



How far can Hybrids take us?

A view of Low Carbon
vehicle technology from the
UK perspective

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Hybrids offer an evolutionary path to environmental sustainability providing attractive products to consumers using existing industry infrastructures



Advanced conventional powertrain technology (down-sized engines, efficient automated transmissions, and advanced control) can continue to offer environmental improvements. However, they alone are not enough to achieve desired levels of CO₂ reduction

Significant reduction in vehicle weight will not be achieved for 10-20 years, due to customer demand for safer, bigger cars

Alternative, low carbon fuels remain too costly for high volume use, and many require massive changes in infrastructure and vehicle technology

Technology is required which complements the evolution of conventional powertrains, while enabling further efficiency gains until a global sustainable energy infrastructure is available

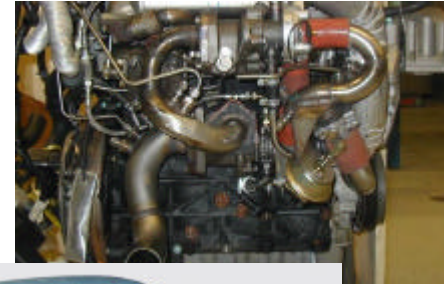
- This technology must be attractive to customers and cost-effective

In an environment where CO₂ reduction is a major goal, evolutionary introduction of Hybrid technology meets these needs

Conventional powertrain technology can continue to offer improvements, but is not sufficient for the challenges beyond this decade



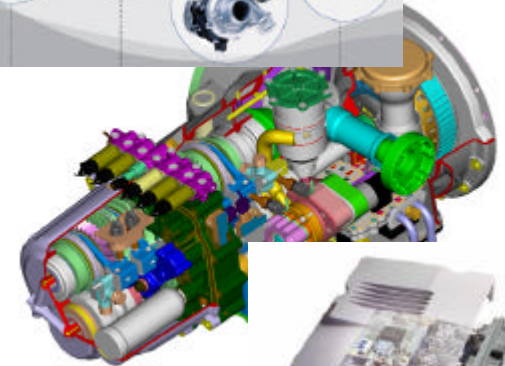
Clean Diesel engines offer 25%+ CO₂ improvement over a conventional Gasoline; down-sizing via advanced turbocharging technology offers perhaps 10-20% more improvement



New gasoline engine technologies will however close the gap with Diesel, and cost less to make - for example Ricardo's Lean Boost system offers Diesel CO₂ at 80% of the unit cost



