The future market for ultra-low carbon vehicles in the UK

Presentation to VW

13th October 2011

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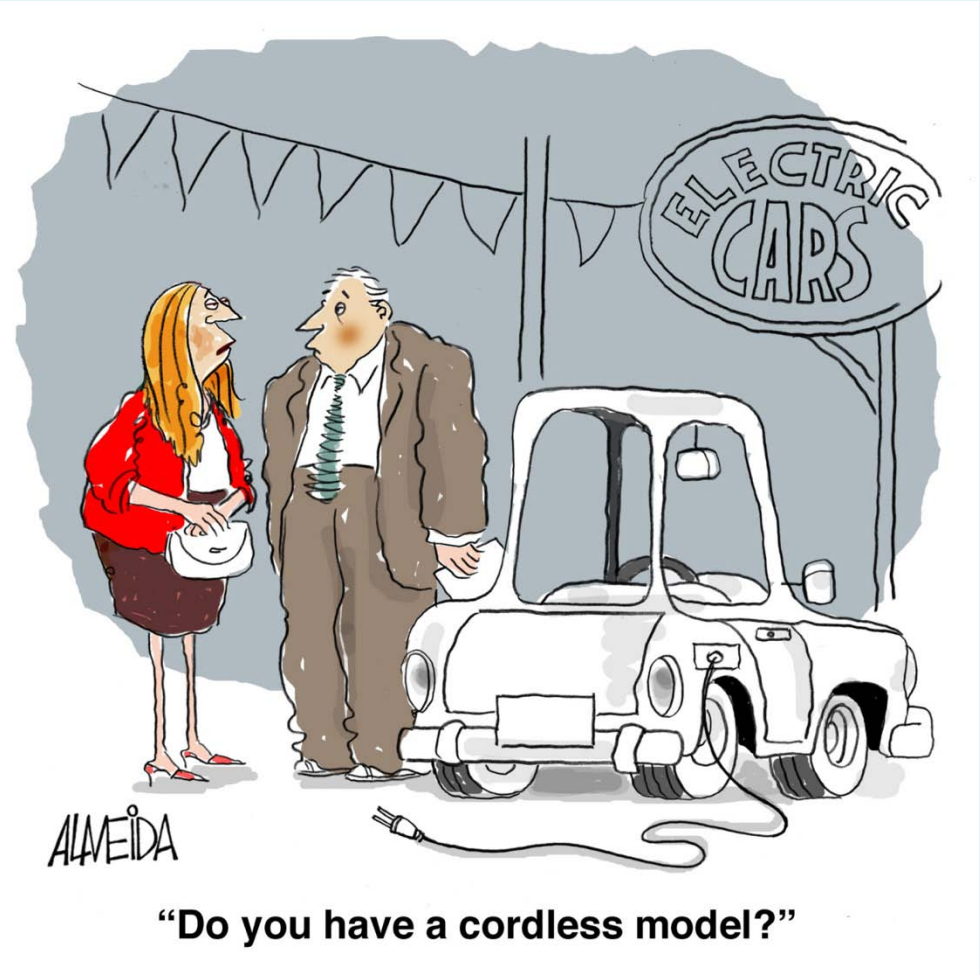
Outline



- LowCVP
- The global shift to electrification of cars
- UK Government and business support for EVs
- Private and fleet buyer attitudes
- Total costs of ownership of electric vehicles
- Greenhouse gas benefits of electric vehicles
- Perspectives on the UK position and business opportunities

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Accelerating a sustainable shift to low carbon vehicles and fuels; stimulate opportunities for UK businesses

- Working with Government (and other policy makers) to enable the development and deployment of more effective market transformation policies and programmes
- Engaging industry, stimulating and leading voluntary industry-wide initiatives
- Ensures consumers are informed about the opportunities and benefits of lower carbon options promoting their uptake
- Helping UK business, especially SMEs, to benefit from the new market opportunities
- Encouraging action and building a consensus for sustainable change through enhancing stakeholder knowledge and understanding.

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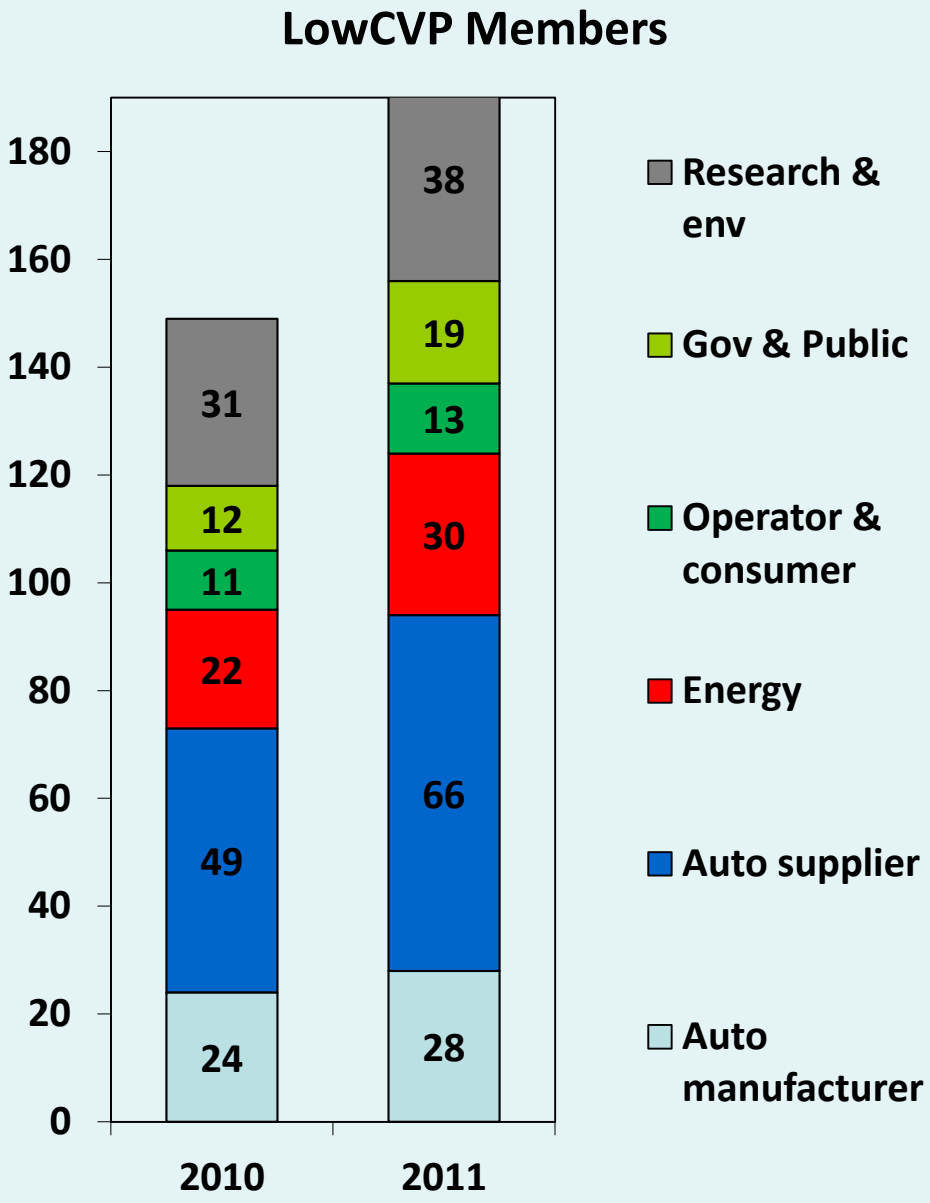
Low Carbon Transport Innovation Strategy

ACT ON CO2

LowCVP has strong and diverse membership working on 6 themes:

- ❑ Incentivising and informing lower carbon choices for cars
- ❑ Building the market for lower carbon commercial and public service vehicles
- ❑ Tackling market barriers to use of lower carbon fuels
- ❑ Facilitating the creation of a successful UK supply chain
- ❑ Monitoring progress and tracking pathways to lower carbon transport
- ❑ Enhancing stakeholder knowledge and understanding



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There is global momentum towards electrification of transport

- EVs address key geopolitical concerns:
  - Climate
  - Energy security
  - Peak oil
- Early consumer interest as sustainable, cool, high technology products
- Substantial public funding of research, development and demonstration and purchase support
- Investment & commitment from global OEMs

