EV, fuel cells and biofuels – competitors or partners?

Presentation to the Institute of Engineering and Technology

16th November 2011

Greg Archer, Managing Director, Low Carbon Vehicle Partnership

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low carbon vehicle partnership

LowCVP - accelerating a sustainable shift to lower carbon vehicles and fuels; stimulating 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.

cenex

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ACT ON CO2

Outline

- LowCVP
- The global shift to electrification of cars
- Hype cycles
- Private and fleet buyer attitudes to EVs
- Costs of ownership
- The future vehicle parc
- Strategies for stimulating ultra-low carbon vehicles
- Greenhouse gas benefits
- Final thoughts

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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 R&D, infrastructure and for purchase support
- Investment & commitment from global OEMs

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

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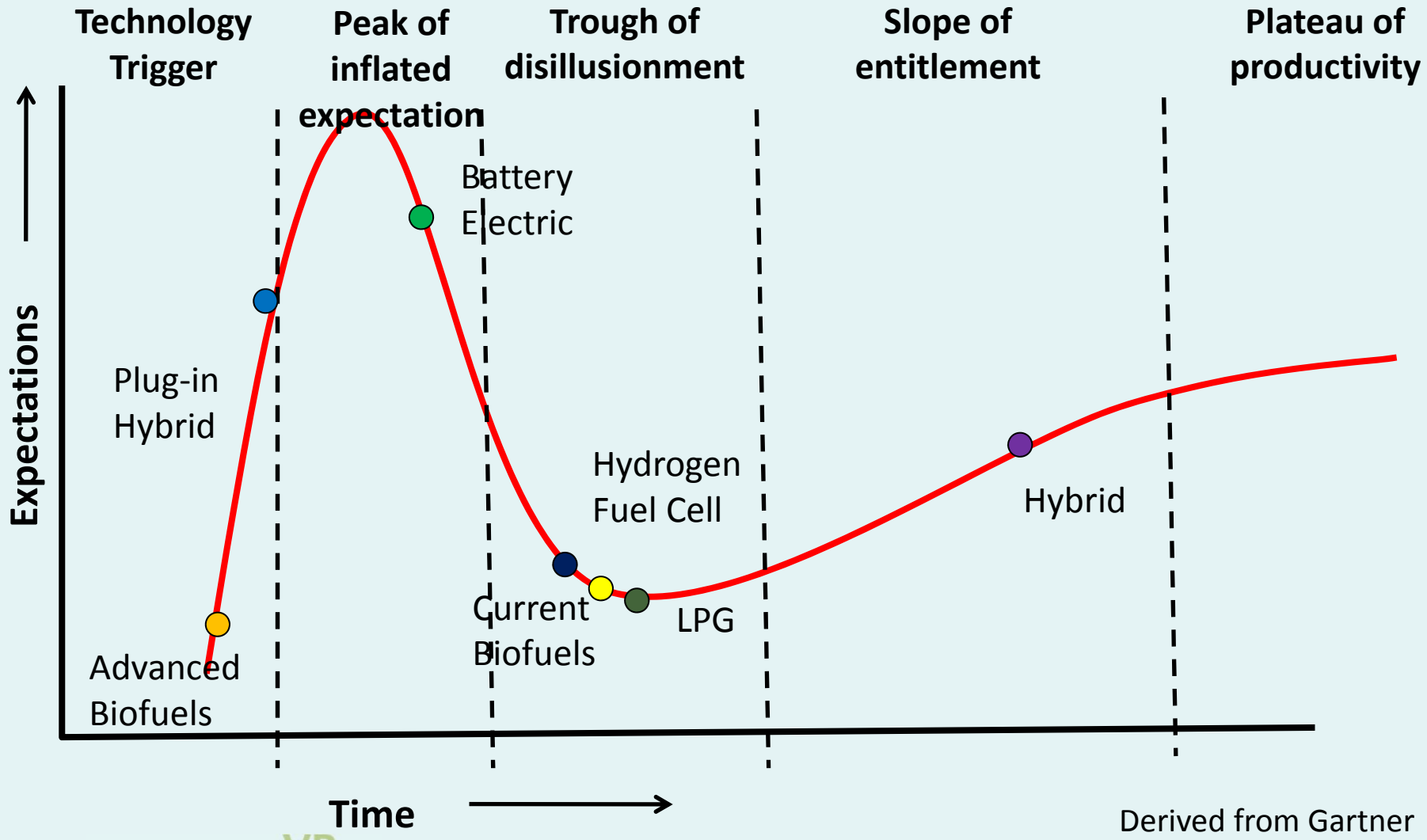
Different renewable transport fuels are at different points in their hype cycle - EVs are at their peak and unlikely to meet inflated short-term expectations



