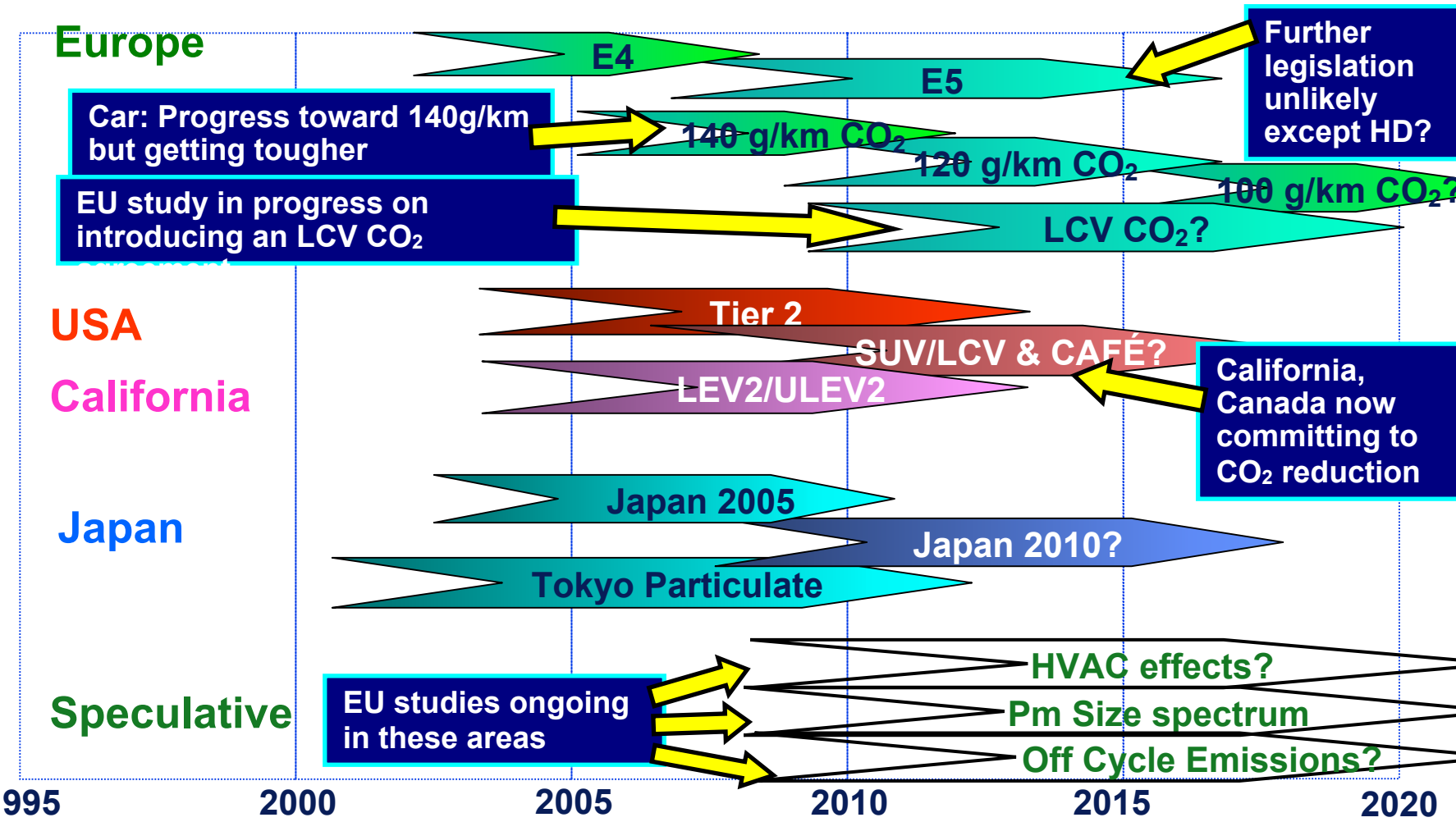

# The Roadmap to Low Carbon Vehicle Technologies

Nick Owen
Senior Manager, Technology
Ricardo UK Ltd
31st March 2004

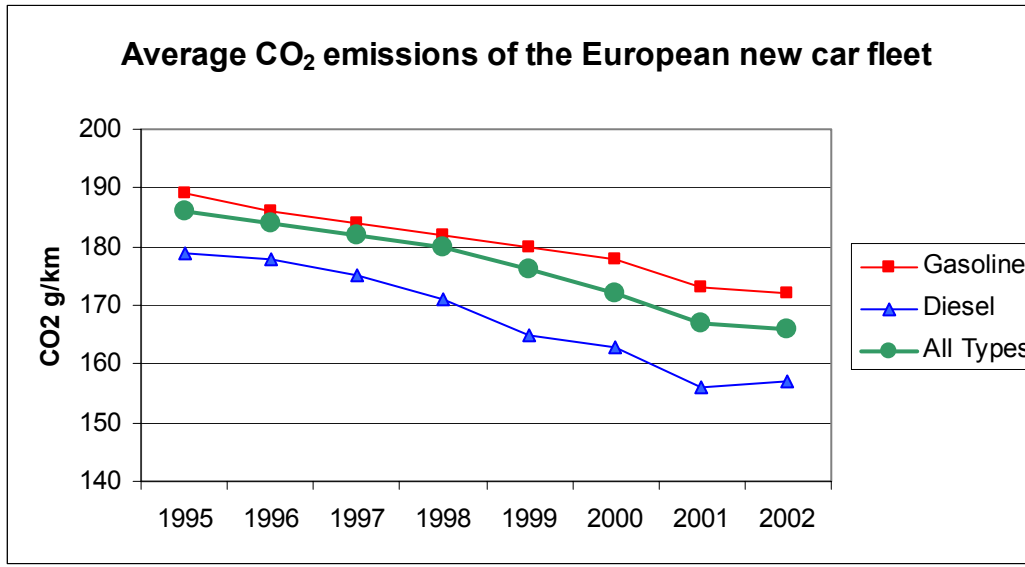
# Global emissions legislation is shifting emphasis toward $CO_2$ and "real world" emission effects

- Shift of emphasis toward $CO_2$ in Europe, Asia, Canada, California