But ...early niche vehicles do not create a mass market

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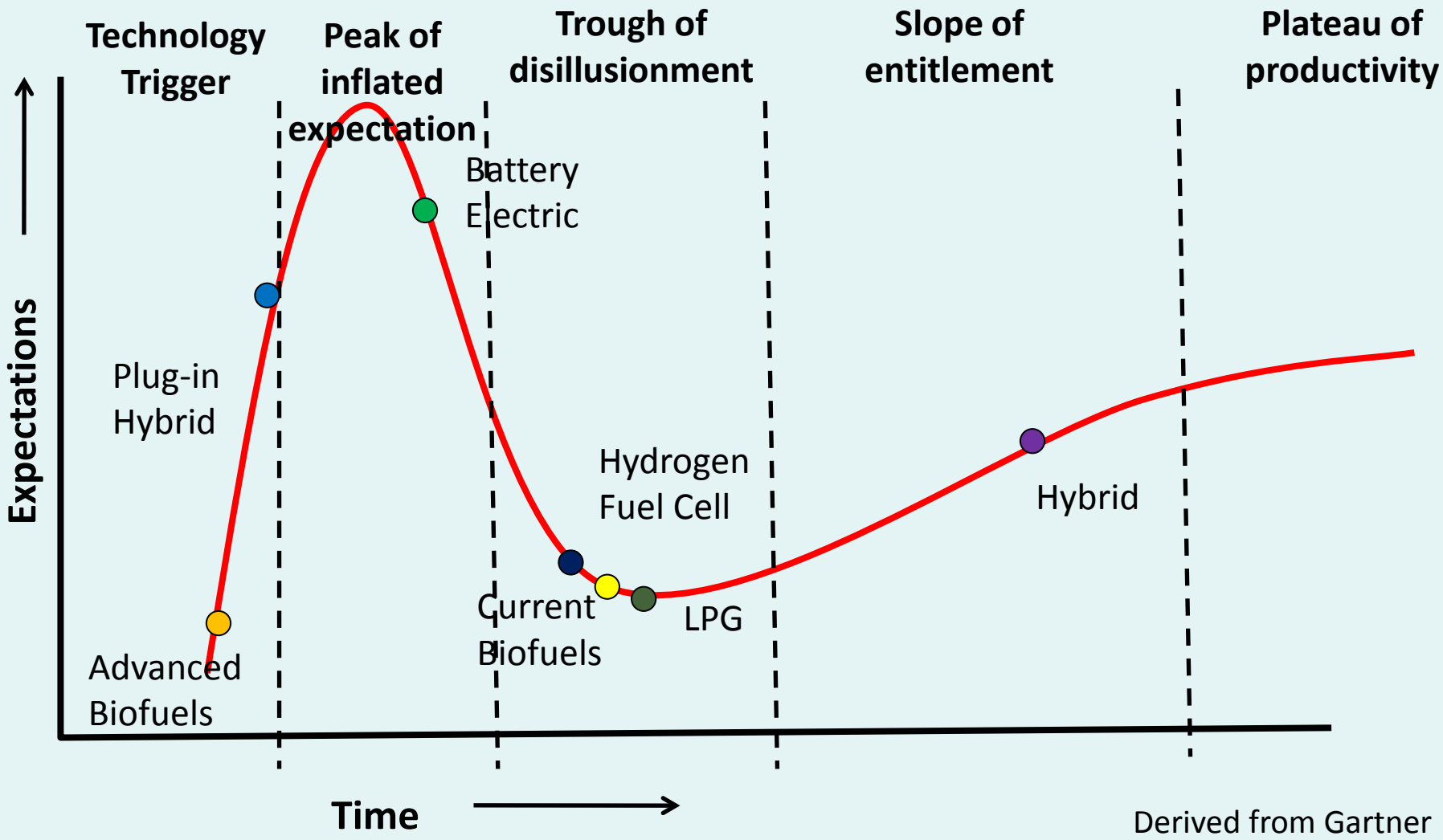
The adoption of new technologies is usually incremental and does not follow the hype cycle



Derived from Gartner

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The views expressed in this slide are illustrative and do not represent LowCVP position

There is significant UK Government and business support for electrification of transport

- Creation Office of Low Emission Vehicles
- >£300M purchase support fund for cars
  - 2011-14, £5k per vehicle
- £15M Low Carbon Vehicle Innovation Platform
- £30M infrastructure support
  - Plugged-in-Places
  - 8 regions, 8,500 recharging points
- £5M Ultra-low carbon car competition
  - 340 vehicles
  - Joint cities demo programme
- £20M public procurement support for electric vans
- Supply chain and advanced manufacturing support (£170M)

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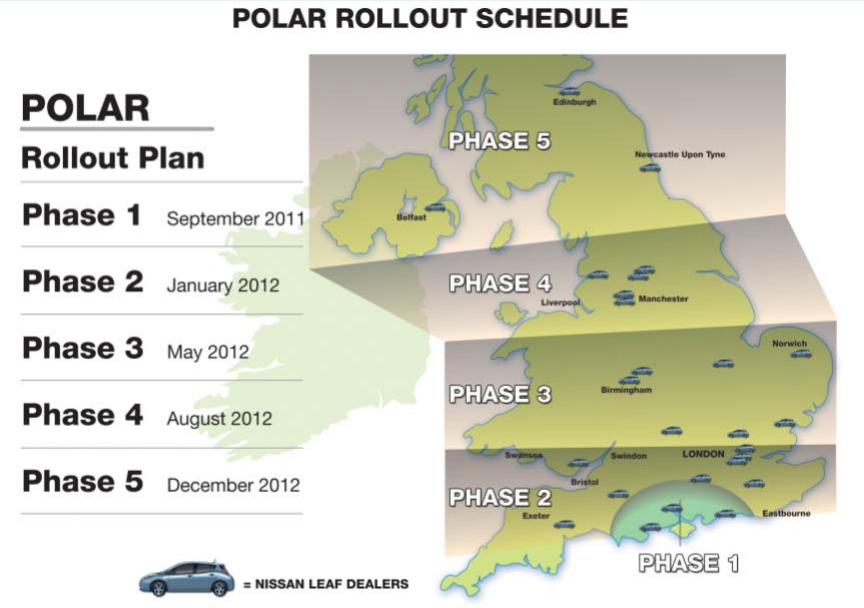
Significant private refuelling infrastructure is also becoming available complementing the publicly funded Plugged in Places scheme. The UK is also a centre for EV manufacturing



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Prospective buyers of electric vehicles are concerned by the high purchase price, limited utility, restricted model range and limited recharging points; fleet managers are at least as sceptical as private buyers

Private and fleet concerns about electric vehicles

	High Price	Limited Range	Time to charge	Inconvenience of recharging	No recharging points	Lack of power or performance	Unfamiliarity	Lack of choice
Household EV owners	+++	++	+	+	++	+	+	++
Household EV considerers	+++	++	+	+	++	+	+	++
Commercial EV owners	+++	+++	+++	++	+++	++	+	+++
Commercial EV considerers	+++	++	+	+	++	+		+

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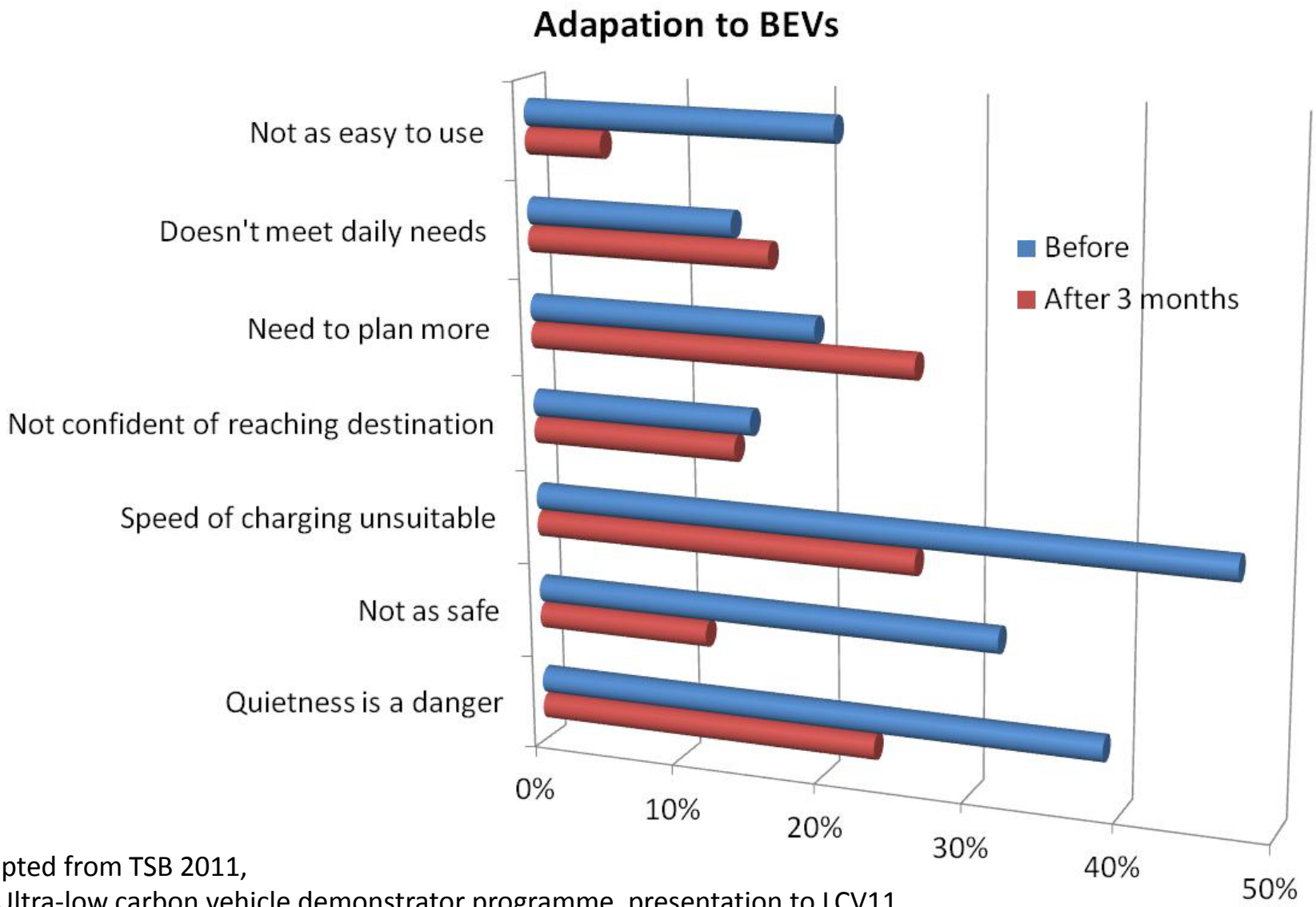
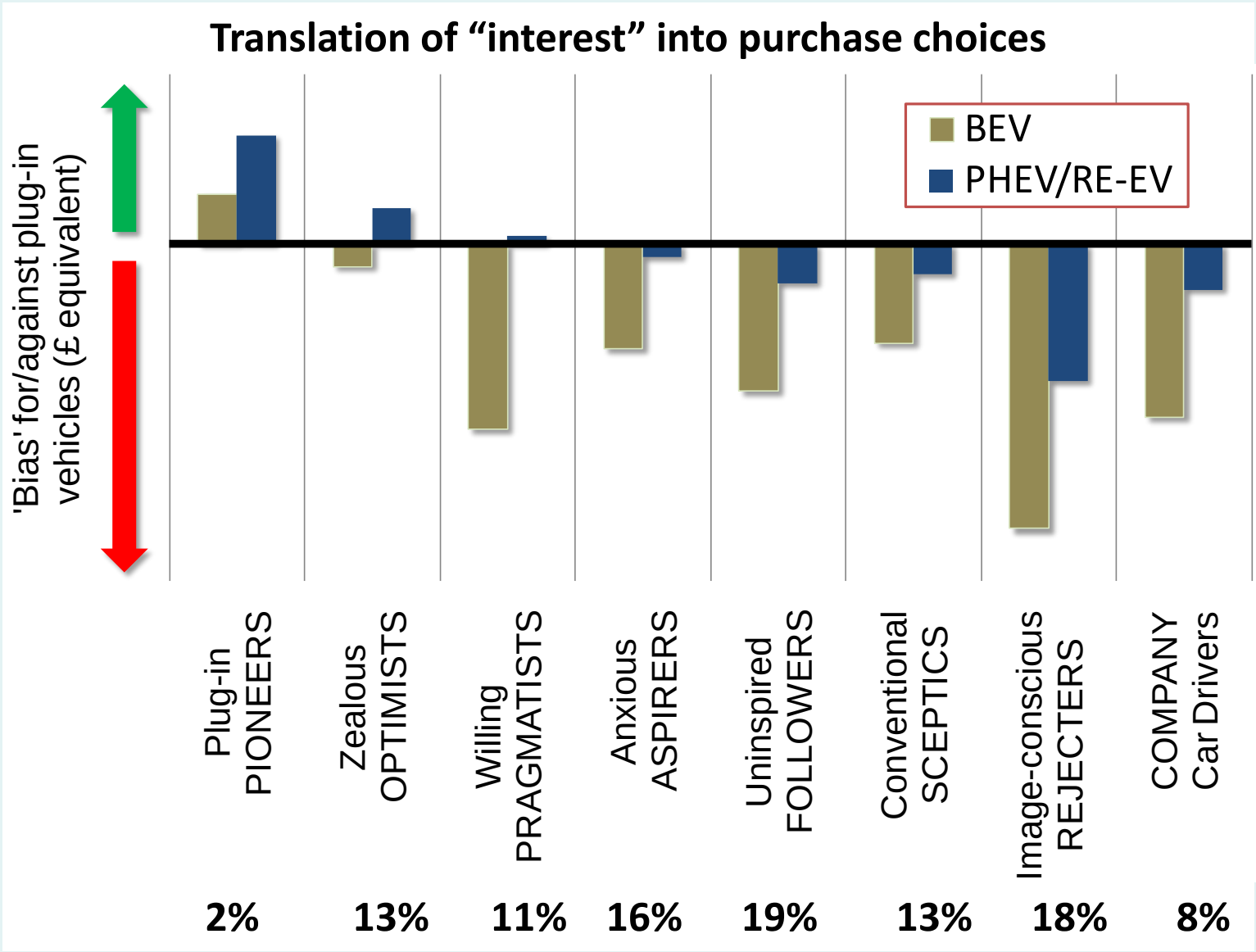
Element Energy, 2009