Derived from Gartner

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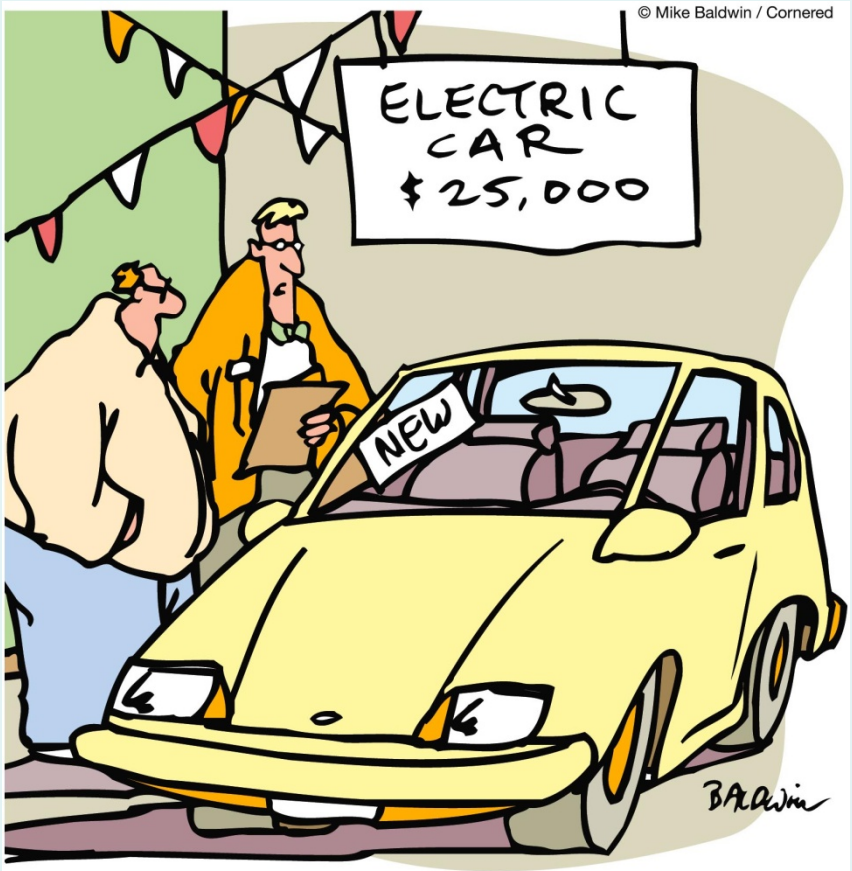
The views expressed in this slide are illustrative and do not represent LowCVP position

EVs are unlikely to dominate the car market until 2035 at the earliest

- There is considerable consumer reluctance to embrace new technology and accept the loss of utility provided by BEVs
- Willingness to pay for EVs is very low & purchase prices will remain high until well beyond 2030
- Total costs of ownership are unattractive and likely to remain so until beyond 2030 – without incentives
- ICE vehicles will become radically more efficient – reducing annual fuel bills
- Advanced biofuels and hydrogen fuel cells will emerge as competing / complementary technologies



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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 more sceptical than private buyers

Private and fleet concerns about electric vehicles

	High Price	Limited Range	Time to charge	Inconvenience of rechargi ng	No rechargi ng points	Lack of power or performa nce	Unfamili arity	Lack of choice
Household EV owners	+++	++	+	+	++	+	+	++
Household EV considerers	+++	++	+	+	++	+	+	++
Commercial EV owners	+++	+++	+++	++	+++	++	+	+++
Commercial EV considerers	+++	++	+	+	++	+		+

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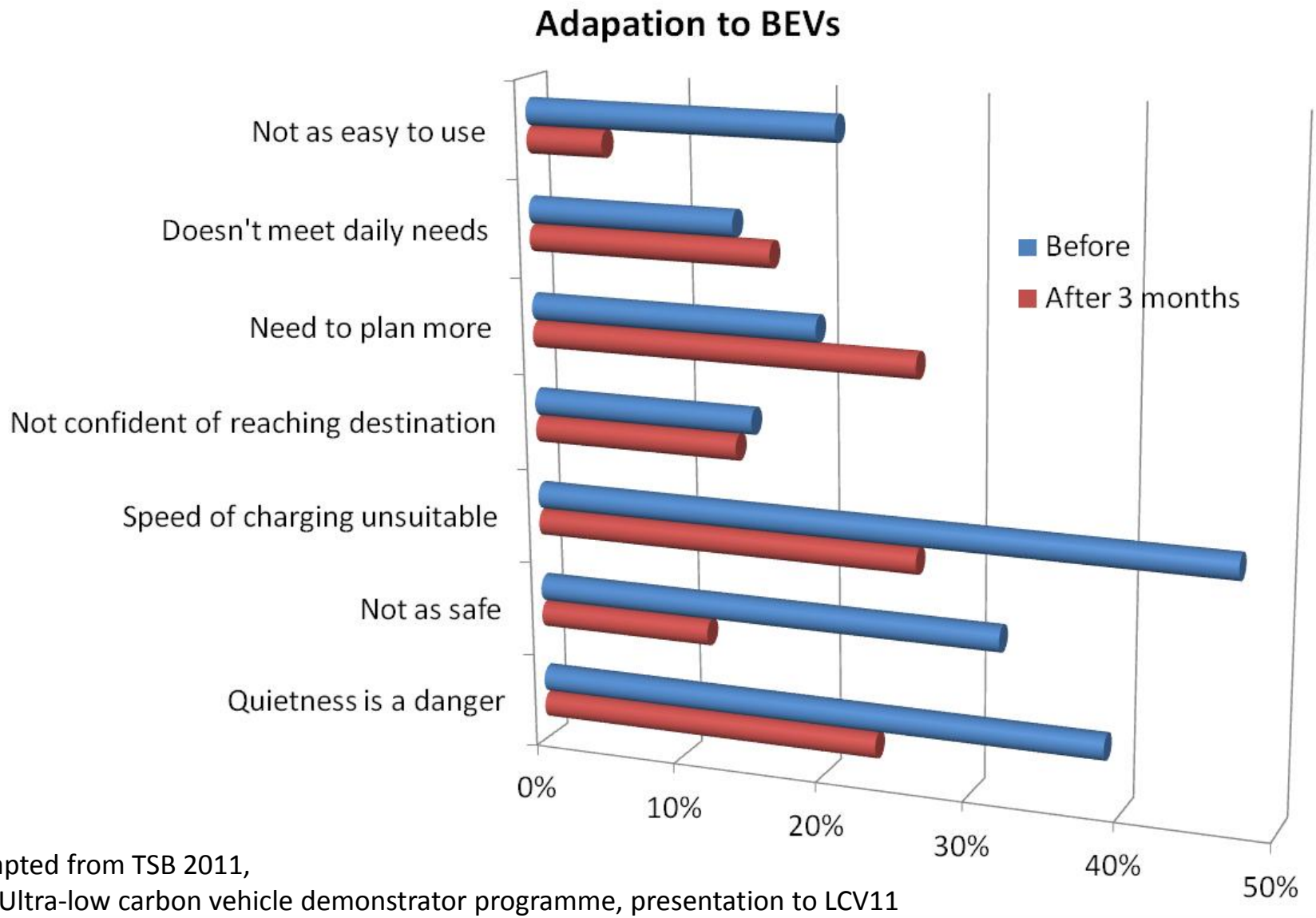
Element Energy, 2009