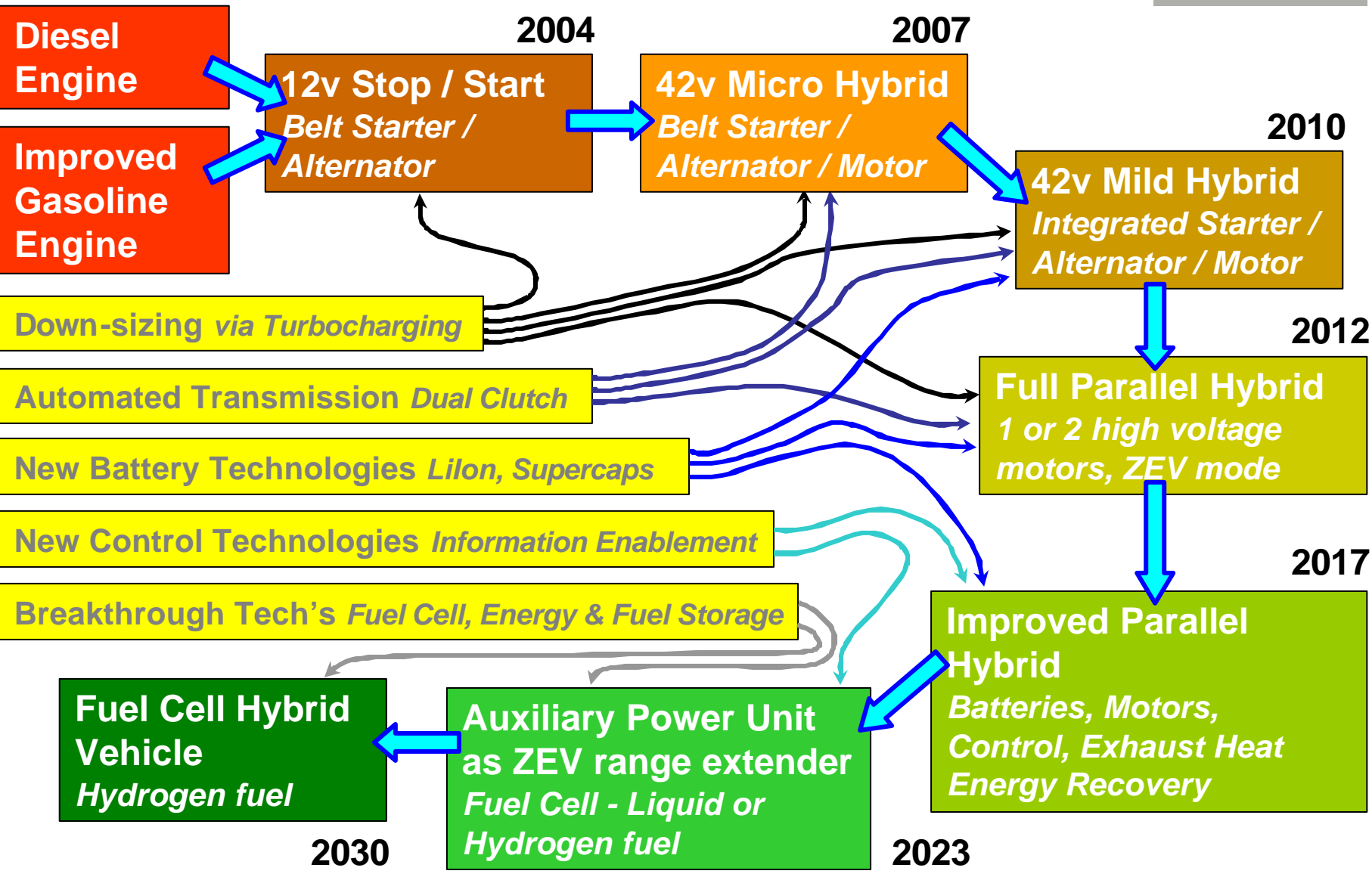
Efficient automated transmissions can offer up to 5-8% CO₂ reduction, can enable down-sized engines to be more driveable, and are attractive to customers on our more congested roads



Advanced control technology allows the vehicle to operate as an integrated whole, and ultimately be more efficient by knowing what lies ahead -via GPS / map or telematics information



Hybrid powertrains offer a low carbon route to hydrogen Fuel Cell vehicles in the medium term