Drivers generally adapt to ultra-low carbon vehicles quickly but using the vehicle requires greater planning and doesn't meet every daily need.

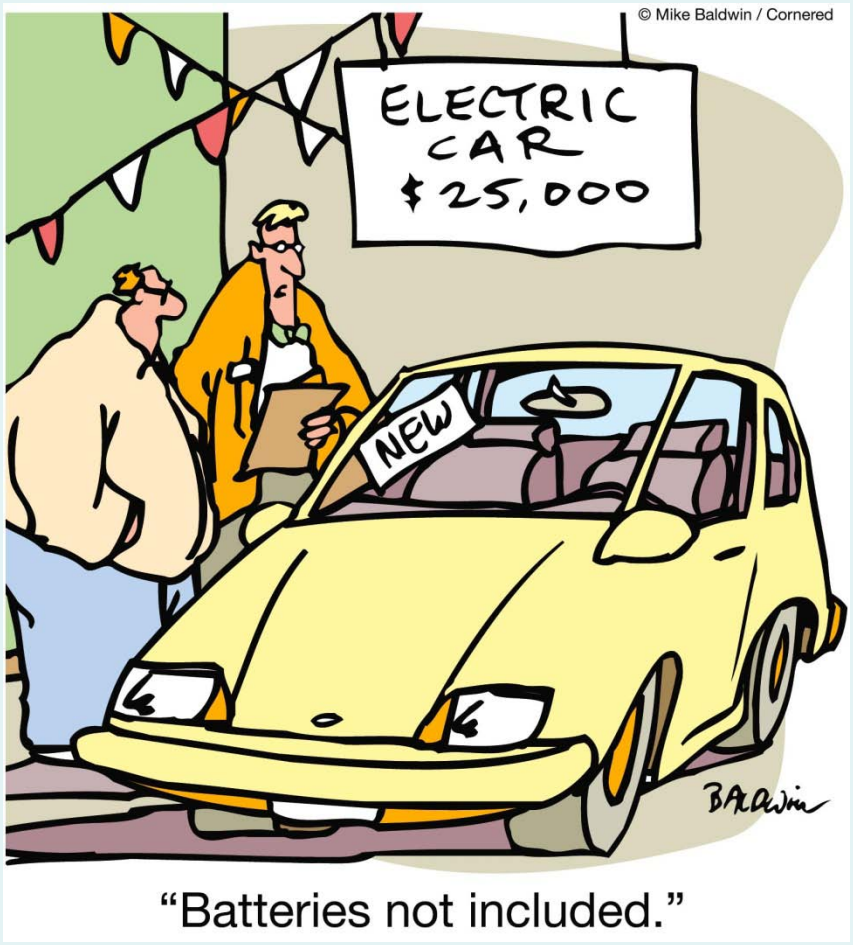


Adapted from TSB 2011,
UK Ultra-low carbon vehicle demonstrator programme, presentation to LCV11

In the mass-market there is no willingness to pay for plug-in technology



Mass market adoption of EVs is only likely once capital costs are significantly reduced and total costs of ownership are attractive compared to ICE equivalents – this will require significant subsidy



For private buyers

- High capital cost is a key barrier
  - Leasing options likely
- Fuel-cost savings are heavily discounted
- Requirement for very high range
- Range anxiety reduces usage to 33-50% of technical range
  - Fast charging / battery swap builds confidence
- Low willingness to pay – beyond early adopters
- Availability of recharging infrastructure is important to for the initial purchase
- New technology aversion

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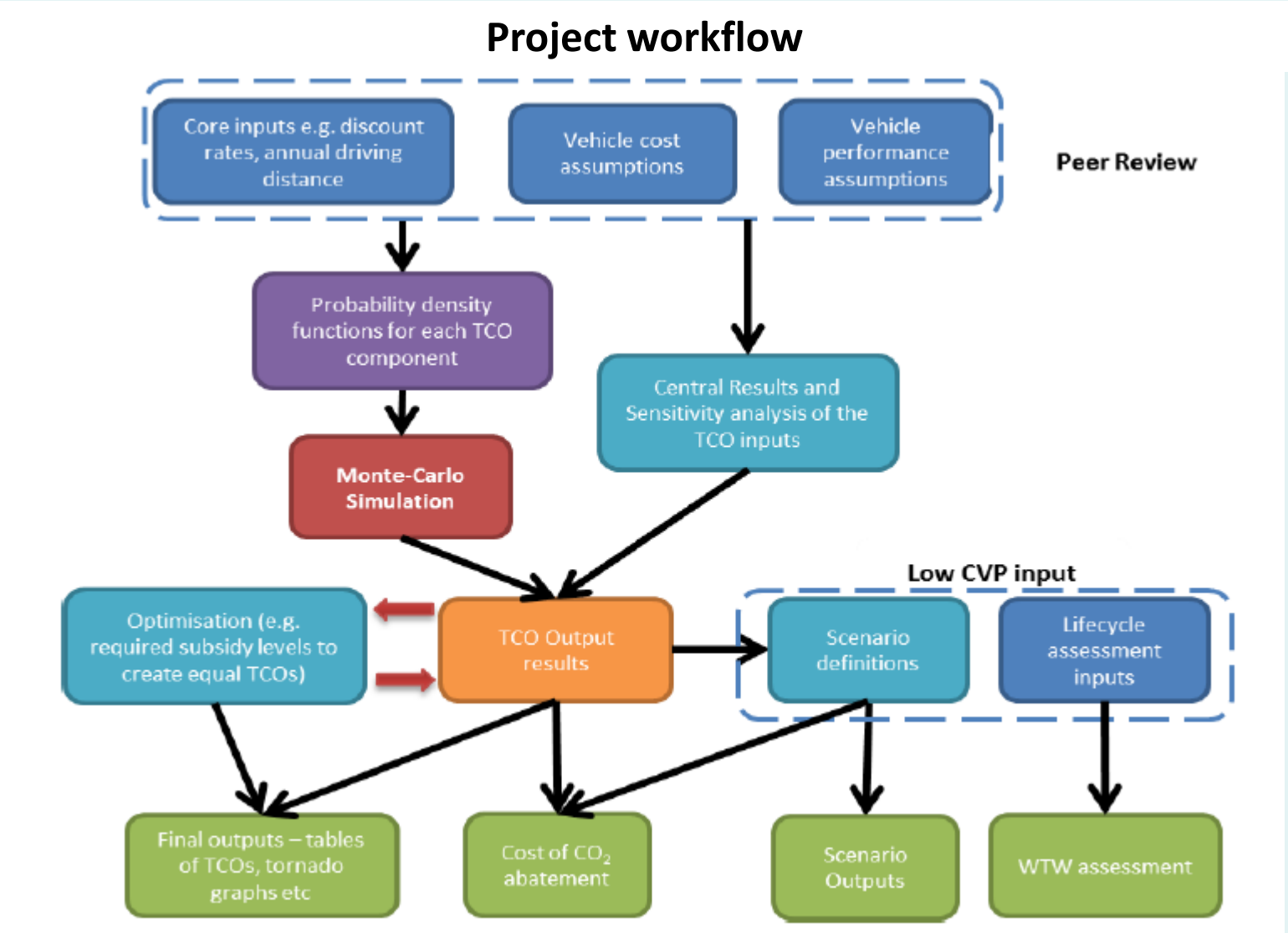
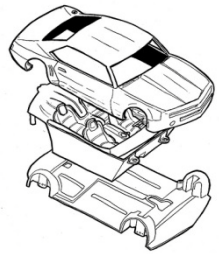
LowCVP examined the total cost of ownership for the first owner (4 years) of a range of powertrains in 3 market segments (small, medium and large) to 2030