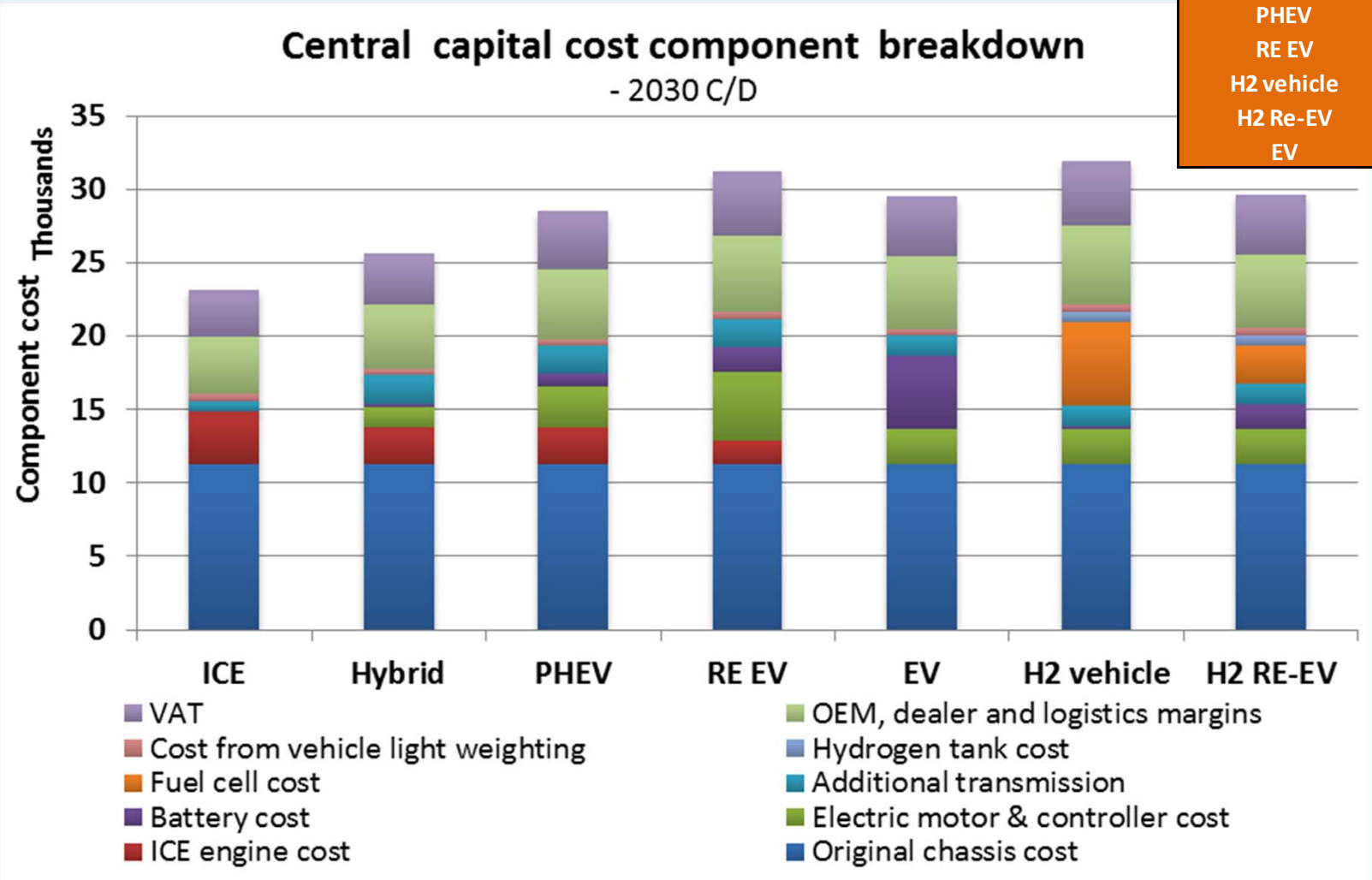
Drivers generally adapt to ultra-low carbon vehicles quickly but using the vehicle requires greater planning and doesn't meet every daily need