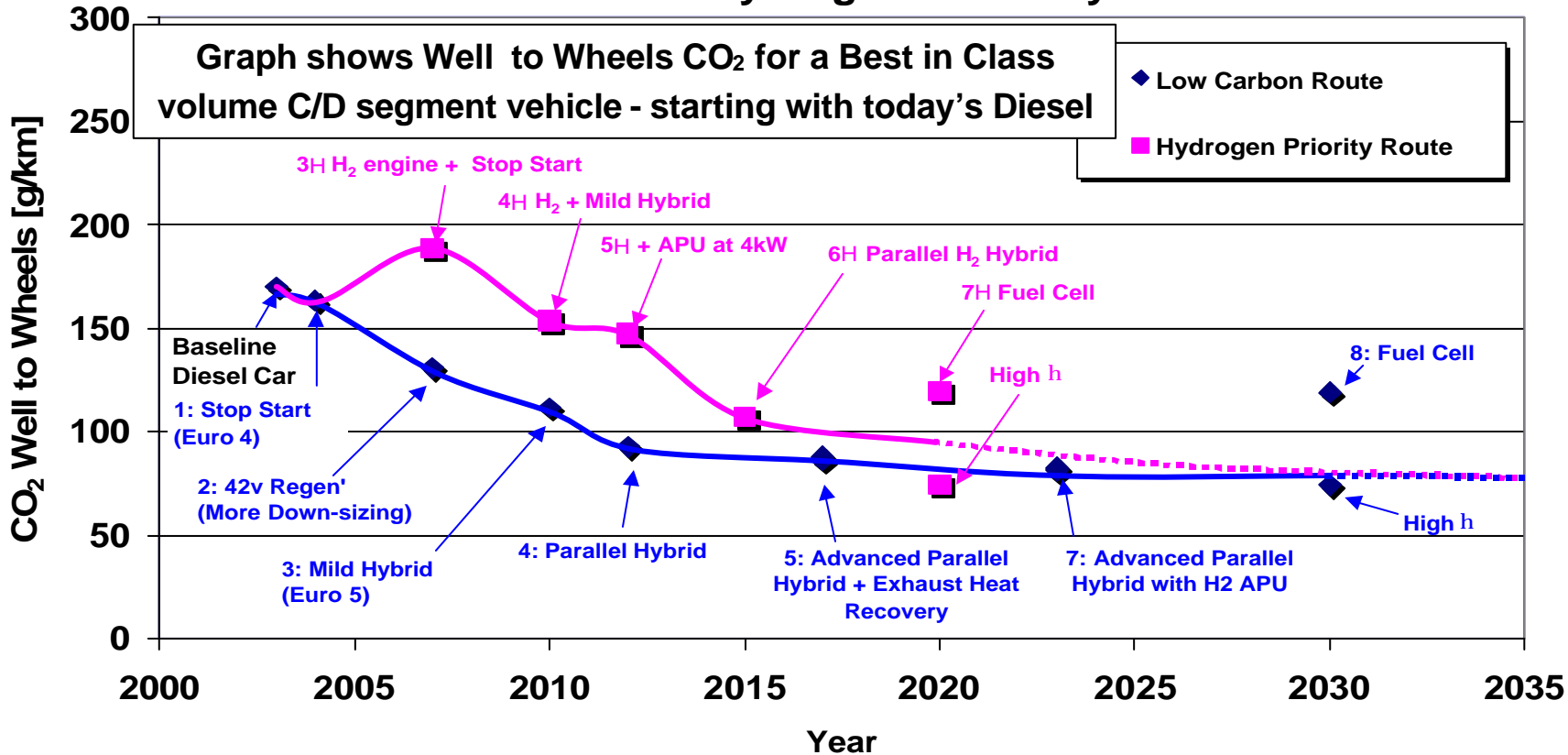


This analysis by Ricardo for the UK's DfT and DTI shows that the "Low Carbon Evolution" is preferable to volume introduction of Hydrogen



- Fuel Cell** not ready for economic high volume introduction until 2020-2030, so IC engine is only volume Hydrogen prime mover until then
- Hydrogen** assumed made from Natural Gas - Limited renewables offer bigger environmental gains if used outside the transport sector

Routes to a Hydrogen Economy



In Europe, the Hybrid has a role as a volume low-carbon vehicle, not a niche product



