Influences on the market for low carbon vehicles 2020-30

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Element Energy

Low CVP conference 2011

About Element Energy

London FC bus, launched December 2010

Riversimple H2 car

Racing Green Endurance BEV

Element Energy applies world class analytical, technical, financial and quantitative thinking to the complex issue of sustainable energy

We help our clients to create policies, strategies and products to decarbonise energy generation, transport and the built environment

http://www.element-energy.co.uk

Comprehensive services to the transport Sector from technology evaluation to project implementation

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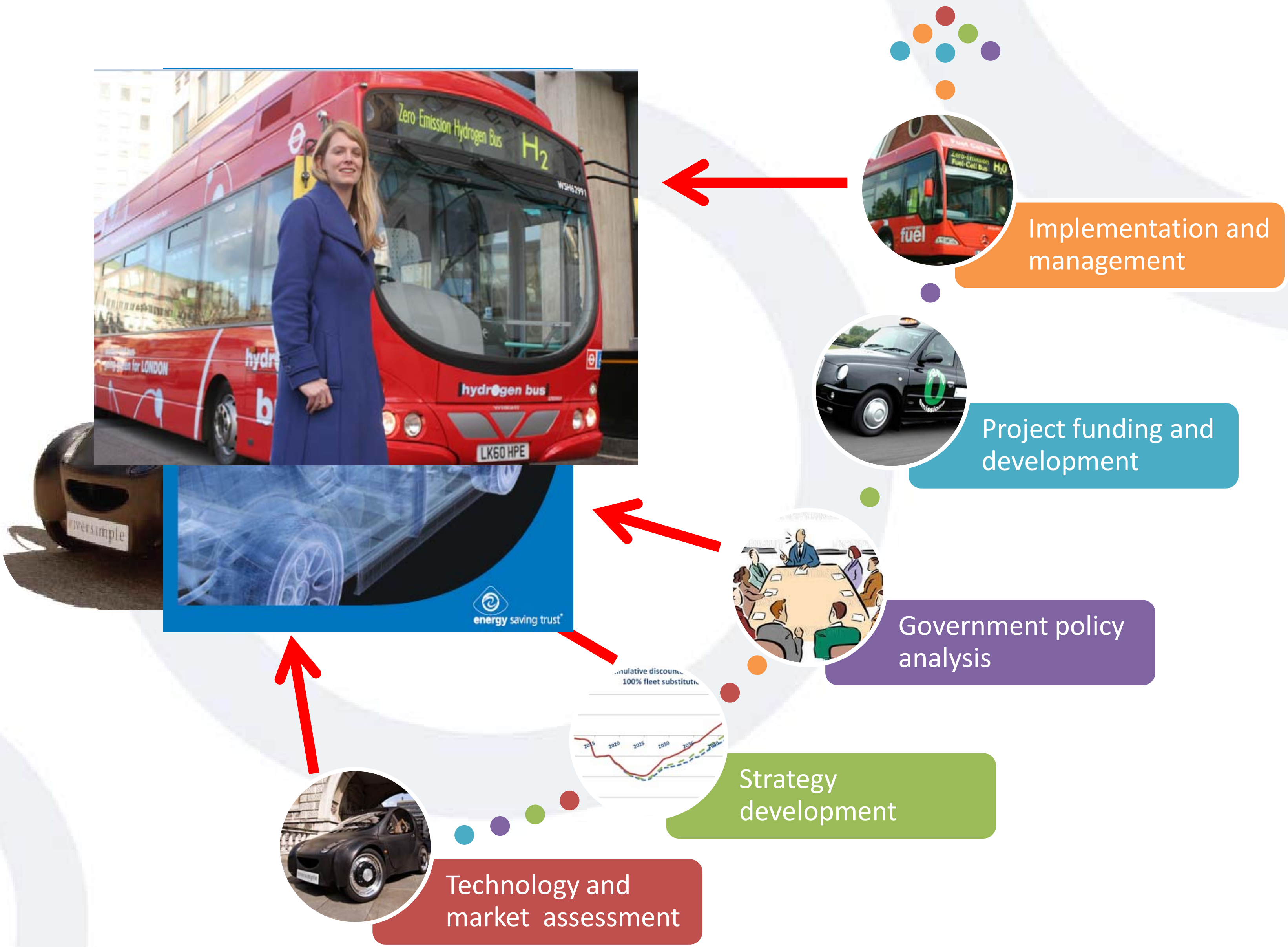

Our Clients

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Central /local government

Department of Energy & Climate Change

Department for Transport

European Commission

Transport for London

LowCVP low carbon vehicle partnership

iea International Energy Agency

Committee on Climate Change

City of Westminster

Energy

EDF Energy

British Gas

UK Power Networks

Scottish and Southern Energy

e.on UK

Manufacturers

riversimple

Hyundai

Daimler

Intelligent Energy

Rolls-Royce

Ballard

Ceres Power

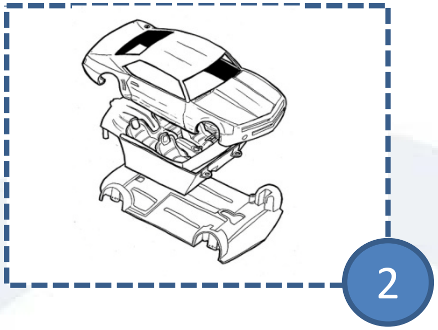
Background

The LowCVP commissioned Element Energy to conduct a study on the total costs of ownership (TCO) for low carbon vehicles in the period 2020-2030.

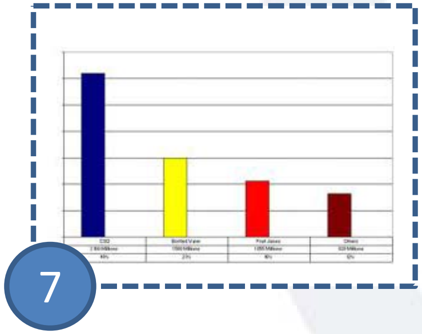
Primary Objectives:

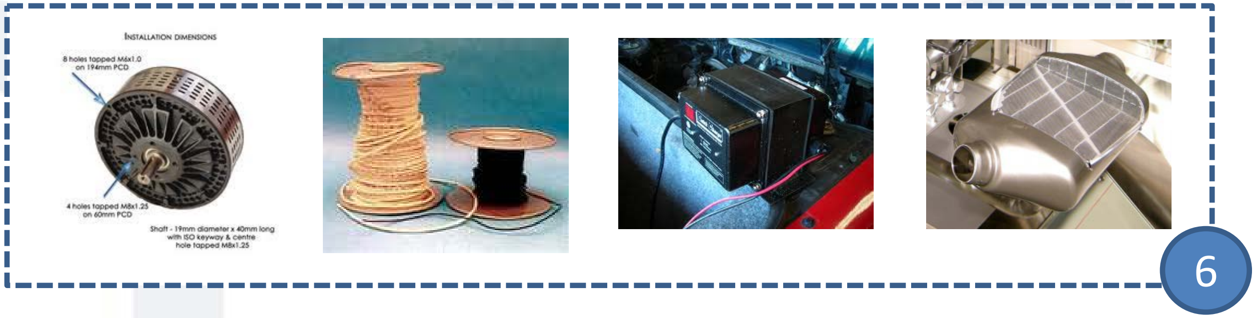
- Identify how future vehicle drivetrains will compare on a TCO basis.
- Identify the required changes in cost and performance to make low carbon vehicles a compelling alternative for a wide range of consumers.
- Identify policies which would be effective in closing the TCO 'gap'
- To show the effect of 'disruptive' events, such as rapid technology improvement, oil price spikes etc.
- To assess the lifetime cost of CO_2 abatement from novel vehicle powertrains, using a whole life cycle approach.