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

The purchase price of ultra-low carbon vehicles will significantly fall, but remain much more than ICE equivalents

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



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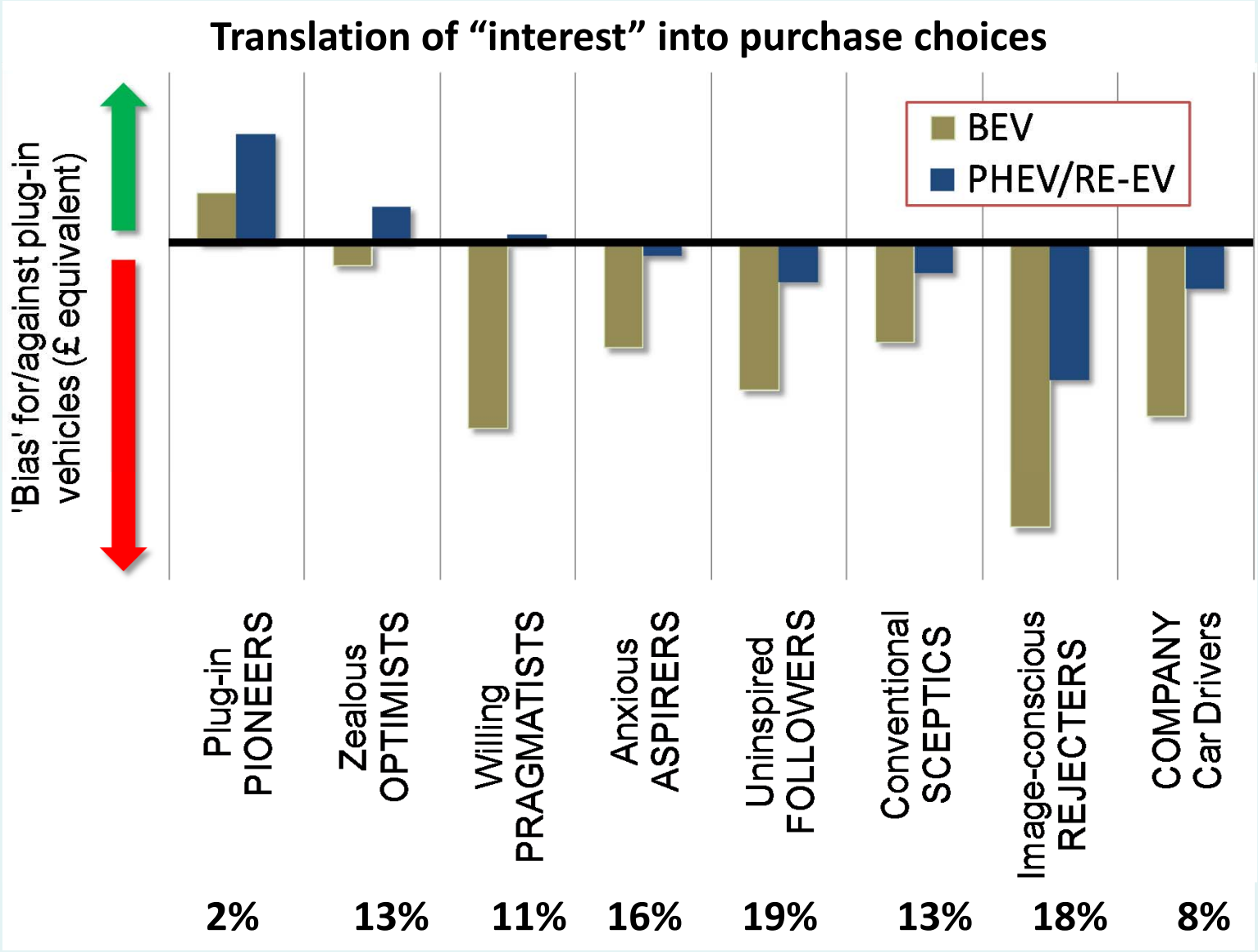
Element Energy, 2010