Capital cost model is based on 7 main components with each a range of future costs were estimated for 2010, 2020, 2025 and 2030

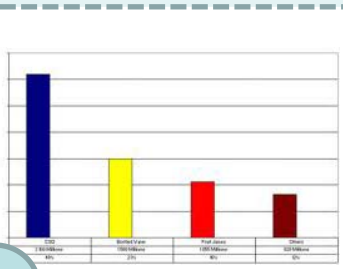
1



2


3

1. Margins
2. Chassis and body
3. Primary and secondary power plant
4. H_2 tank (where relevant)
5. Electric motor (incl. controller and inverter)
6. Additional components (e.g. wiring)
7. Chassis and body light weighting



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4

5

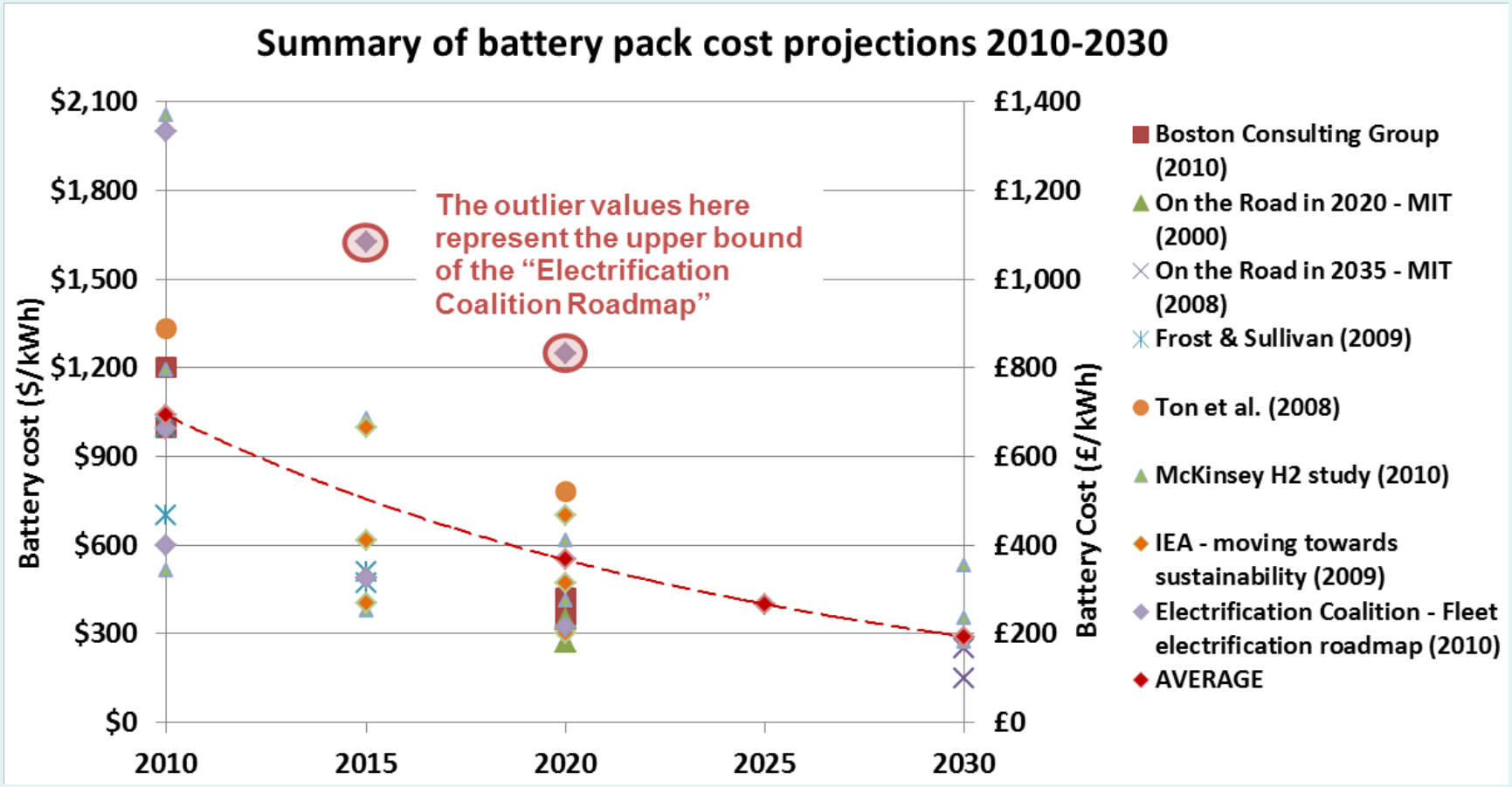


6

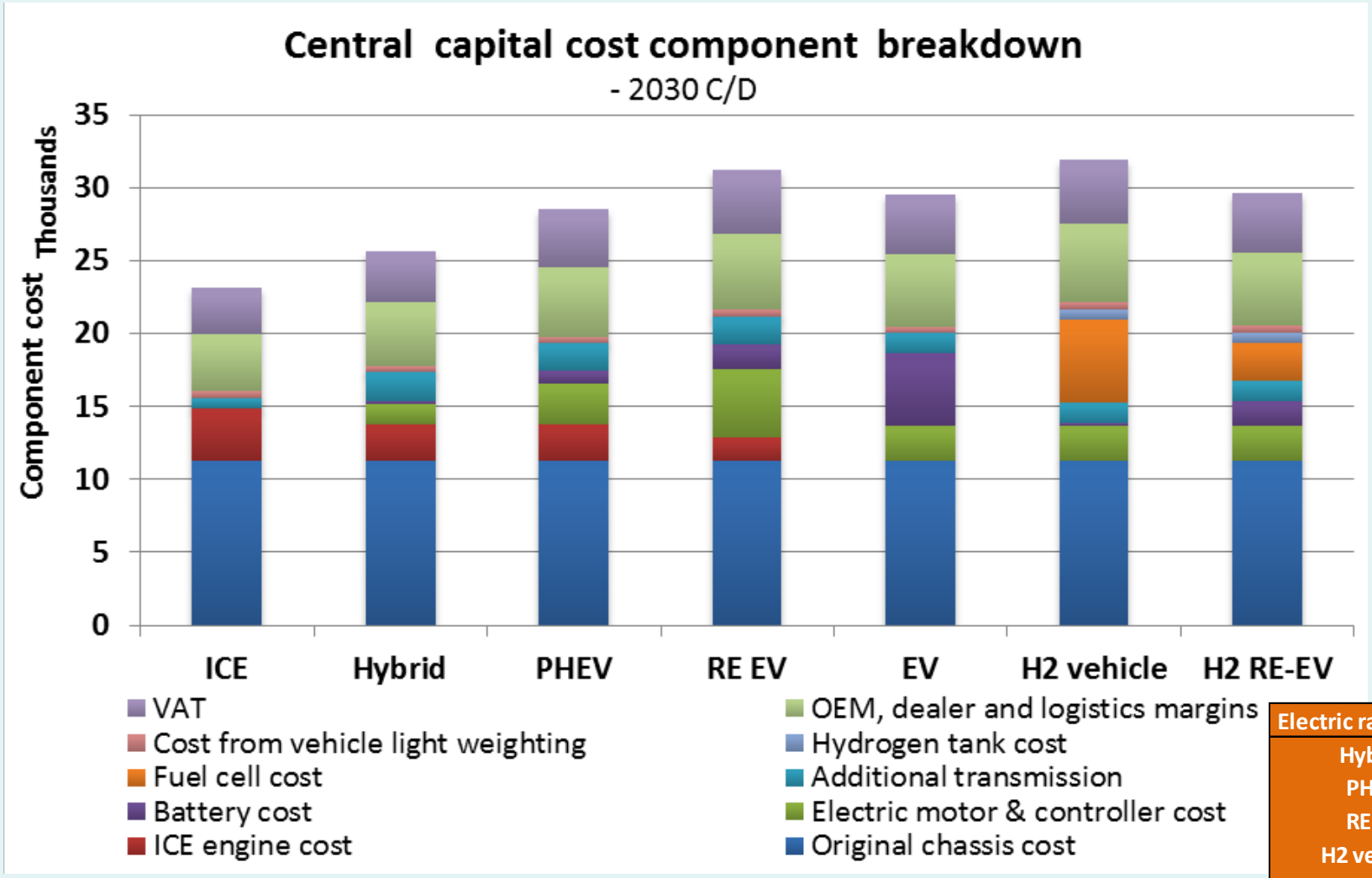
Pictures source: internet / various copyrights

Battery cost projections: based on 9 publications (incl. MIT, IEA, BCG, Electrification Coalition) and were peer reviewed

Battery costs through time £/kWh	2010	2020	2025	2030
Best Fit Value	£693	£367	£267	£194
Low	£342	£181	£141	£100
High	£1,369	£833	£681	£530



The price of a medium sized ICE vehicle is estimated to rise from c£18k (2010) to c£23k (2030). The cost increment for BEV's falls from £14k (2020) to £6k (2030) in the Central case



Electric range (km)	2030
Hybrid	2
PHEV	30
RE EV	60
H2 vehicle	2
H2 Re-EV	60
EV	240