Capital cost model is based on 7 main components:



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





Pictures source: internet / various copyrights

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

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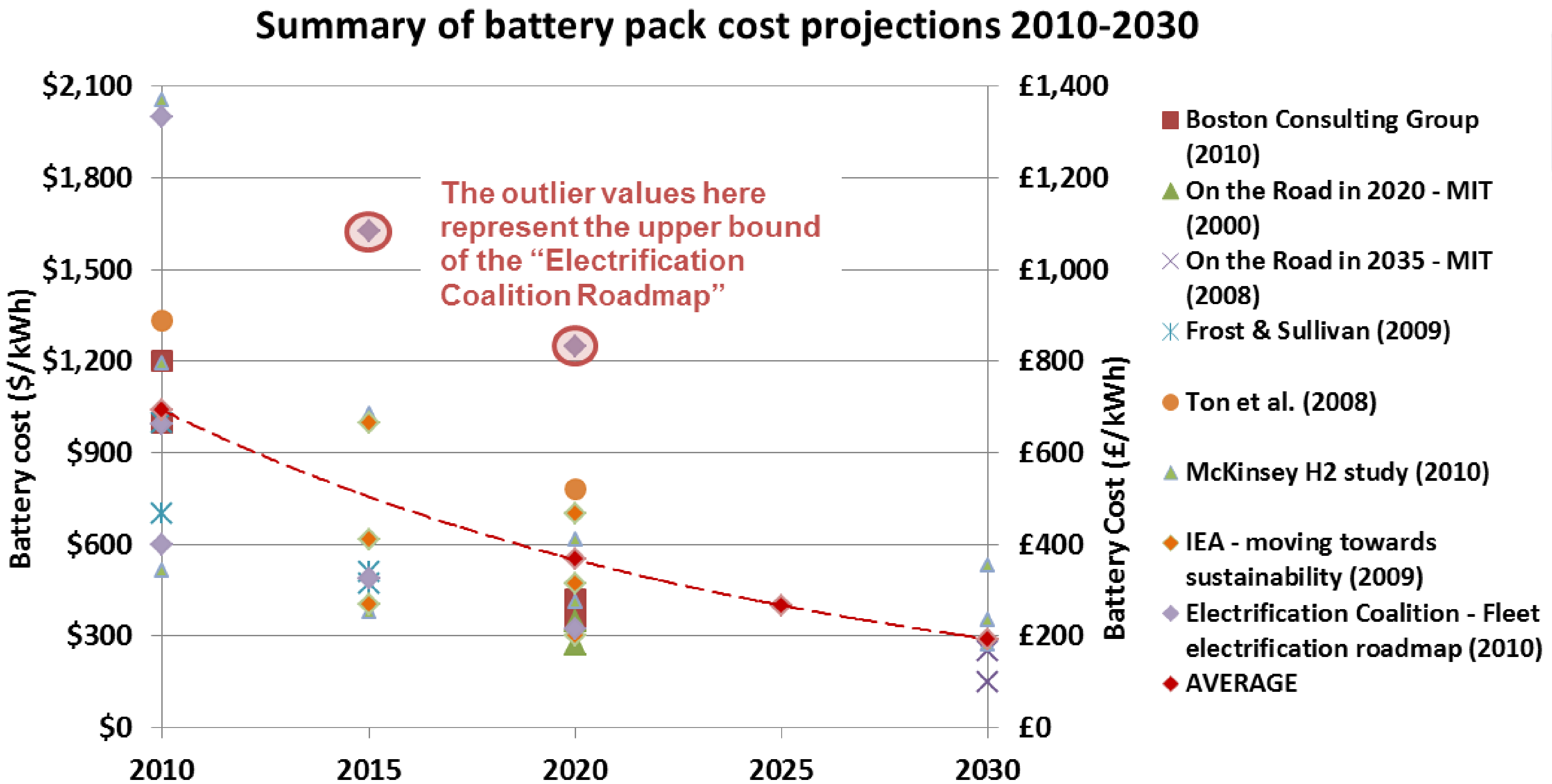
Battery costs through time £/kWh	2010	2020	2025	2030
Best Fit Value	£693	£367	£267	£194
Low	£342	£181	£141	£100
High	£1,369	£833	£681	£530



NOTE: the graph is displaying results in both $ and £ , an exchange rate of 1.5 was used to convert $ values to £

Fuel Cell system cost projections: based on 6 major publications (incl. Concawe, MIT, McKinsey, HyWays)

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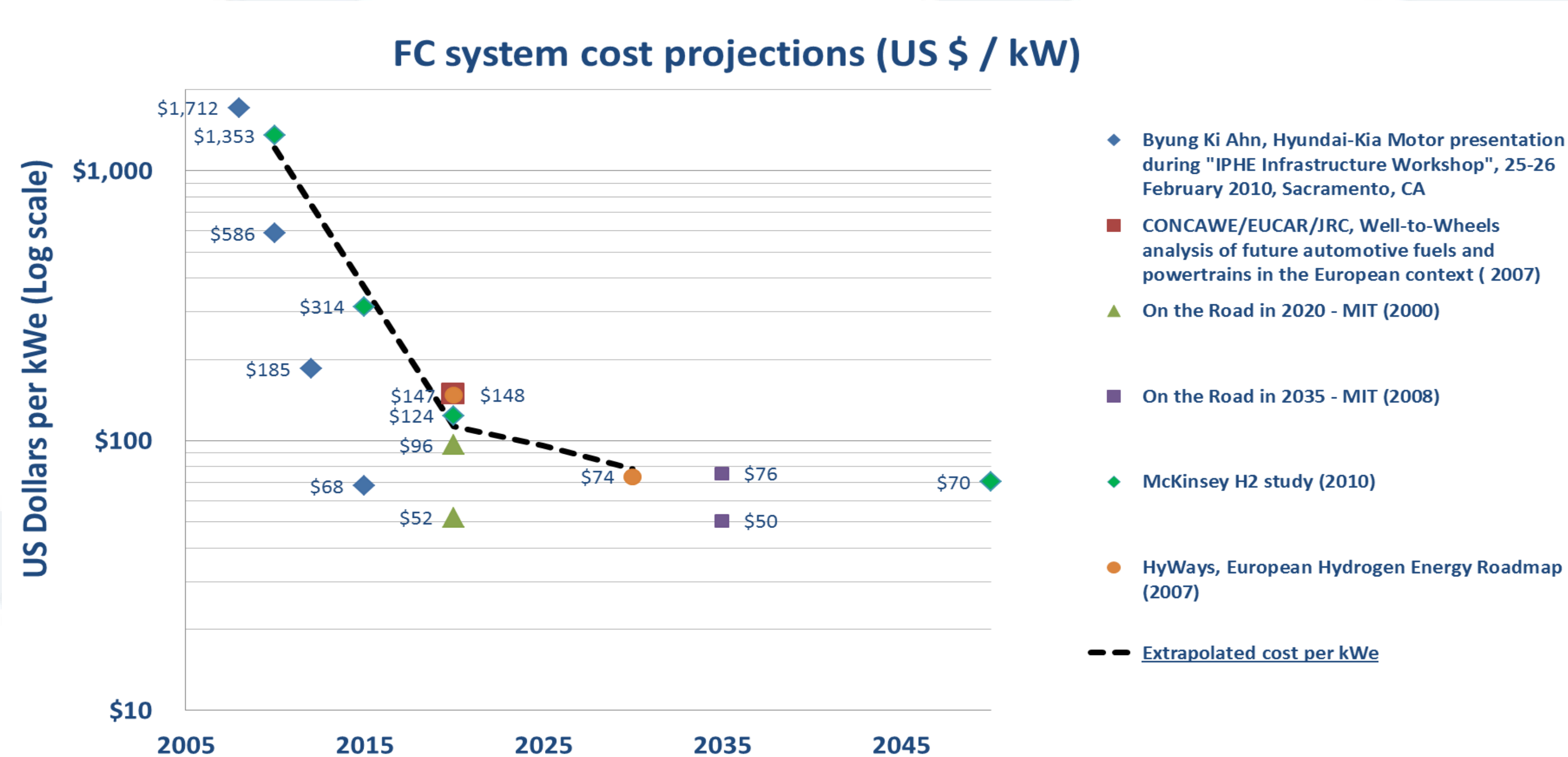
Fuel cell costs are heavily dependent on assumptions on future production volumes.