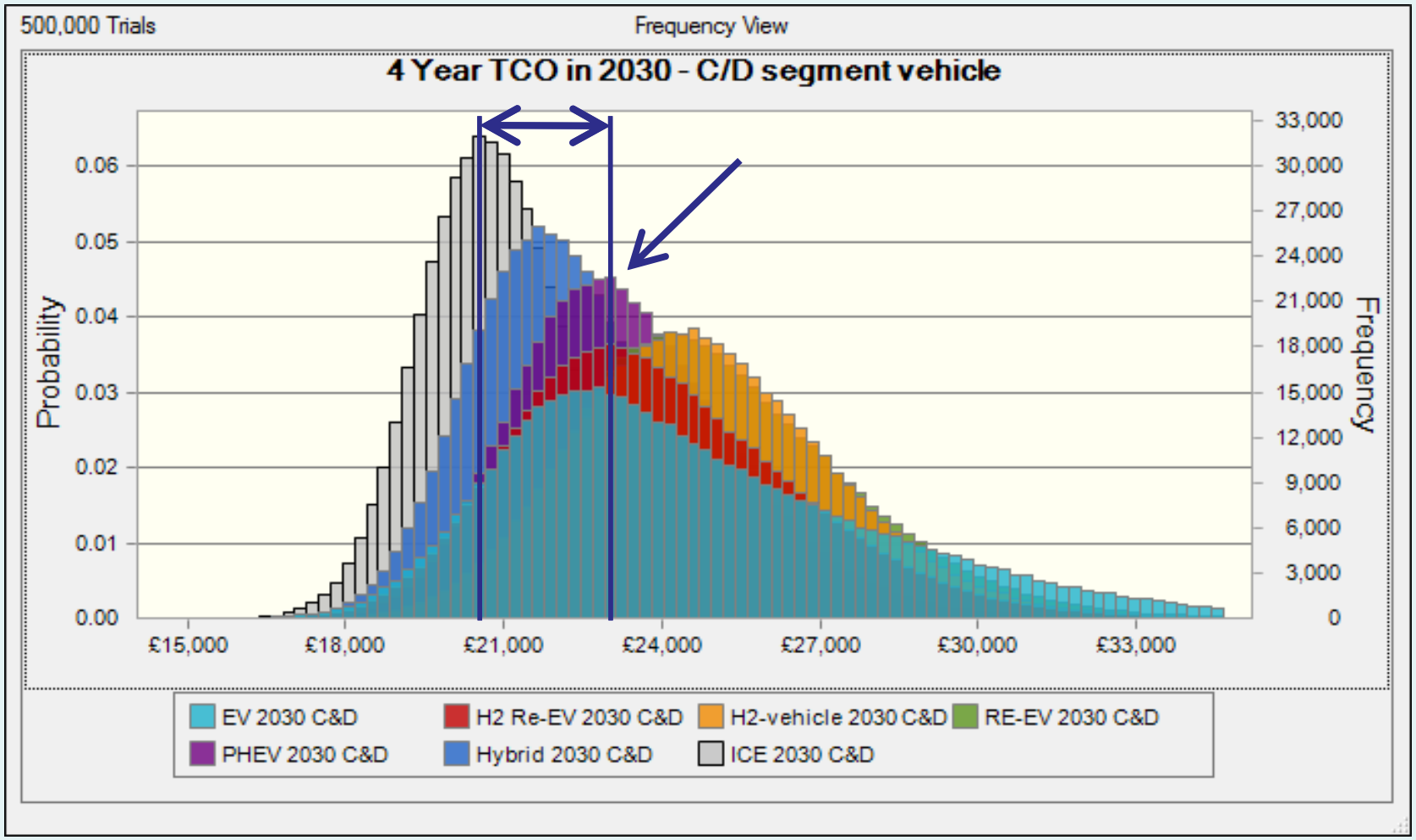
In the mass-market there is little willingness to pay for plug-in technology



ET1 2011, LowCVP Annual Conference

In 2030, the probability is that the Total Cost of Ownership of ICE vehicles will still be lower than ultra-low carbon equivalents *without policy intervention*

1st Owner TCO for a medium-sized car in 2030



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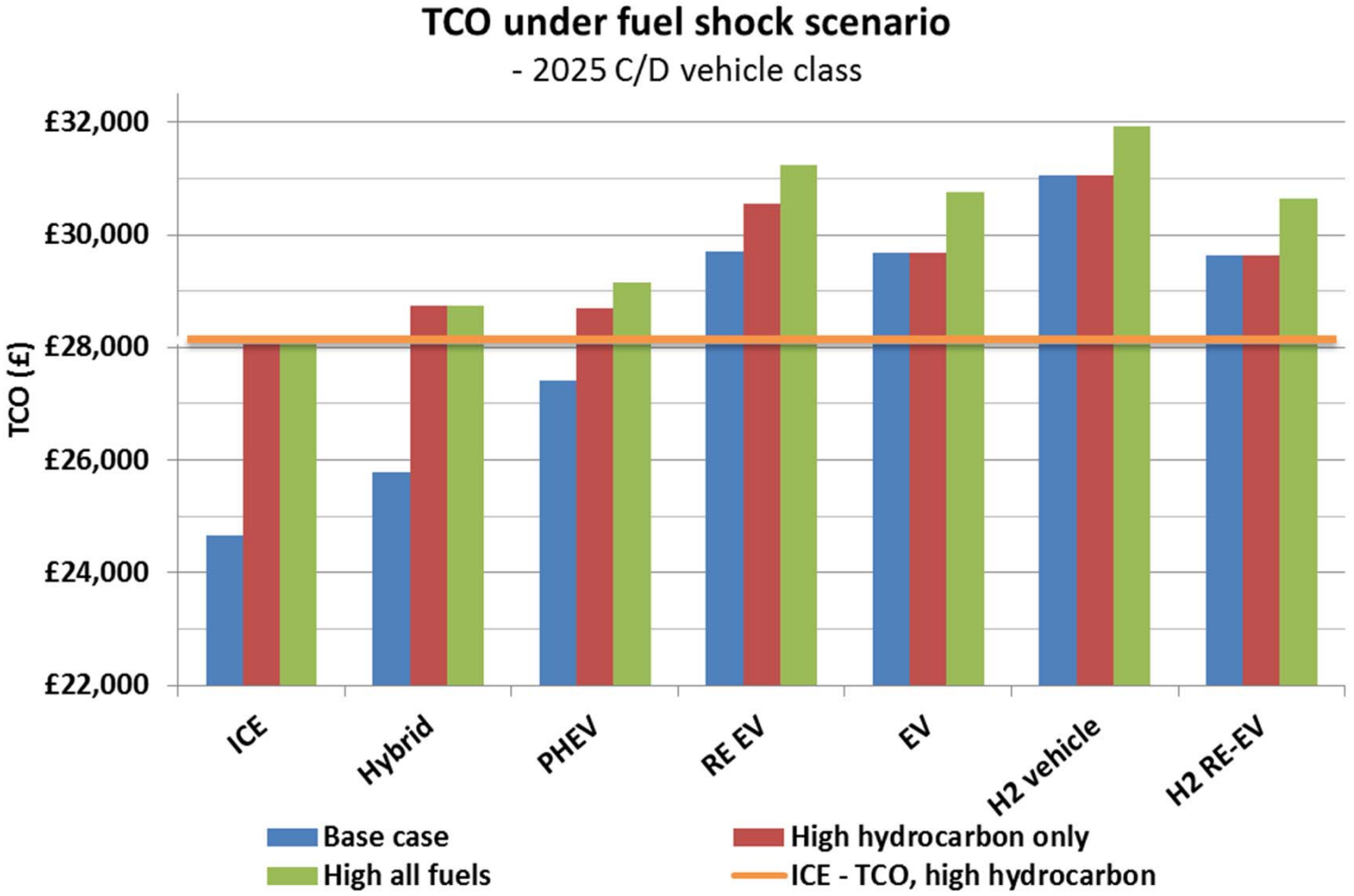
Element Energy, 2010