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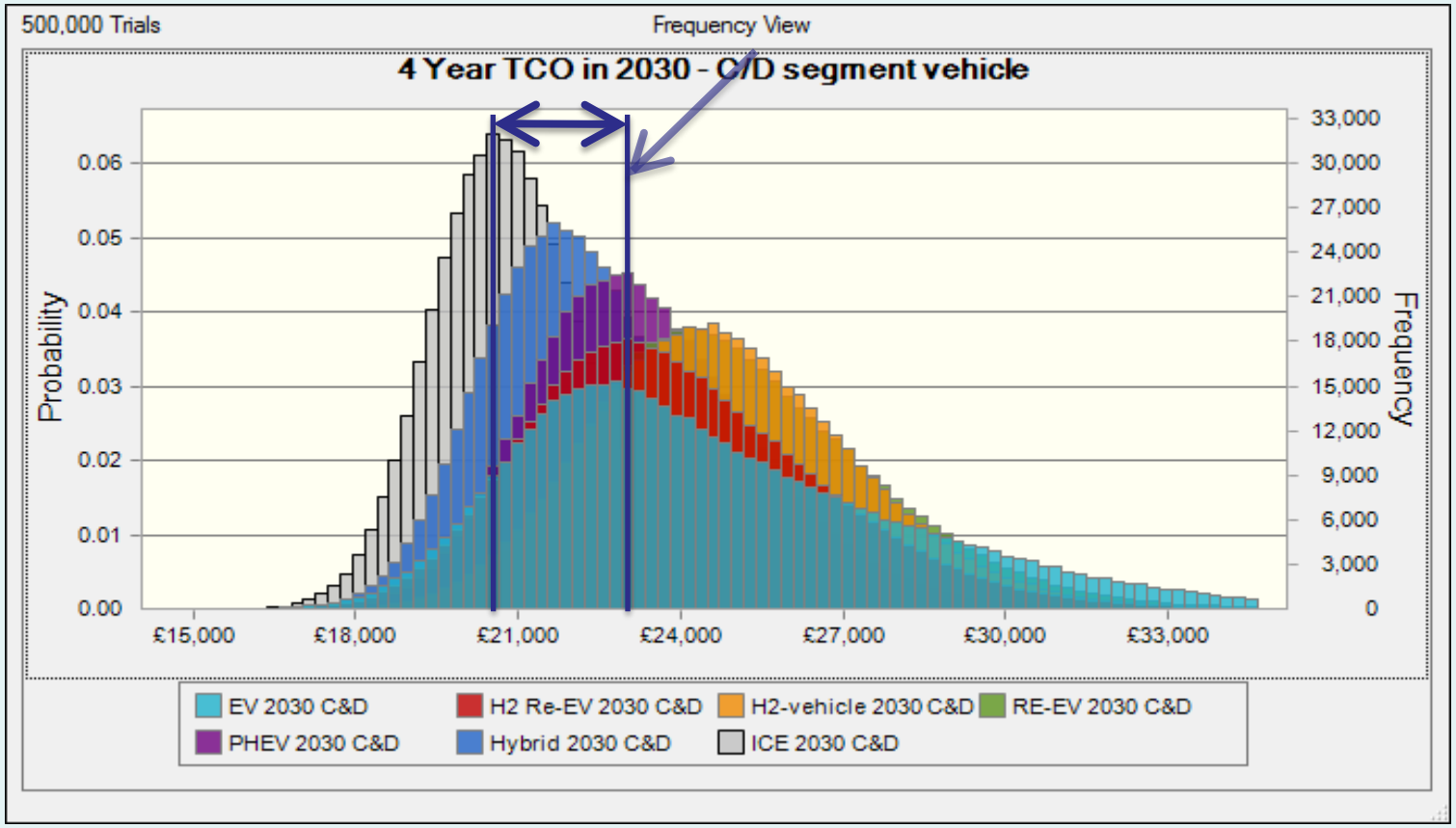
In 2030, the probability is that the TCO of ICE vehicles will still be lower than hybrid, plug-in and fuel cell vehicles *without policy intervention*

- Significant difference in TCO between conventional and plug-in/H_2 vehicles remains in 2030.
- The differential for the PHEV, RE-EV and pure EV is c.£2,400, implying additional costs due to two powertrains in the plug-in hybrids offset the saving from a smaller battery.



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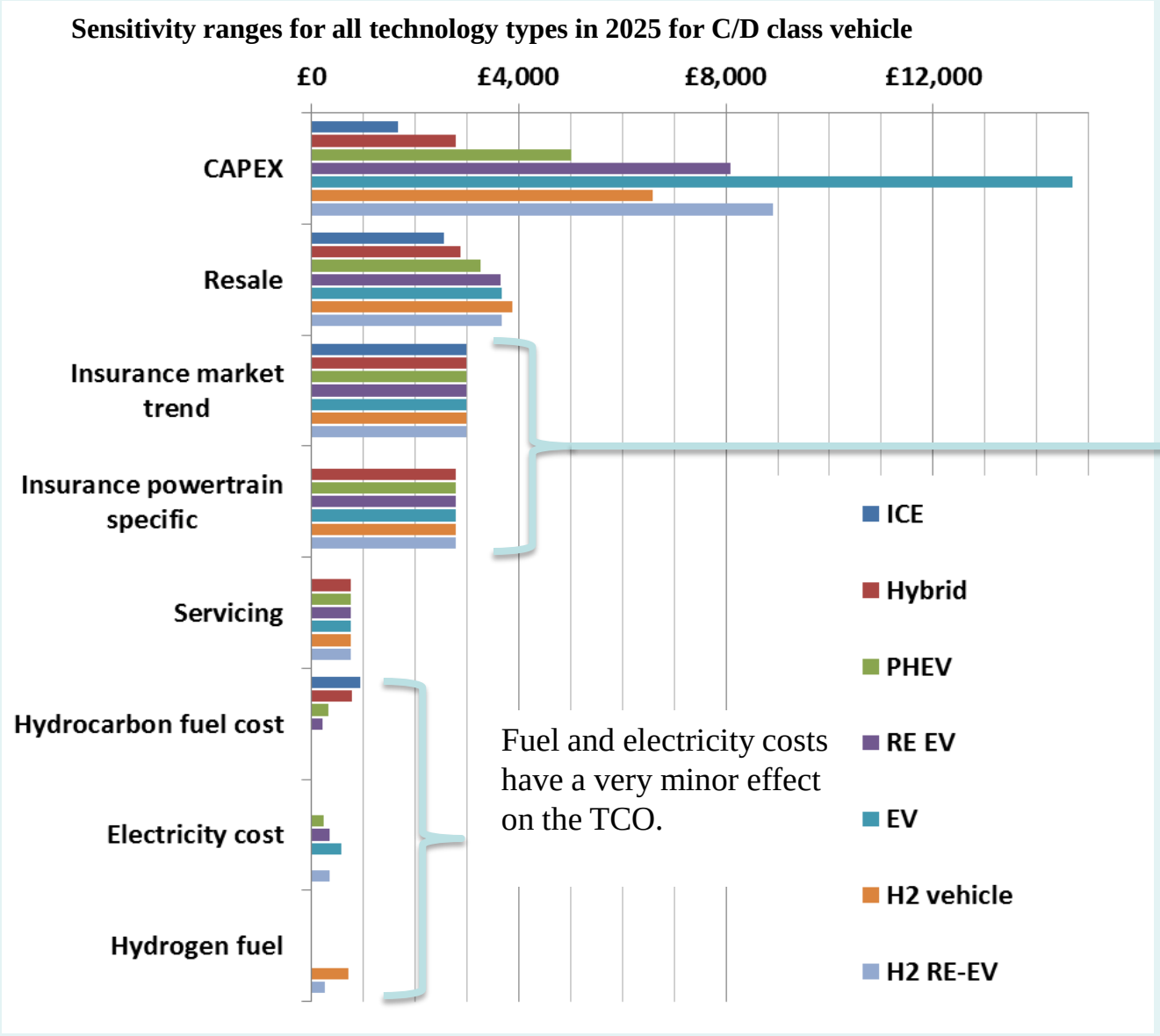
Uncertainties in capex/resale dominate the TCO outcome for non ICE powertrains; insurance cost uncertainties are more significant than those of fuel costs

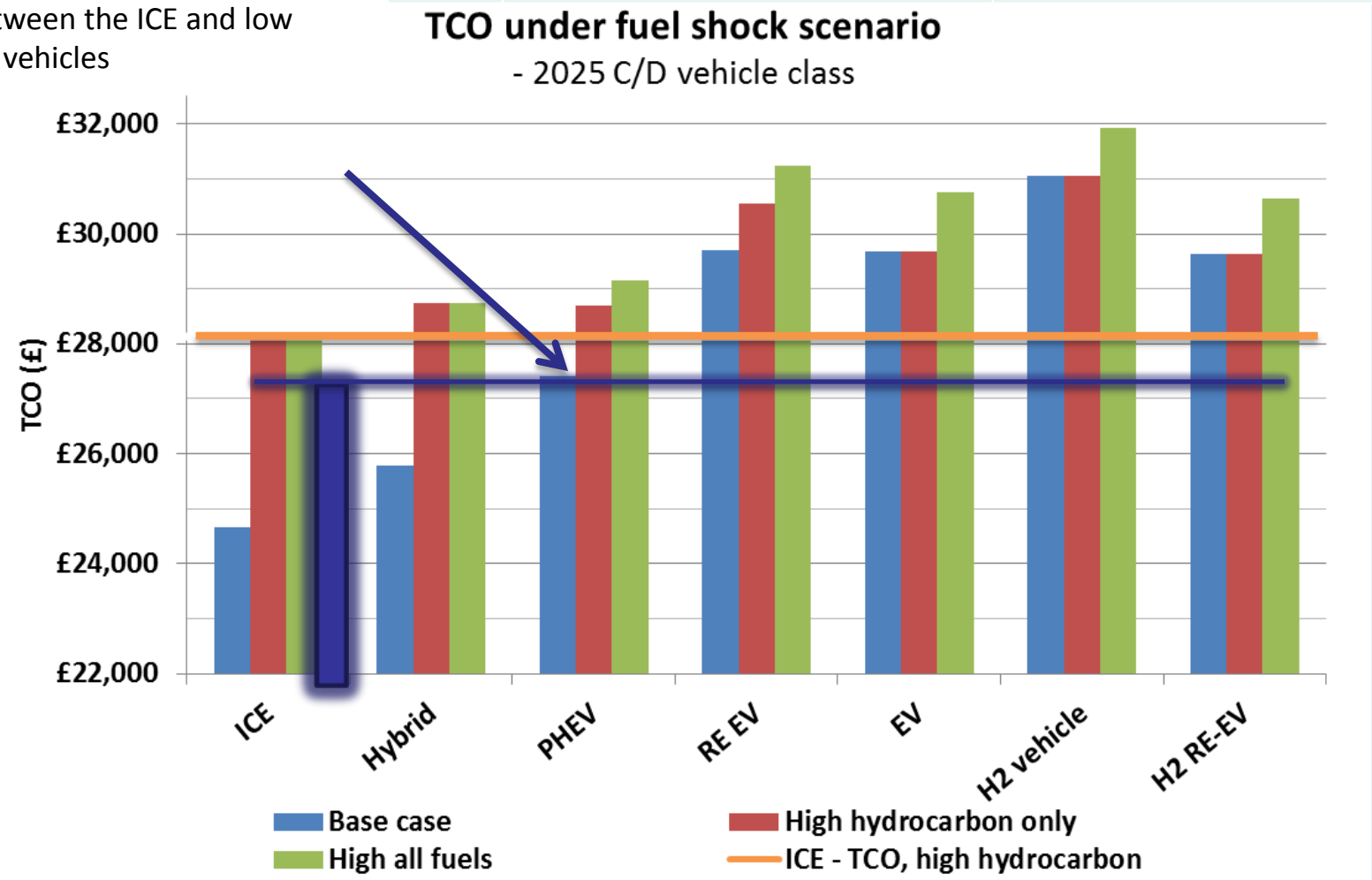


Note The variation in insurance cost, both in the market trend and in the variation in powertrain specific costs, outweighs any effect of variations in fuel cost in 2025.