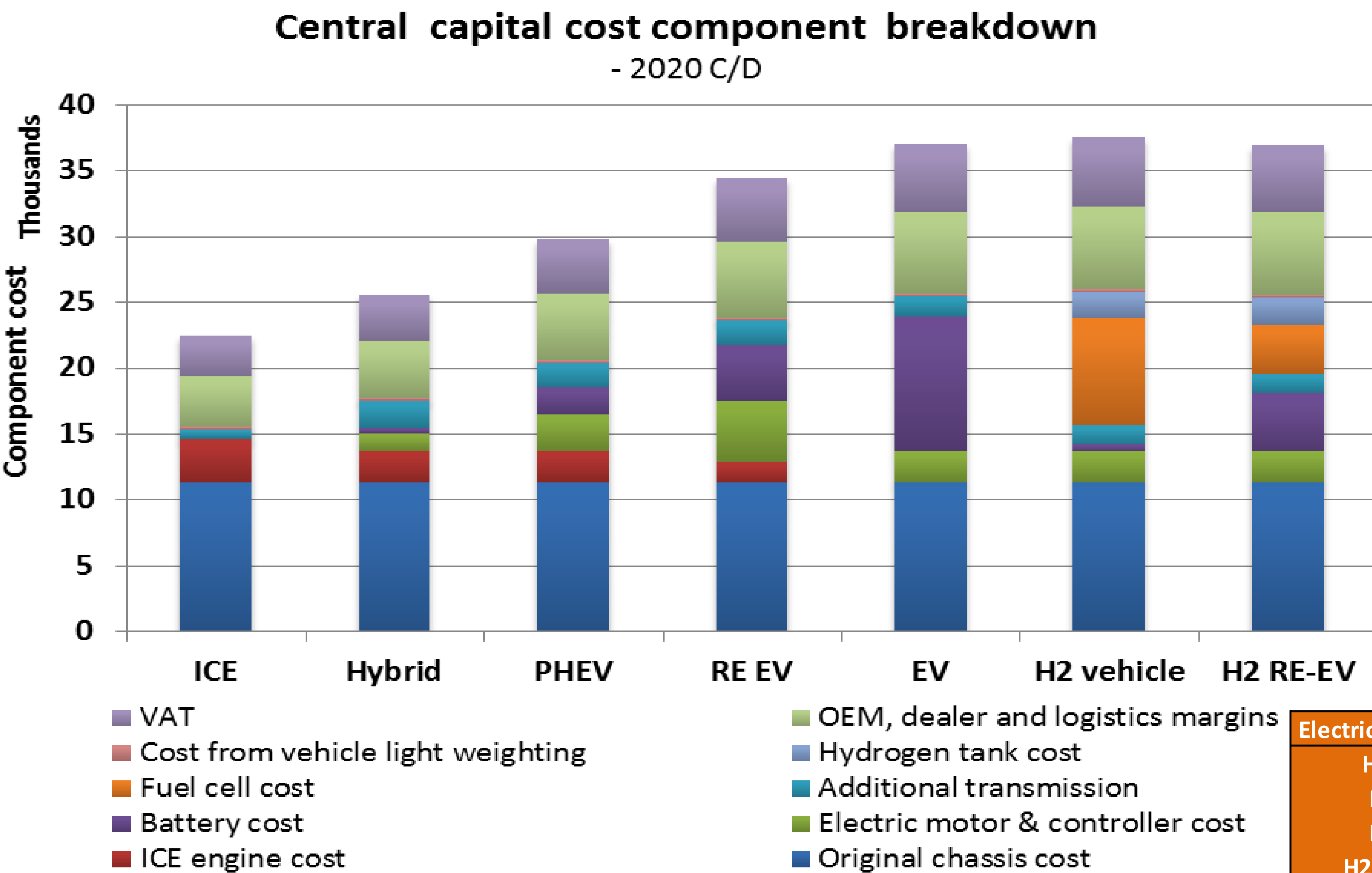
fuel cell 'system' costs through time £/kW	2010	2020	2025	2030
Best Fit Value	£811	£75	£64	£53
Low	£391	£35	£34	£34
High	£902	£99	£71	£70

Assumes a volume of approx.100,000 per OEM

Assumes a volume of approx.500,000 per OEM



Medium 2020 CAPEX results



Electric range (km)	2020
Hybrid	2
PHEV	30
RE EV	60
H2 vehicle	2
H2 Re-EV	60
EV	200