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



By2030 different fuel/powertrain solutions will be competing in each market sector

<table>
<tr><th>Fuel</th><th>Small car</th><th>Medium car</th><th>Large car</th><th>Light CV</th><th>Heavy CV</th></tr>
<tr><td>Biomethane</td><td></td><td></td><td></td><td>Dedicated</td><td>Dedicated & Dual Fuel</td></tr>
<tr><td>Electricity</td><td rowspan="3">BEV</td><td>BEV</td><td rowspan="3">HEV
PHEV
REEV</td><td>BEV</td><td rowspan="2"></td></tr>
<tr><td rowspan="2">HEV
PHEV
REEV</td><td>HEV
PHEV</td></tr>
<tr><td>Biofuel</td><td rowspan="2">Efficient ICE + biofuels blends</td><td>Efficient ICE + biofuels blends</td><td rowspan="2">Efficient ICE + biofuel blends</td></tr>
<tr><td>Oil</td><td colspan="2">HFCV</td><td>HFCV</td></tr>
<tr><td>Hydrogen</td><td></td><td colspan="2">HFCV</td><td>HFCV</td><td></td></tr>
</table>

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What would significantly stimulate adoption of ultra-low carbon ?

- High levels of fuel duty & public subsidy
- Purchase subsidies funded through a “gas-guzzler” tax
- Utility benefits for ULCVs (e.g., using bus lanes or restricted city centre access for ICEs)
- Development of “mobility services” providing high utilisation for ultra-low carbon vehicles and rental vehicles when required
- Cross-subsidy by electricity generators seeking off-peak markets for new renewable generation
- Battery ownership by electricity suppliers enabling vehicle to grid (house) supply
- Attractive 2nd & 3rd market applications for batteries
- Low insurance premiums

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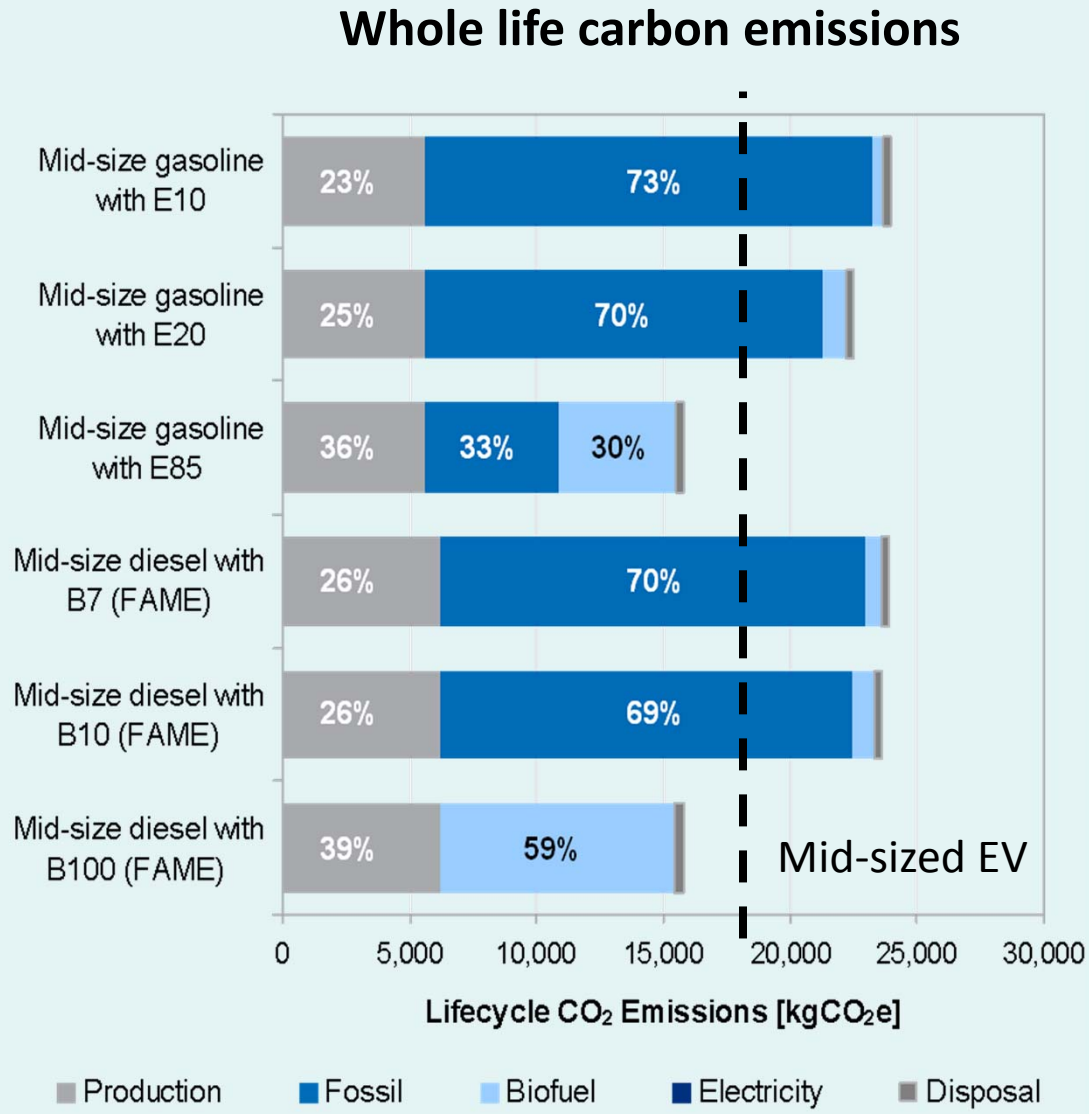
Gasoline and diesel vehicles have similar WLC emissions - increasing the biofuel significantly reduces well-to-wheel CO_2 emissions … assuming it can be sustainably produced