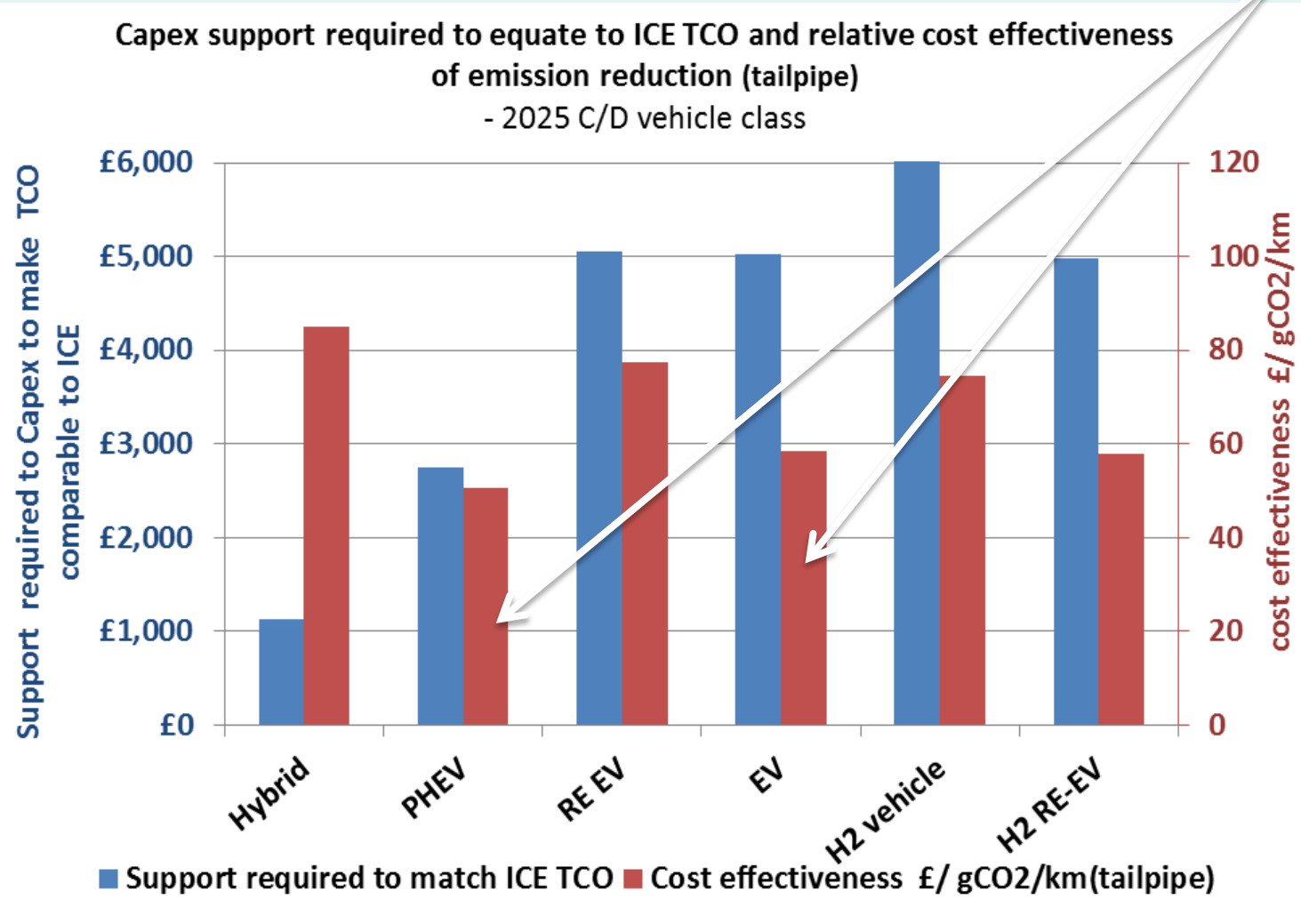
The study tests a number of scenarios - a fuel price shock of £3/l narrows the TCO premium for plug-in and hydrogen vehicles, but these remain more expensive for the first owner

Hydrocarbon Fuel	Electricity	Hydrogen
£3 /l	40p /kWh	£8 /kg

£3/l fuel price nearly closes the gap between the ICE and low carbon vehicles



Capex support to equalise the TCO varies widely between technologies. Although the PHEV and EV require very different subsidy costs to equalise their TCOs; higher CO_2 savings for the BEV means 'cost effectiveness' (£/gCO_2/km) are similar.



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Key messages for the introduction of Ultra Low Carbon Vehicles

- Differences in TCOs between ICE and Plug-in and H_2 vehicles will fall substantially between 2011 and 2020;
  - The capital cost and total cost of ownership for ULCV likely to remain challenging over the period to 2030
  - Battery leasing and other innovative business models do not significant alter the TCO outcome
- Long term incentives are likely to be required to achieve the widespread adoption of ULCV
  - What form should these take? What is the exit strategy for current grants
- Improvements in ICE efficiency means 'conventional' cars will become less exposed to fuel prices over time, reducing some of the running cost benefits of ULCVs
  - Insurance costs of ULCV may significant add to the TCO and constrain the take-up
- There are no significant difference in the cost effectiveness of CO_2 savings between PHEV and pure EV (on a tailpipe basis)
  - PHEVs/RE-EVs could play a dominant role in decarbonising transport possibly using biofuels in high blends in ultra-efficient generators

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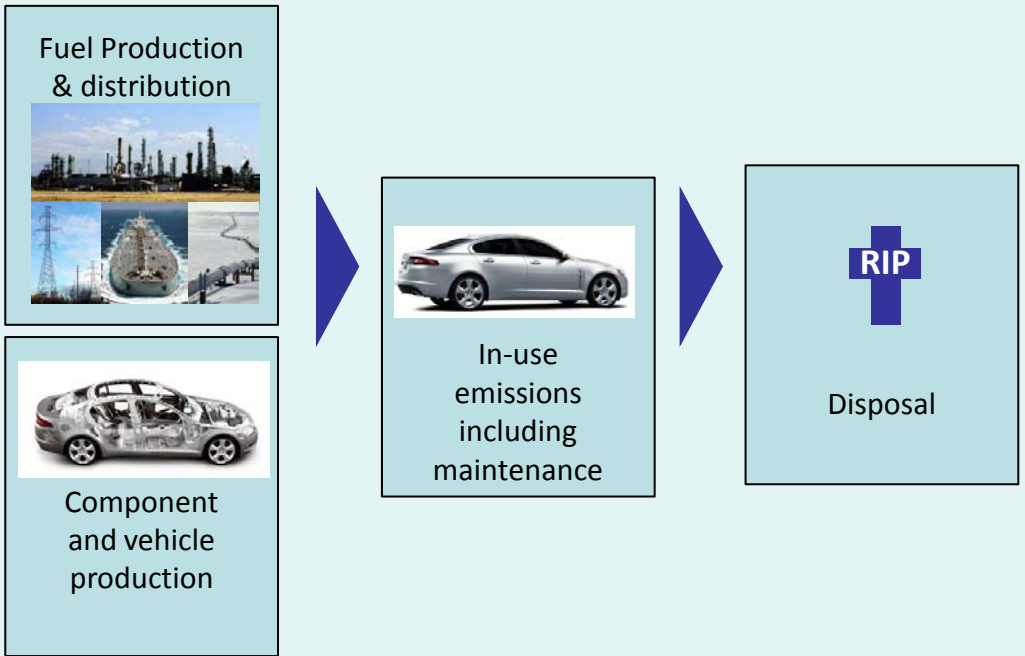
Current tailpipe comparisons of car CO2 emissions will become increasingly inappropriate with the introduction of lower carbon car technologies

- Tailpipe measures are a good basis for comparing ICE's but the current NEDC cycle is not sufficiently representative of real world driving
  - Reduces consumer confidence in test results and consumer information
- WTW measures are better but do not account for embedded emissions in batteries and fuel cells
- A shift to a WLC measure to compare the CO2 performance of vehicles will be required as new technologies achieve significant market penetration
- WLC C metric must include:
  - Production
  - In use – TTW
  - Fuel –WTT
  - Disposal