Medium 2030 CAPEX results

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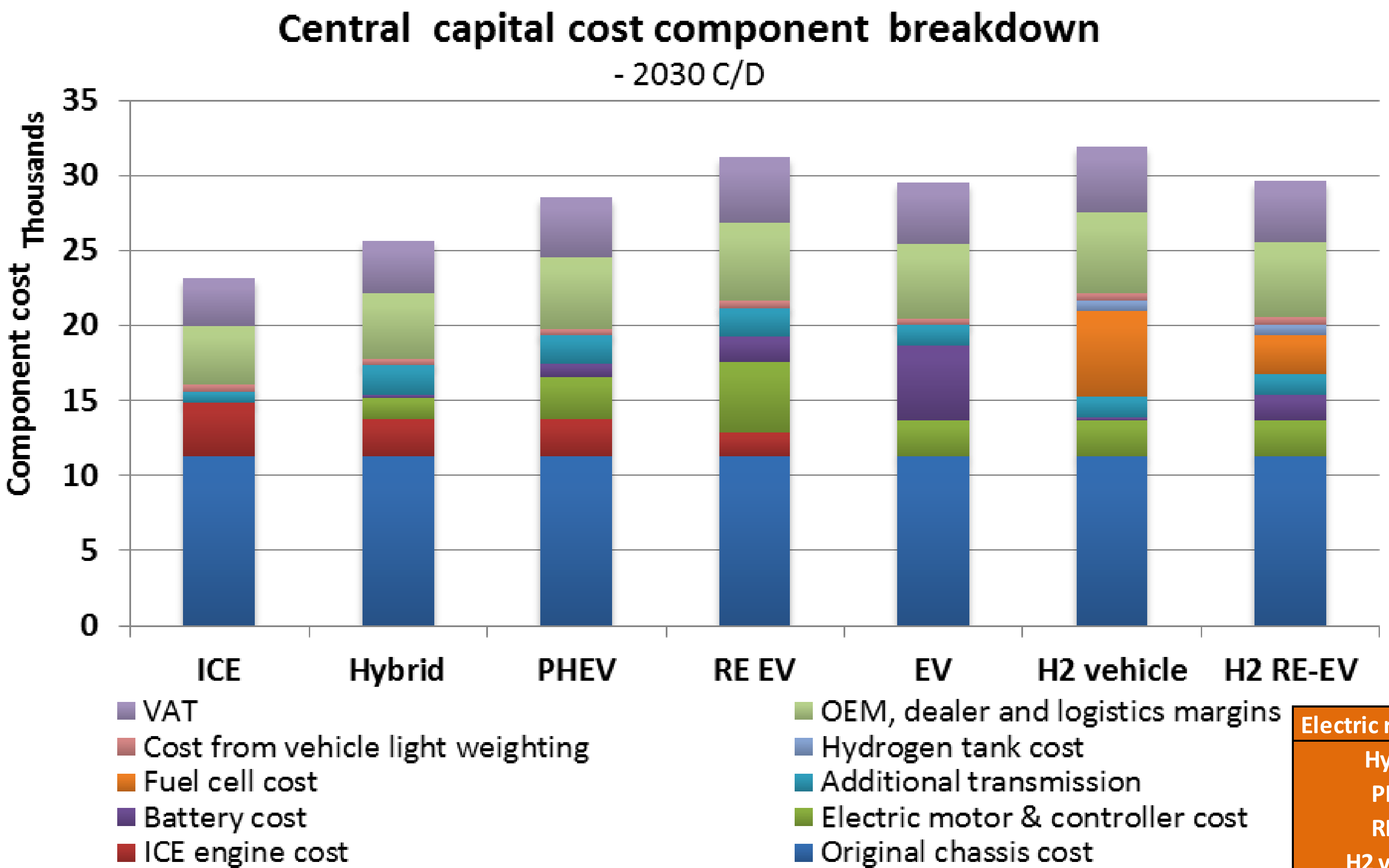

Electric range (km)	2030
Hybrid	2
PHEV	30
RE EV	60
H2 vehicle	2
H2 Re-EV	60
EV	240

The effect of electric range on tailpipe emissions

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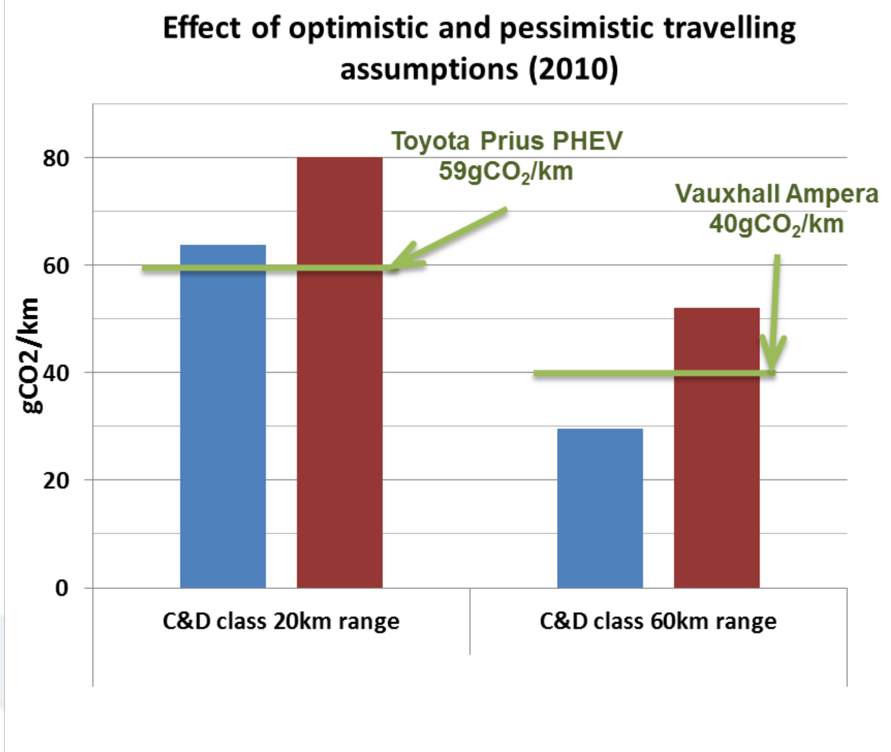
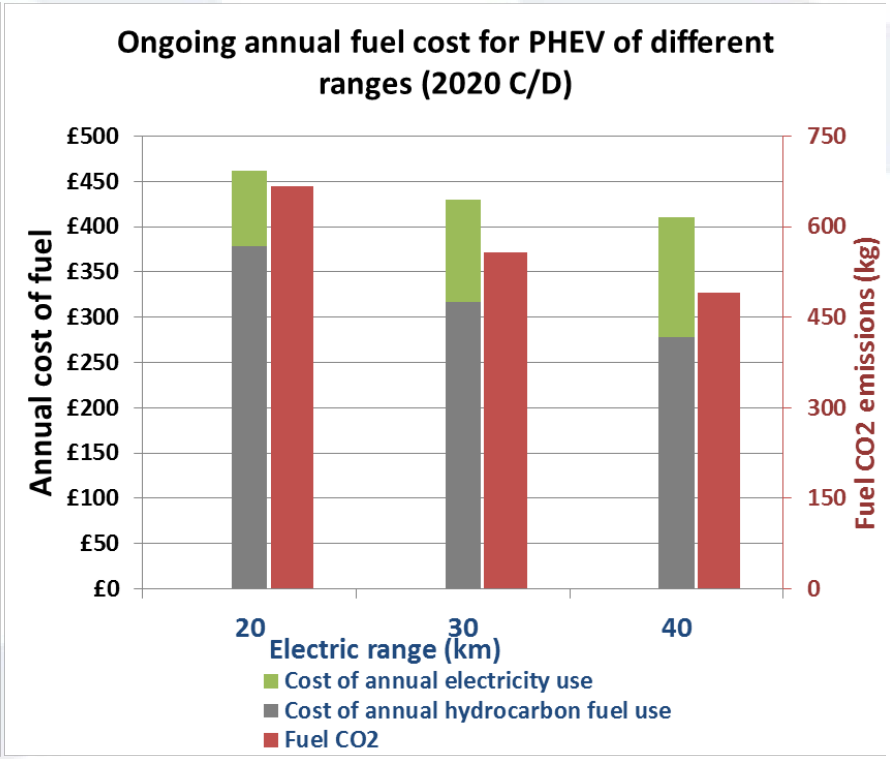
- Tailpipe emissions for plug-in hybrids and RE-EVs are based on the proportion of annual driving distance that can be covered using electricity (from National Travel Survey data)
- Two scenarios used to account for whether vehicles can recharge at the end of each trip (i.e. widespread charging infrastructure) or only at the end of the day (home charging only).