- 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

Final thoughts ....

- There are no silver bullets!
- Technology is politically seductive
- Vehicle and fuel technologies will become increasingly diverse
- Consumer awareness and interest must be raised
- UK support for EVs should not be diluted but complemented by support for: H2, biomethane & advanced biofuels
- EVs only provide ultra-low emissions with decarbonised generation and vehicle production and are not the only option
- EVs, fuel cells and biofuels are largely complementary solutions
- Partnership working is effective in increasing understanding & tackling market failings – join LowCVP!

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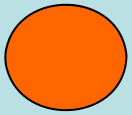
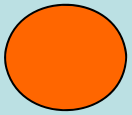
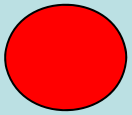
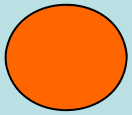
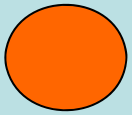
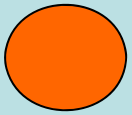
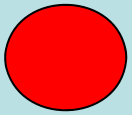
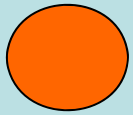
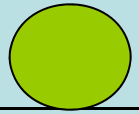
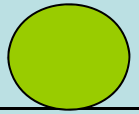
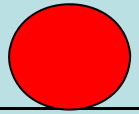
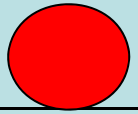
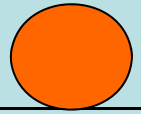
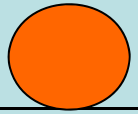
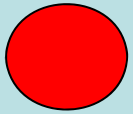
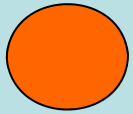
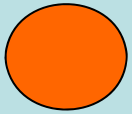
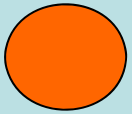
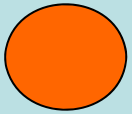
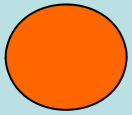
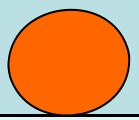
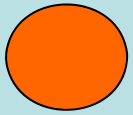
EV's have sufficient range for most daily journeys – but car buyers typically choose vehicles that meet exceptional needs

Cenex 2011, LCV11 Nissan Presentation

For alternative transport fuels to achieve widespread adoption they must meet 6 key criteria - there remain significant challenges with each option

	Current Biofuel	Adv. Biofuel	H2-IC	H2-FCV	Bio-CH4	EV
Technology readiness						
Cost competitiveness						
Vehicle availability						
Infrastructure deployment						
Driver acceptability						
Sustainability						