- Increased focus on "real world" emissions issues - off cycle etc



# Much progress has been made with passenger car $CO_2$ reduction in Europe and Japan

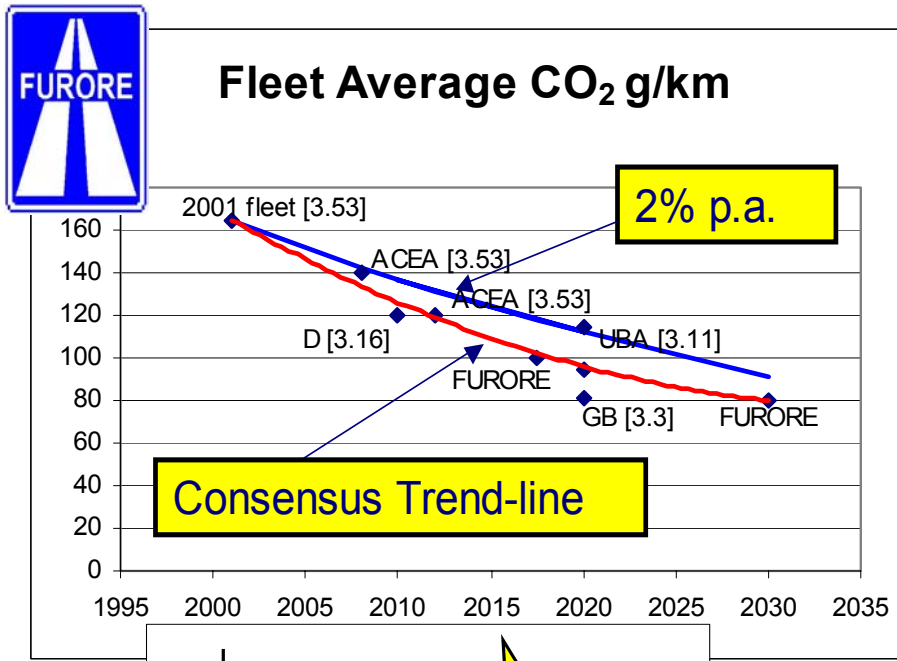
- **European progressing towards 140 g/km $CO_2$ in 2008**
  - But latest (2002) figures show progress stalling at c165 g/km
  - Past gains attributed to Diesel penetration (>40% in 2002), and other technology improvements