Note: CO_2 emissions are 'tailpipe' values and do not include CO_2 emissions from electricity production

Insurance costs for new, non-conventional vehicles are likely to be in the upper range at their market entrance

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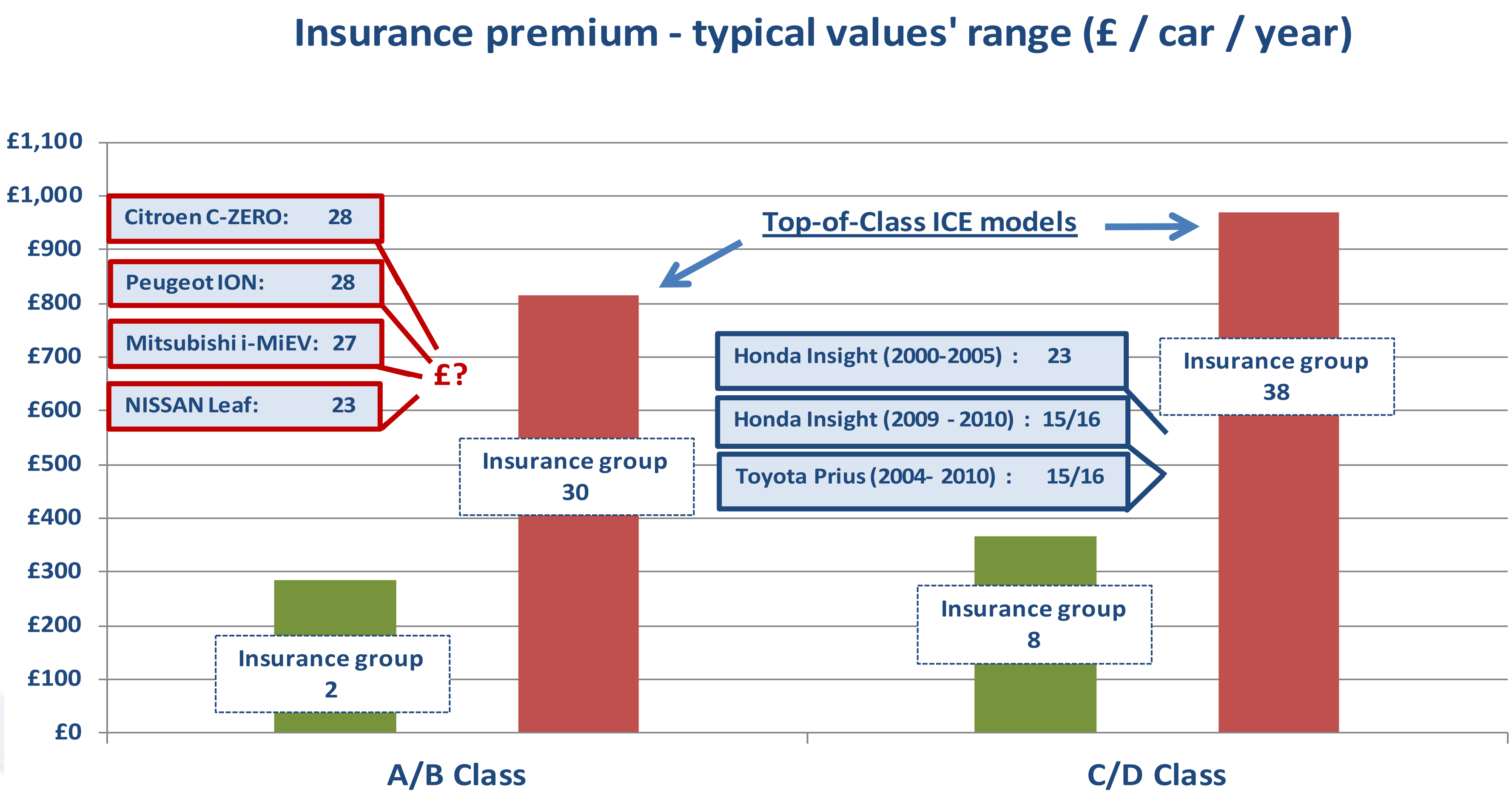
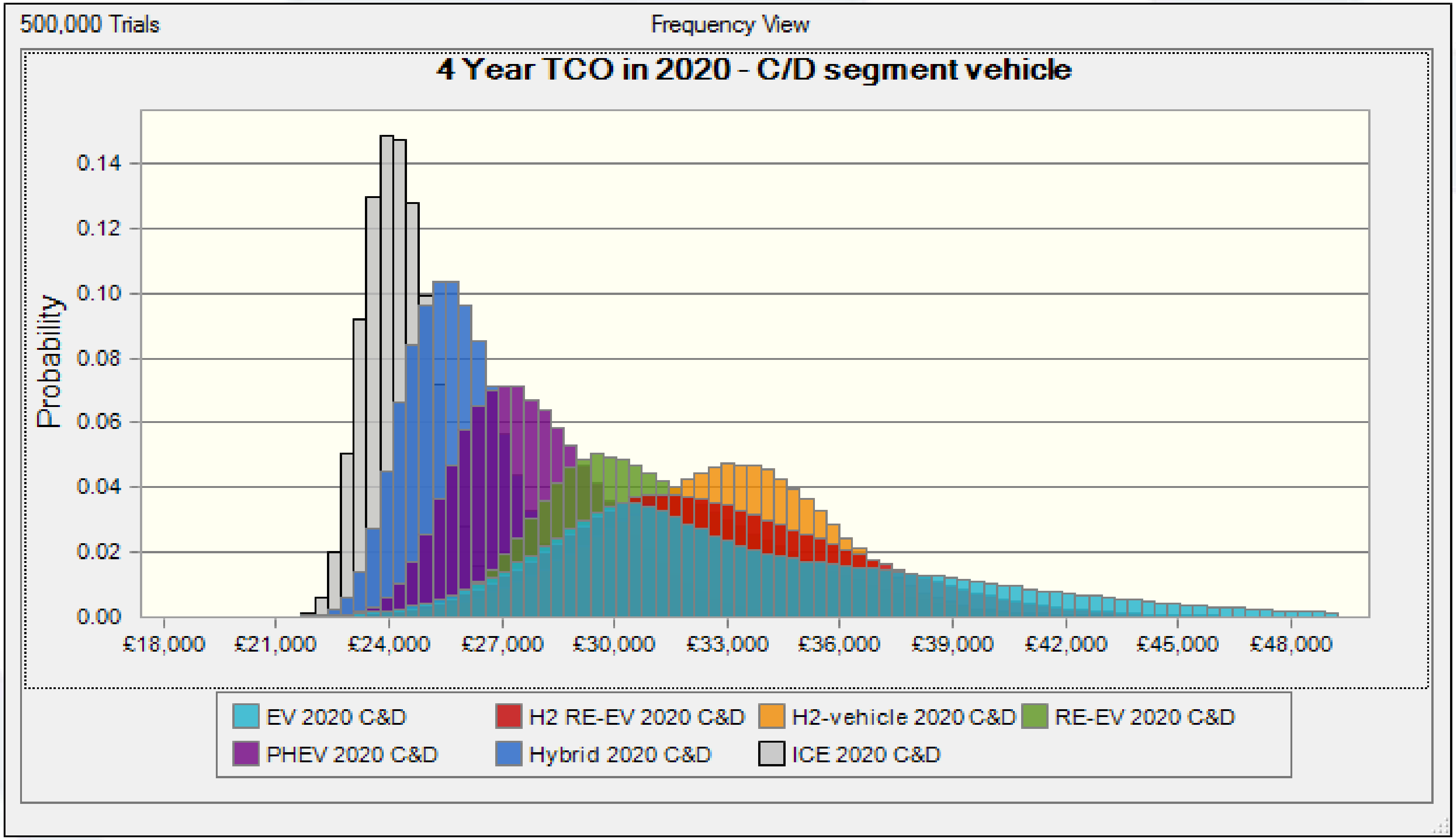