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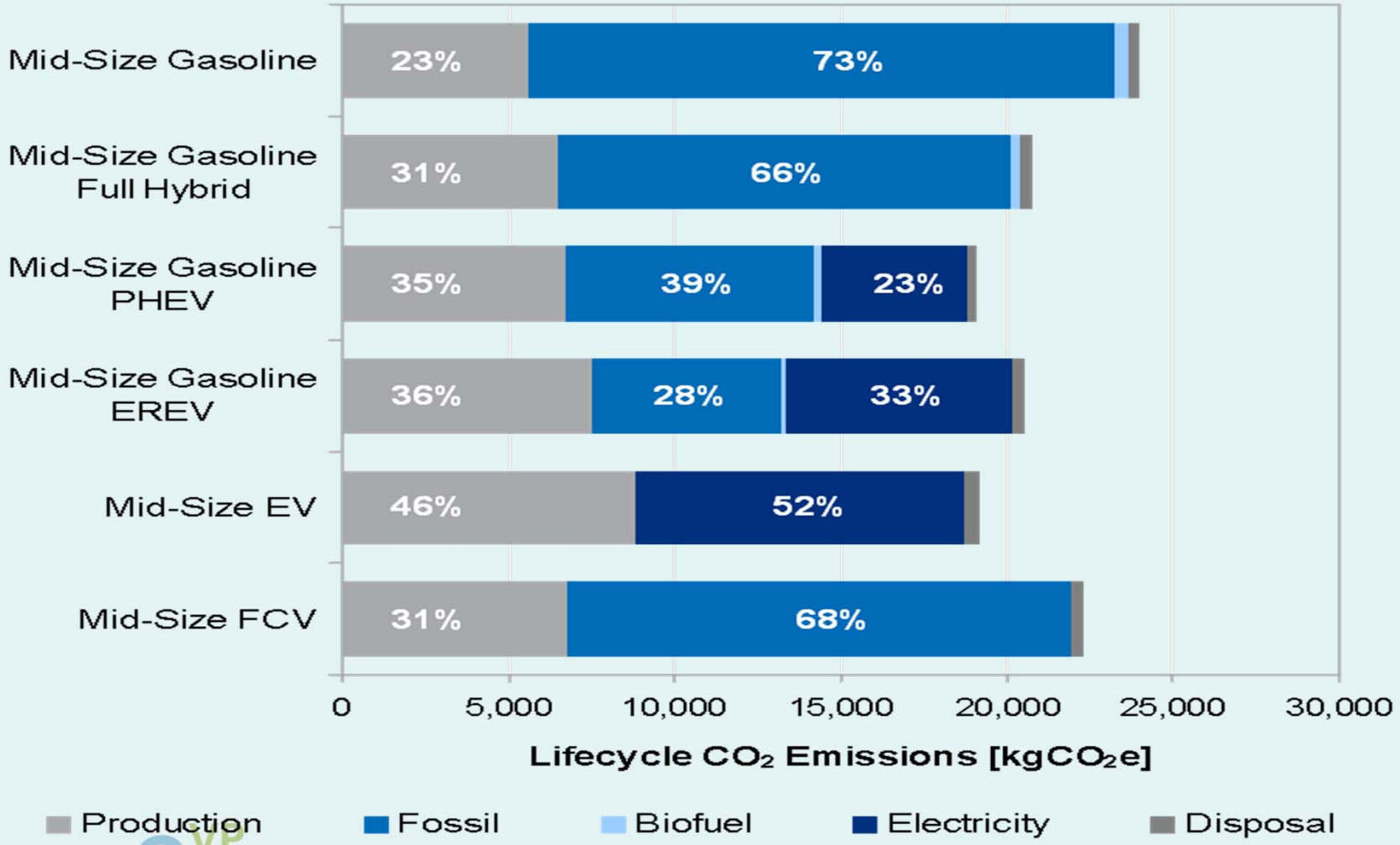
The relative scores do not represent LowCVP policy

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



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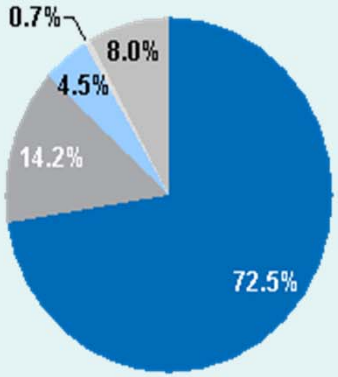
The technology evolution to plug-in vehicles will lead to higher embedded CO_2 emissions due to the addition of new components

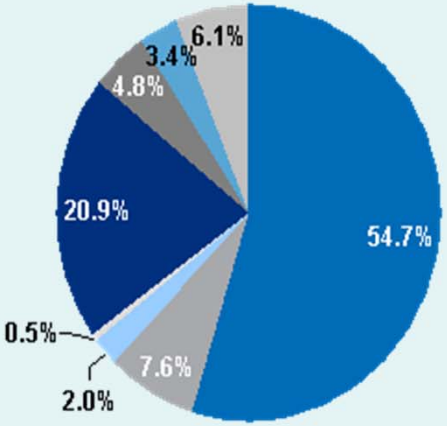
Embedded CO_2 Emissions [$kgCO_2e$]

Mid-Size Gasoline



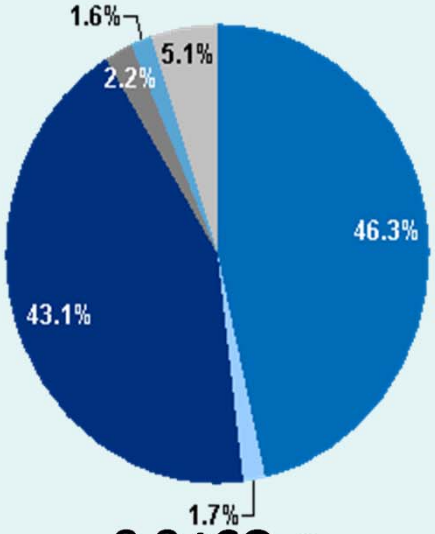
5.6 tCO_2e

Mid-Size Gasoline EREV



7.5 tCO_2e

Mid-Size EV



8.8 tCO_2e

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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