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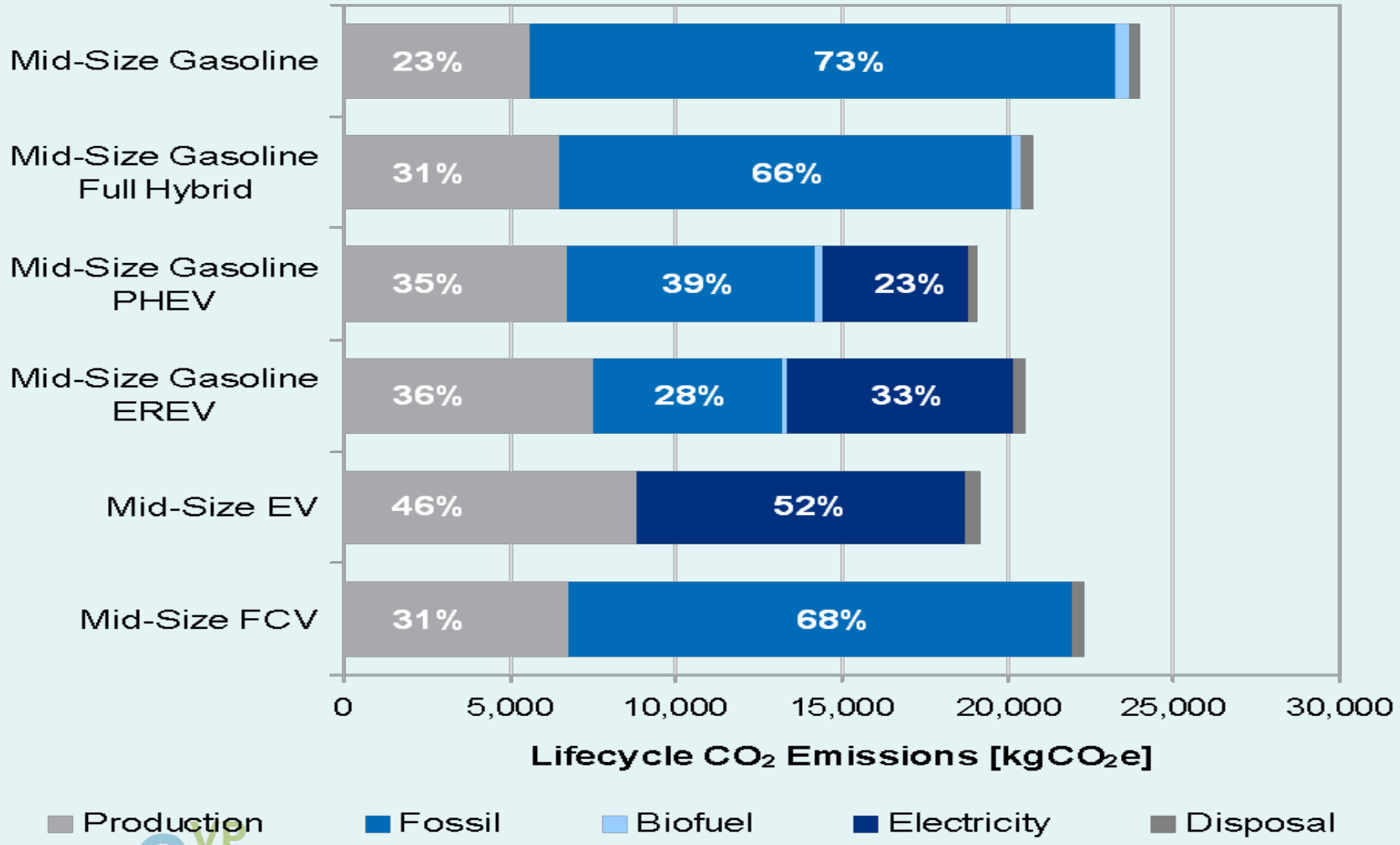
WLC assessment demonstrates electric variants do reduce carbon emissions relative to conventional ICE vehicles – but production emissions are higher



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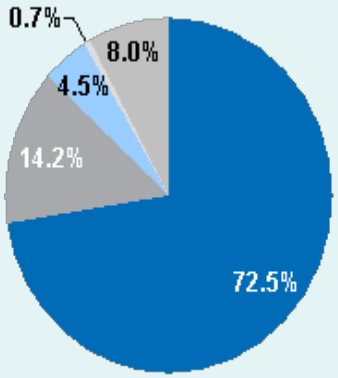
The technology evolution to plug-in vehicles will lead to higher embedded CO_2 emissions due to the addition of new components

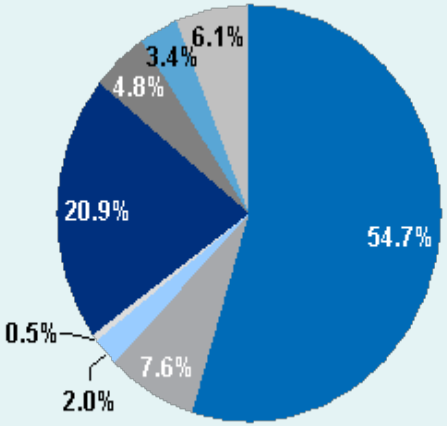
Embedded CO_2 Emissions [$kgCO_2e$]

Mid-Size Gasoline



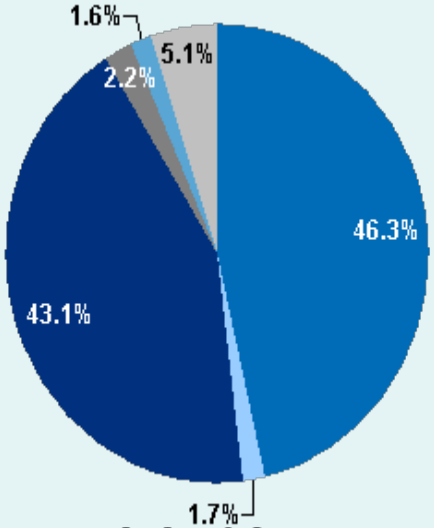
5.6 tCO_2e

Mid-Size Gasoline EREV



7.5 tCO_2e

Mid-Size EV



8.8 tCO_2e

- Vehicle Glider
- Engine, including after treatment
- Transmission and Driveline
- Fuel System
- Battery
- Motor
- Power Electronics
- Assembly Energy

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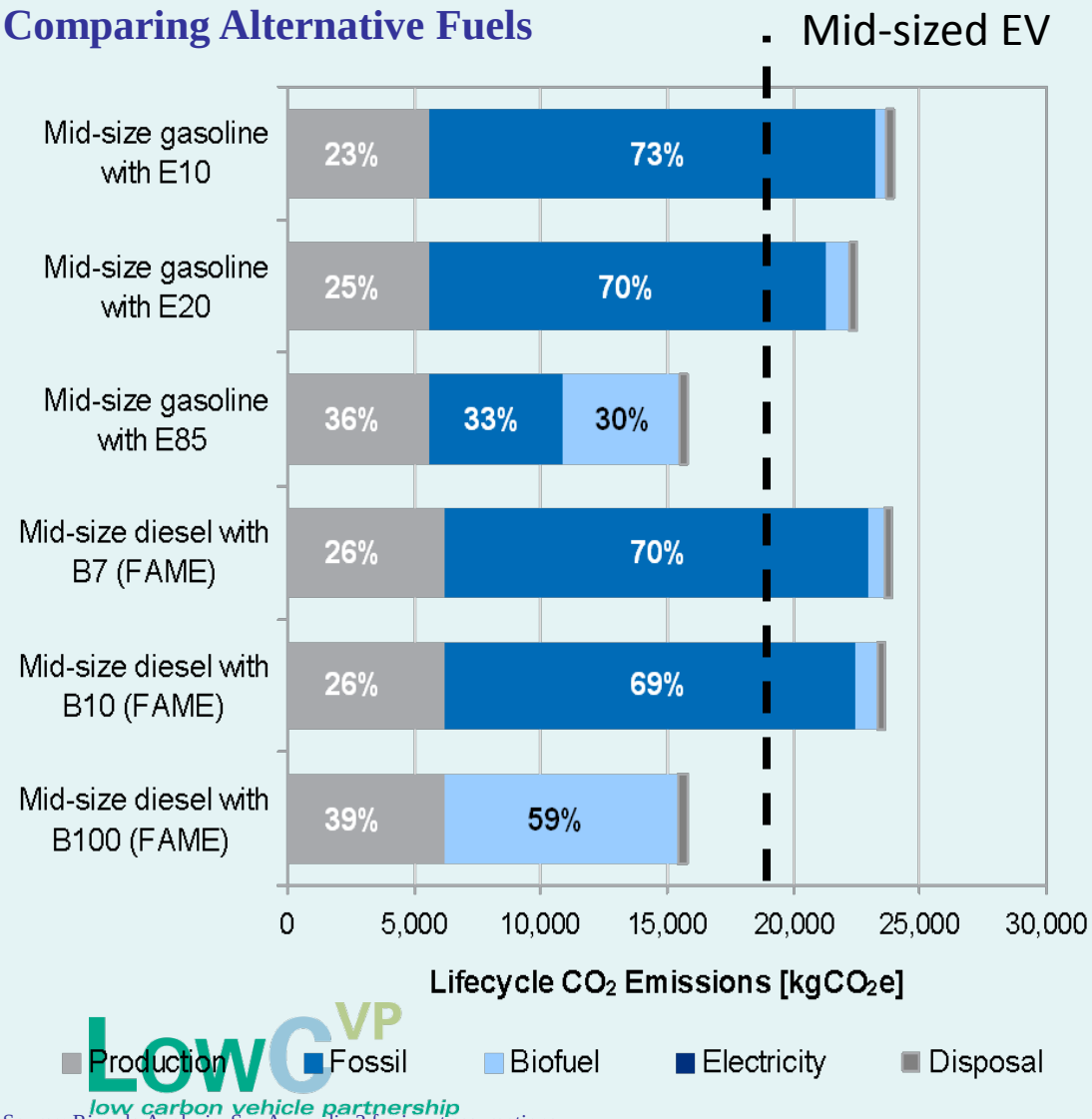
Gasoline and diesel vehicles have similar WLC emissions - increasing the biofuel significantly reduces well-to-Wheel CO_2 emissions … assuming it can be sustainably produced



- The higher the biofuel content, the lower the WTW CO_2 emissions resulting from the use of fuel
- The actual level of saving is dependent on the feedstock and production processes used to make the biofuel
- As WTW CO_2 emissions reduce, the embedded CO_2 emissions from production and disposal become a more significant part of the whole life cycle CO_2 metric

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Source: Ricardo Analysis See Appendix 2 for input assumptions

Comparison of vehicles on a whole-life carbon basis will become increasingly important as new powertrains penetrate the market

- WLC is a robust performance based metric to compare competing powertrains and fuels
  - Methodologies need to be standardised at an EU or UNECE level
  - Voluntary industry action is an important first step
- The WLC benefits of diesel over petrol are marginal and needs more active consideration by policy makers
- ULCV's will only deliver ULC emissions if the fuels are produced sustainably and the production emissions also decarbonised
- LowCVP should:
  - Seek to build international consensus in favour of shifting to lifecycle metrics
  - Facilitate standardisation of approaches between VMs and practitioners

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Final thoughts ....