Data adapted from http://www.whatcar.com/ , http://www.thatcham.org/

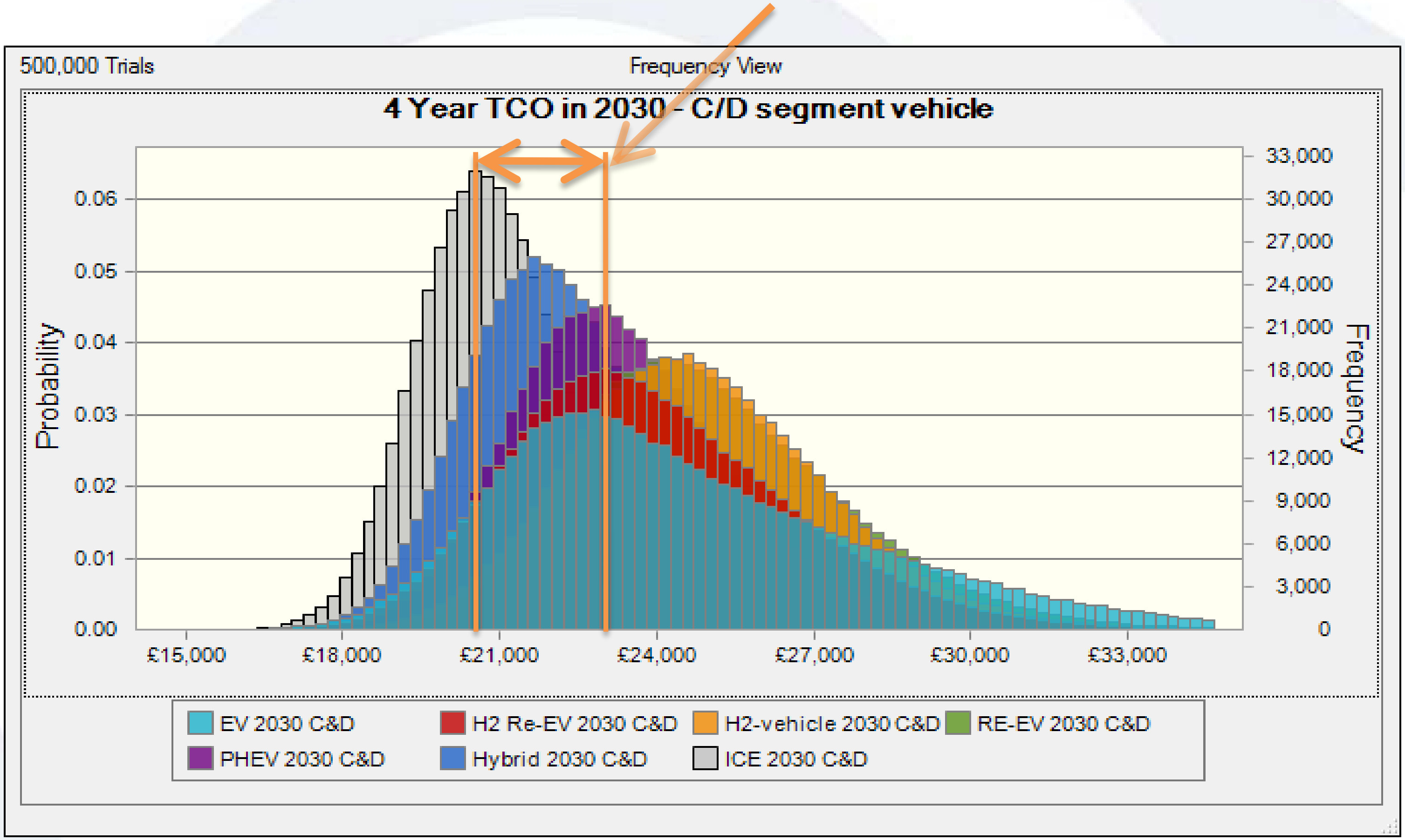
Results: 2020 C/D vehicle class - 4 year TCO

- ICE and hybrid vehicles still have the lowest 4 year TCO in 2020.
- The PHEV's TCO is c. £3k over the ICE; RE-EV and pure EV have c.£5.5k premium.
- Long 'tail' for the pure EV is due to uncertainty on battery prices.

