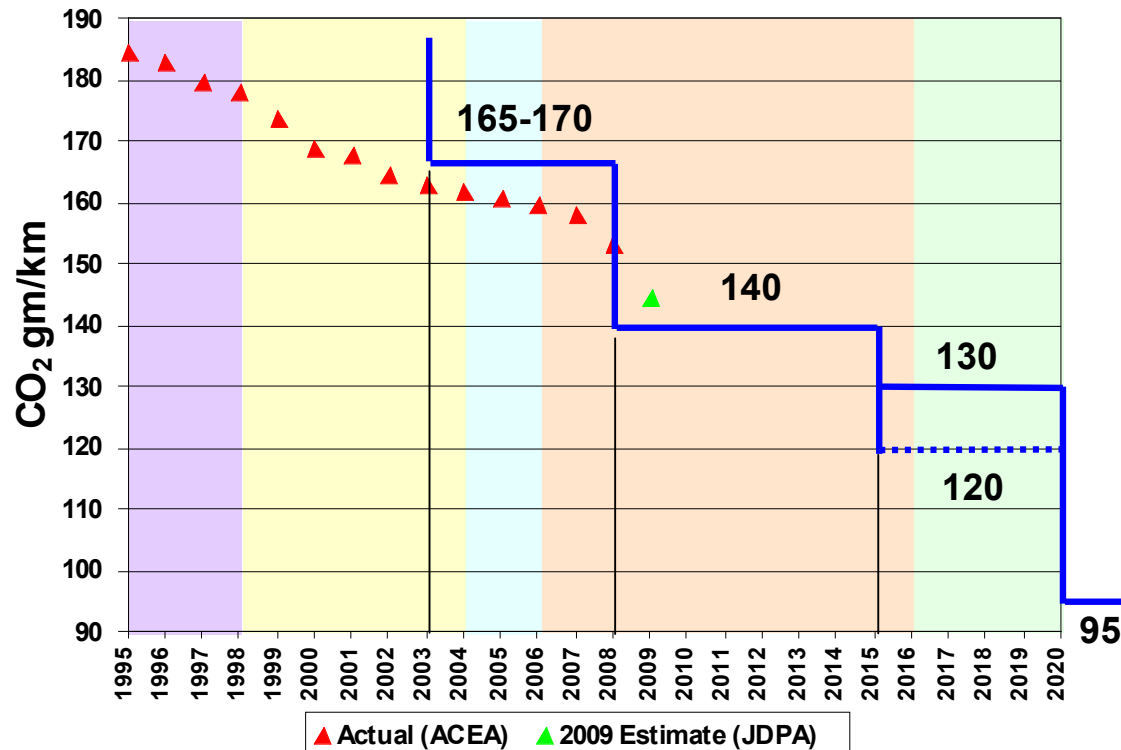
Contribution by Category:

- IC optimisation 33%
- Vehicle 26%
- Electrification 14%
- Market 14%
- Fuels 10%
- Other 3%

CO₂ reduction from 153.5gm/km (2008) to 95gm/km (expected 2020 target)

CO₂ Phase-Down - Key Powertrain Steps

ACEA-EU CO₂ Targets



CO₂ Reduction

- Pre-1998, gasoline sector was key
- Diesel boom 1998 – 2004
- Focus has now shifted from diesel
- Little progress 2004-2006
- Current focus is on PT optimisation, esp. gasoline
- And vehicle measures
- PT electrification will play a bigger part post-2017
- EREV & BEV likely long-term winners (post 2020)

Sequential
MPFI

Diesel

Cheap Oil, Political
Deadlock

IC / Vehicle
Optimisation

PT
Electrification

Conclusions

- 2009's big drop in fleet CO₂ will be hard to repeat in 2010
- Diesel has peaked but remains vital for CO₂ conformity
- DI & turbocharging are moving from diesel to gasoline (fast)
- Despite exciting changes, IC architecture evolves slowly
- Transmissions: Auto will gain the upper hand by 2025
- Europe's electrified powertrain market: 1.7mn cars by 2020
 - Hybrids will dominate until at least 2020
 - Plug-ins (mostly BEV) will grow fastest after 2020
- **It's evolution not revolution, but the pace is hotting up!**



Automotive Forecasting

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