- There are no silver bullets! Vehicle and fuel technologies will become increasingly diverse
- Current policies are inadequate for the scale of the challenge
- New metrics will be needed
- Consumer awareness and acceptability must be increased
- Supporting UK innovators can provide significant green business opportunities for the UK
- Transport tax revenues will decline with increasing lower carbon vehicle adoption
- Partnership working is effective in tackling market failings

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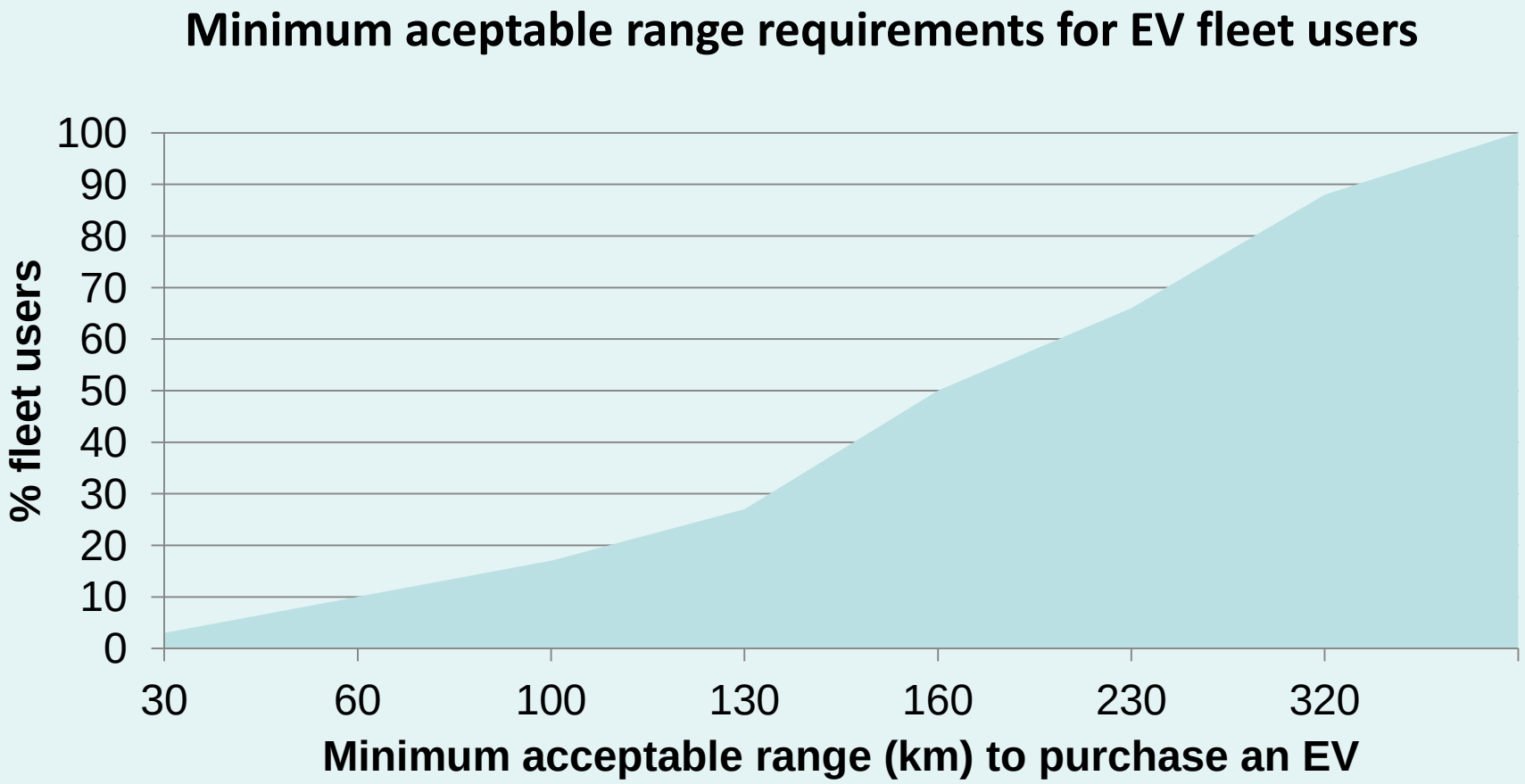
50% of fleets will consider buying an EV with a range of at least 160km



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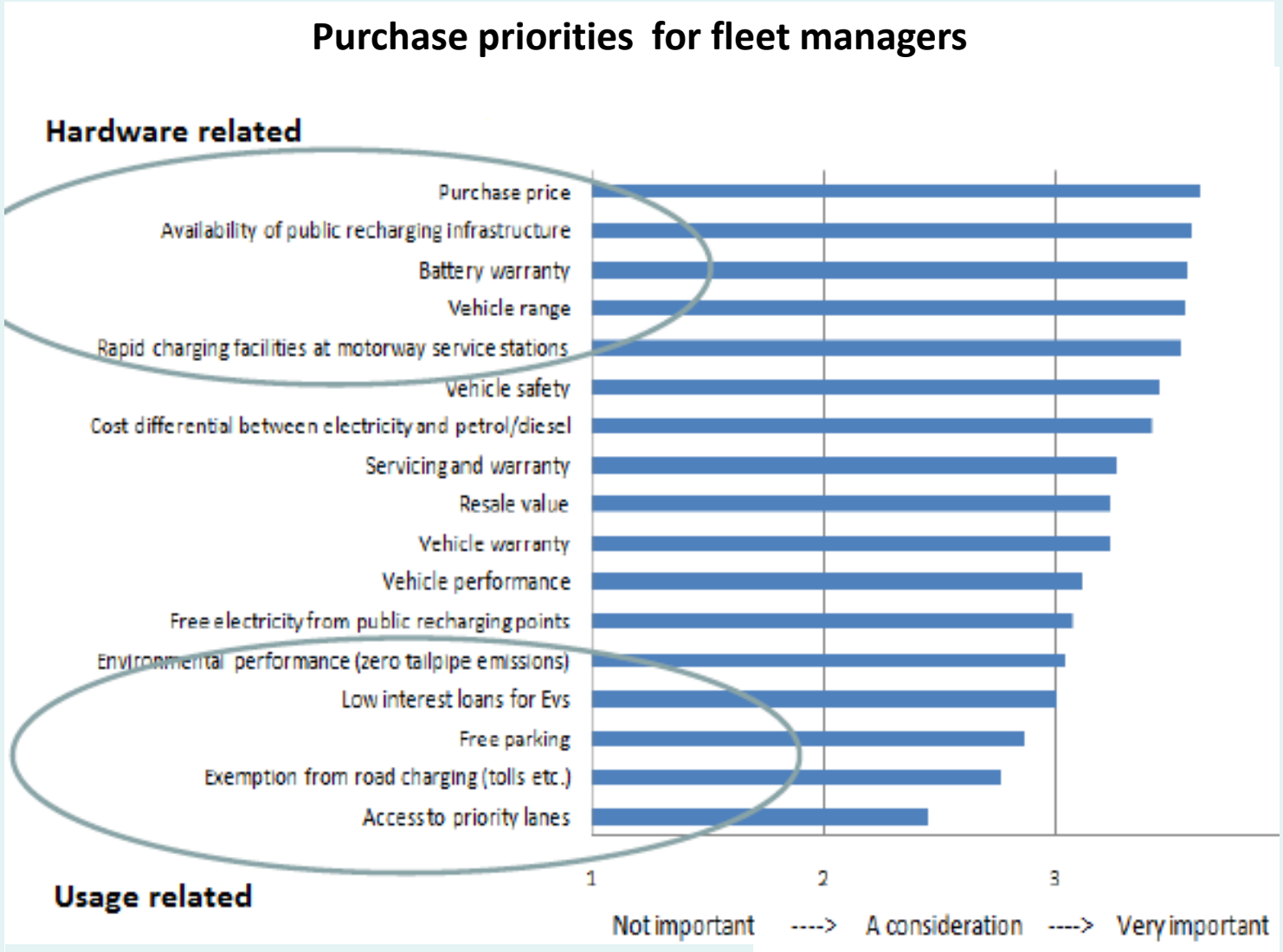
Adapted from Cenex LCV11 presentation on Smart Moves trial

EV's have sufficient range for most daily journeys – but car buyers typically choose vehicles that meet exceptional needs

Cenex 2011, LCV11 Nissan Presentation

Consistently fleet managers highlight “hardware” related challenges as the most important; “usage” related incentives are nice to haves



Cenex 2011, LCV11 presentation on Smart Moves trial

Mass market adoption of electric vehicles will require a increase in buyer interest – particularly for BEVs

Market Segment	PHEV Interest	BEV Interest	Innovativeness	Greenness
Plug-in PIONEERS 2%	Very High	Very High	Very High	Very High
Zealous OPTIMISTS 13%	High	High	High	High
Willing PRAGMATISTS 11%	High/Medium	Low	Medium	Very High
Anxious ASPIRERS 16%	Medium	Medium / Low	High	High
Uninspired FOLLOWERS 19%	Medium / Low	Medium / Low	Very Low	High
Conventional SCEPTICS 13%	Medium / Low	Low	High	Very Low
Image REJECTERS 18%	Very Low	Very Low	Low	Low
COMPANY car drivers 8%	Medium	Medium	Very High	Medium

Adapted from the Energy Technology Institute 2011 presentation to the LowCVP Annual Conference