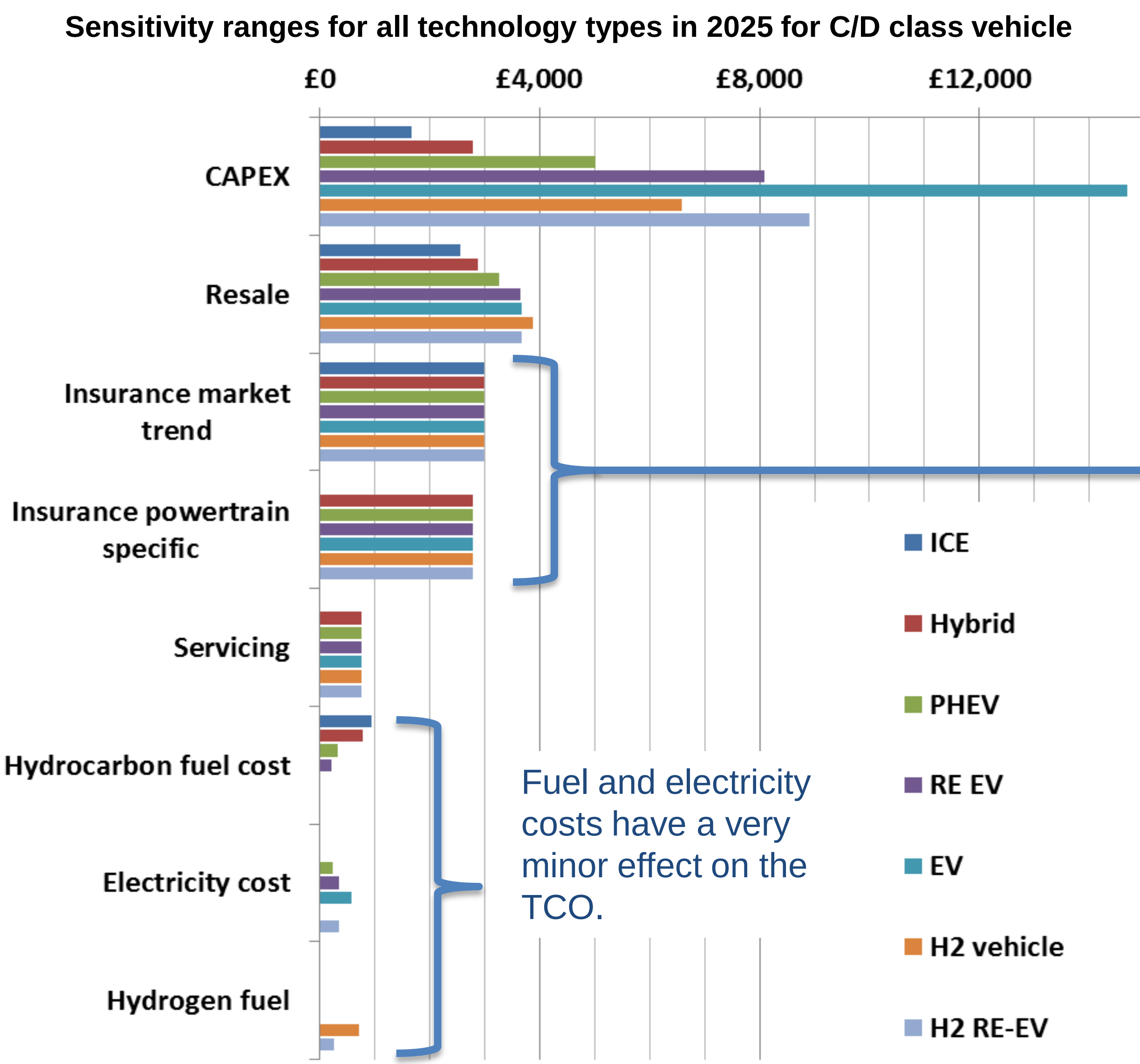


Results 2030 C/D vehicle class - 4 year TCO

- 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.



Effect of cost components on the TCO
2.5% and 97.5% confidence levels used



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.

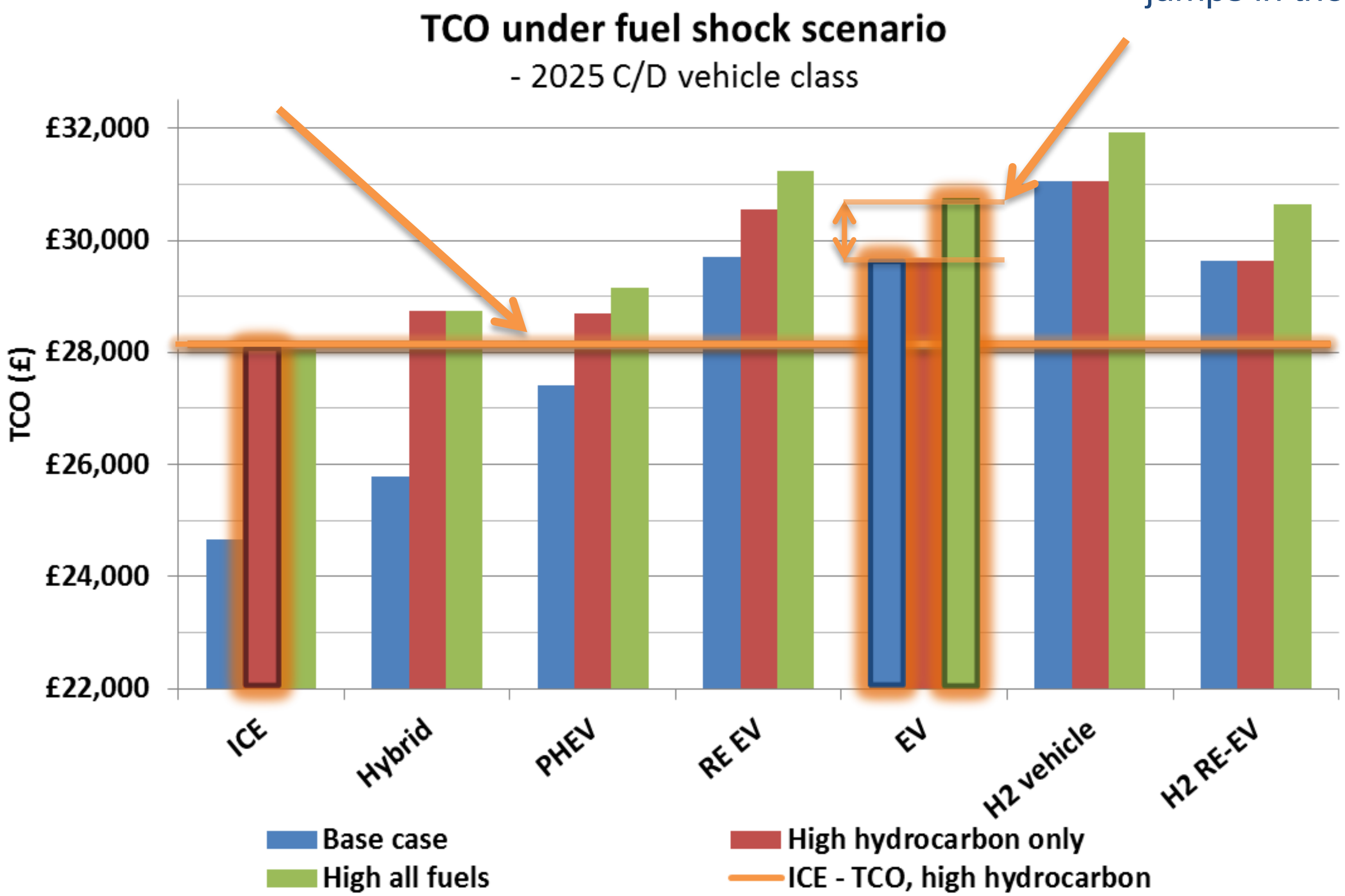
Fuel and electricity costs have a very minor effect on the TCO.