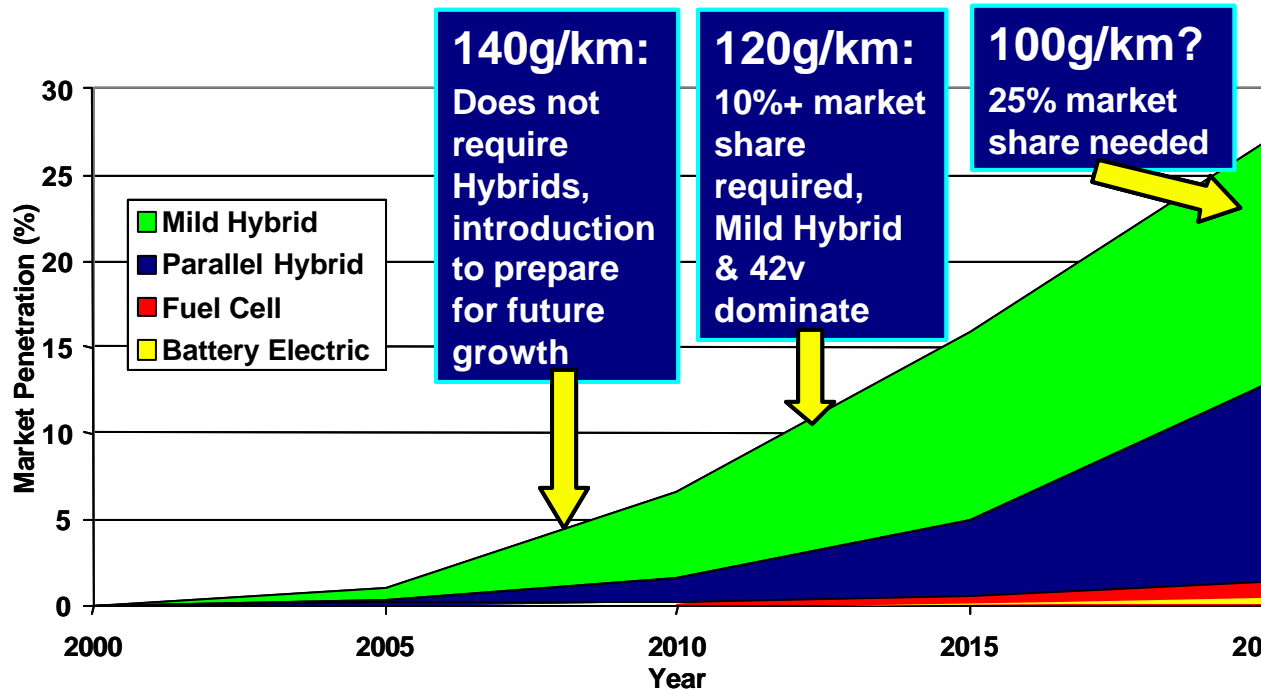
Gasoline-powered hybrids have demonstrated complete technical credibility, but European sales are much lower than Japan or USA



Standard Diesel vehicles are still seen as the low-risk choice by many buyers – performance “feel” with economy

Hybrid Sales will grow if they offer improved economy and *Performance*

Diesel powertrains will be the basis of many of these vehicles



The UK is investing in Hybrid technologies which appeal strongly to the European marketplace



i-MoGen - Ricardo / Valeo collaboration,
Down-sized Diesel Mild Hybrid, 104g/km CO₂,
0-100km/h in 12 sec



HALVANIS - Energy Savings Trust project,
partners Ford, Valeo, Gates, Ricardo - Mild
Hybrid technology for cost-effective delivery van



Ultra Low Carbon Car Challenge - Five Hybrid projects
supported by EST, involving Ricardo, PSA, Qinetiq, MG
Rover, MIRA, Pi Technology, ZyteK, DaimlerChrysler,
Bertrandt, Xtrac, Dana, Multimatic, Artemis, CTG & Echo

PSA PEUGEOT CITROËN



Low Carbon Vehicle Partnership - Industry stakeholder collaboration
Foresight Vehicle - Technology Roadmapping and Industry / Academia research

- **Ricardo is active in all of these arenas**



How far can hybrids take us?

To desirable vehicles with half today's CO₂

To the transition point to the Hydrogen economy

To customer-desirable products that won't cost the earth

More than 763 miles