Effect of fuel price shocks

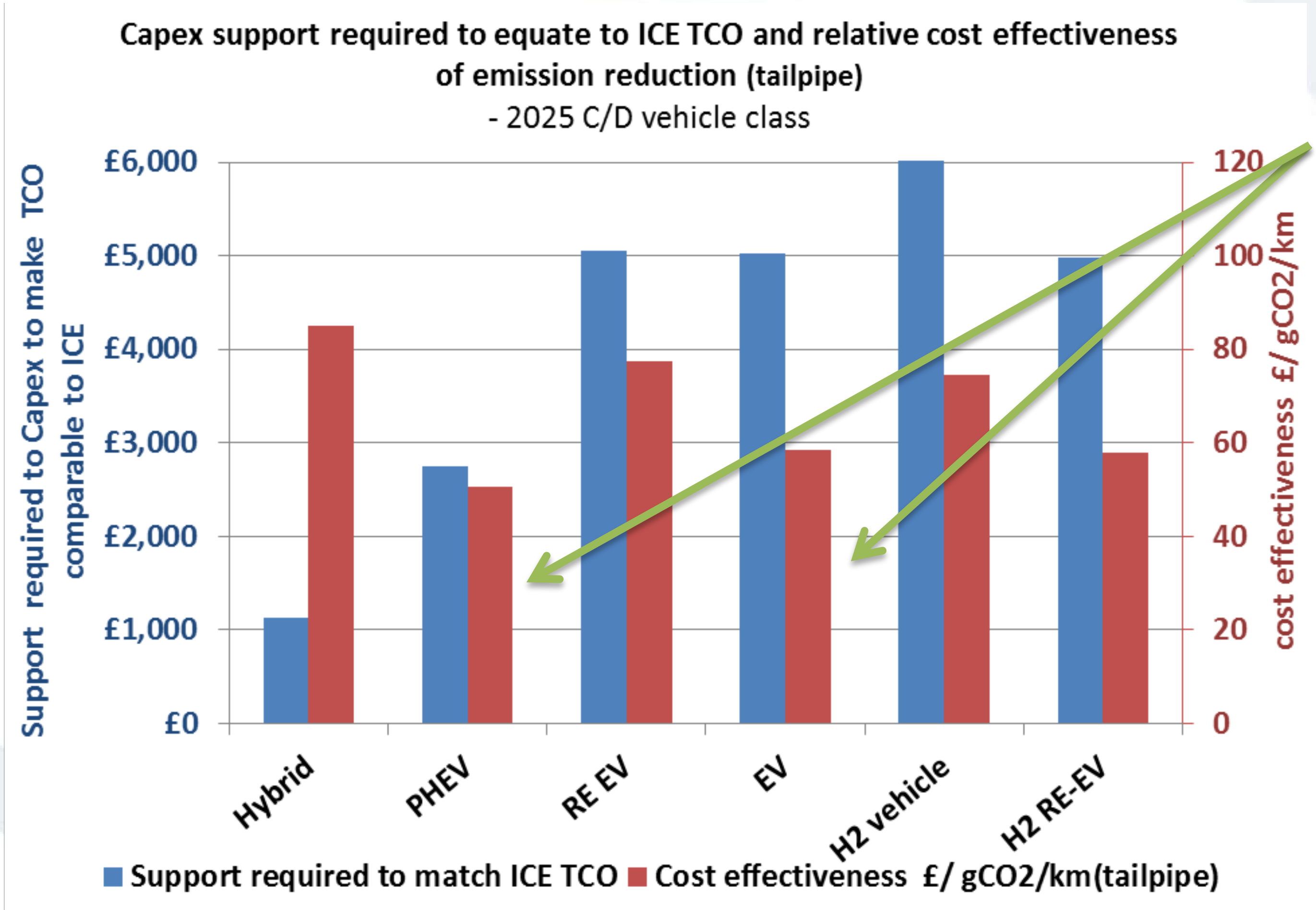
Hydrocarbon Fuel	Electricity	Hydrogen
£3 /l	40p /kWh	£8 /kg

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

Pure electric vehicle relatively insensitive to large jumps in the electricity price



Cost-effectiveness of support for low carbon vehicles (based on tailpipe emissions)



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.

Cost-effectiveness of support (inc. electricity and H_2 production emissions)

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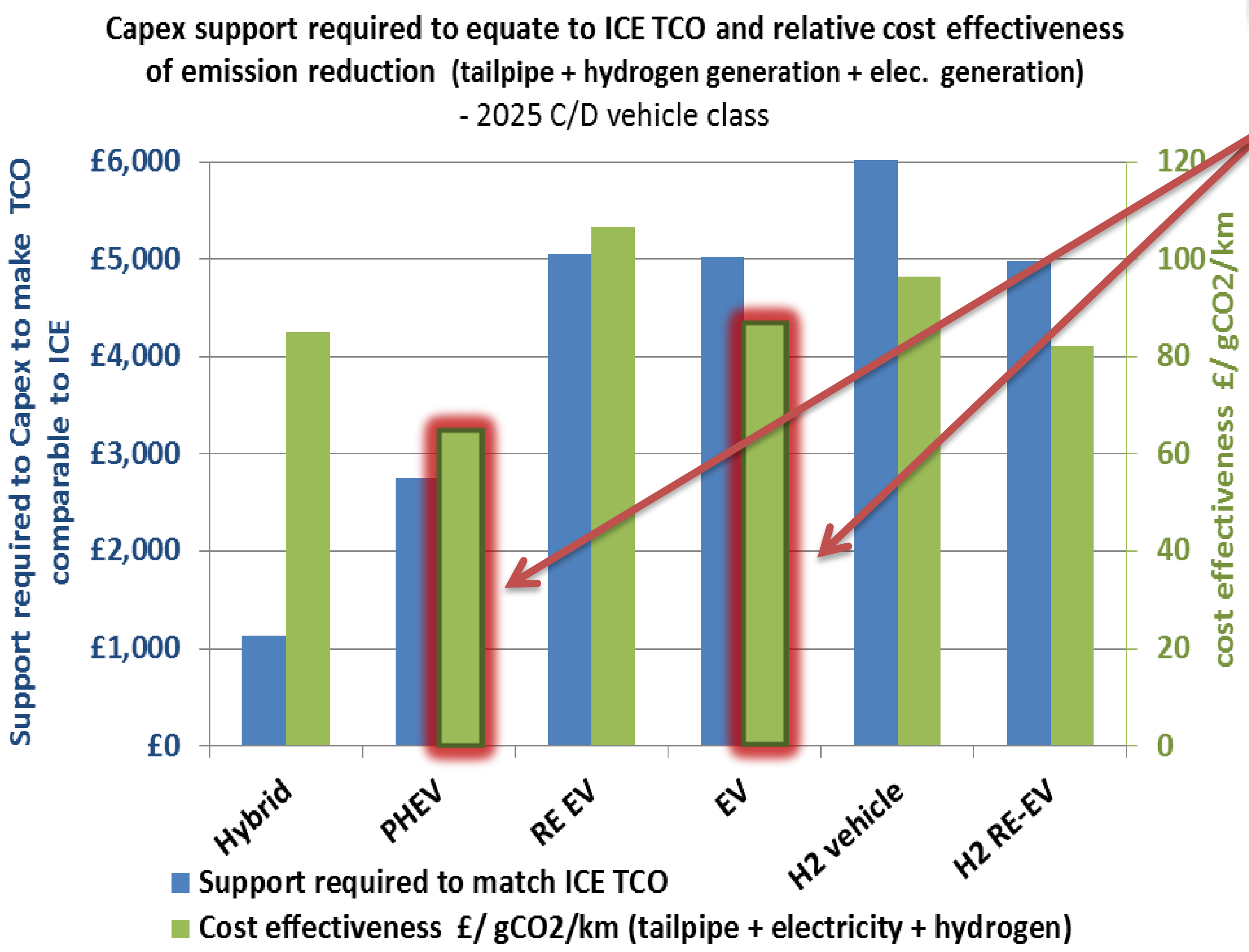

When considering the total emissions from the fuel, PHEVs still have a better cost effectiveness than EVs.

Assumes a grid intensity of 0.27kgCO_2/kg and hydrogen production emissions of 4.5kgCO_2/kg

Challenges for the introduction of Ultra Low Carbon Vehicles

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- Differences in TCOs between ICE and Plug-in and H_2 vehicles will fall substantially between 2011 and 2020.
- Capital cost and total cost of ownership for ULCV likely to remain challenging over the period to 2030.
- Long term incentives required. What is the exit strategy for current support (e.g. plug-in car 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.
- No significant difference in the cost effectiveness of CO_2 savings between PHEV and pure EV – PHEVs/RE-EVs could play a dominant role in decarbonising transport rather than being only an ‘interim’ solution.