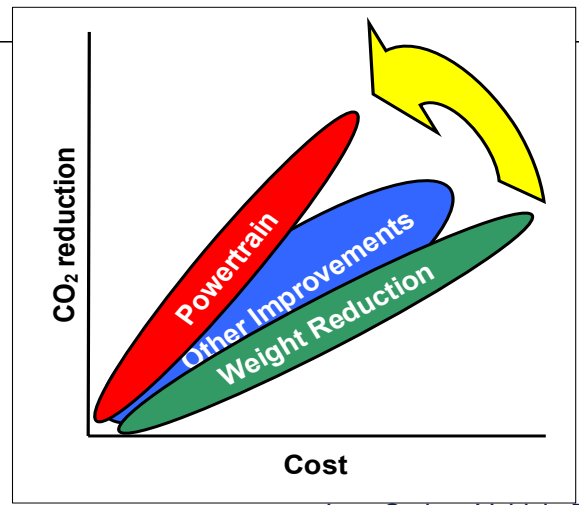



- **California, under new Governor, still committed to $CO_2$ reduction and incorporating SUVs in passenger car measures**
- **Canada, Australia, Japan and other Asia / Pacific nations moving towards $CO_2$ reduction policy -** Japanese developing total dominance in Hybrids
- **Federal USA making no commitment at present…**
  - …but pressure growing, historically follows Californian lead

# Political will for low carbon remains strong in "Kyoto" nations, but making further progress will become more challenging

- All evidence from government policy documents in EU and Asia suggests **continuing pressure for road transport $CO_2$ reduction**
- **New technologies** will be required before the end of this decade in many markets **- even the USA?**
- **Powertrain efficiency improvement** remains the most cost-effective way to reduce fossil-fuel $CO_2$
- **Commercial markets** offer the opportunity to make a business case for costlier but more efficient technology - **Private cars** tend not to

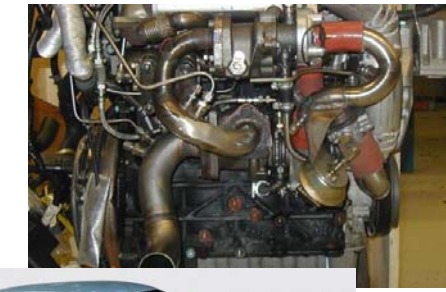


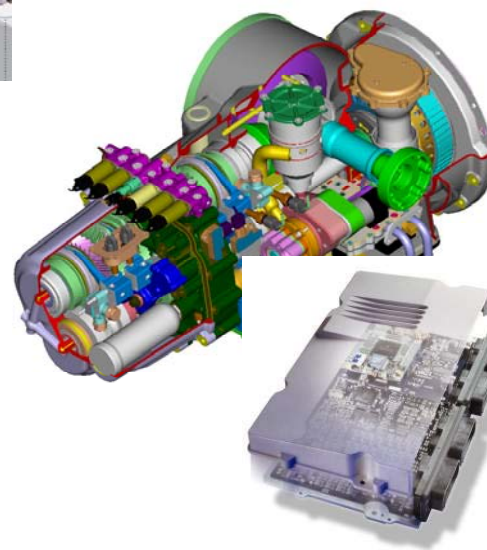




Source: EU project FURORE

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

- **Clean Diesel engines** offer 25%+ $CO_2$ 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 $CO_2$ at 80% of the unit cost
- **Efficient automated transmissions** can offer up to 5-8% $CO_2$ 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



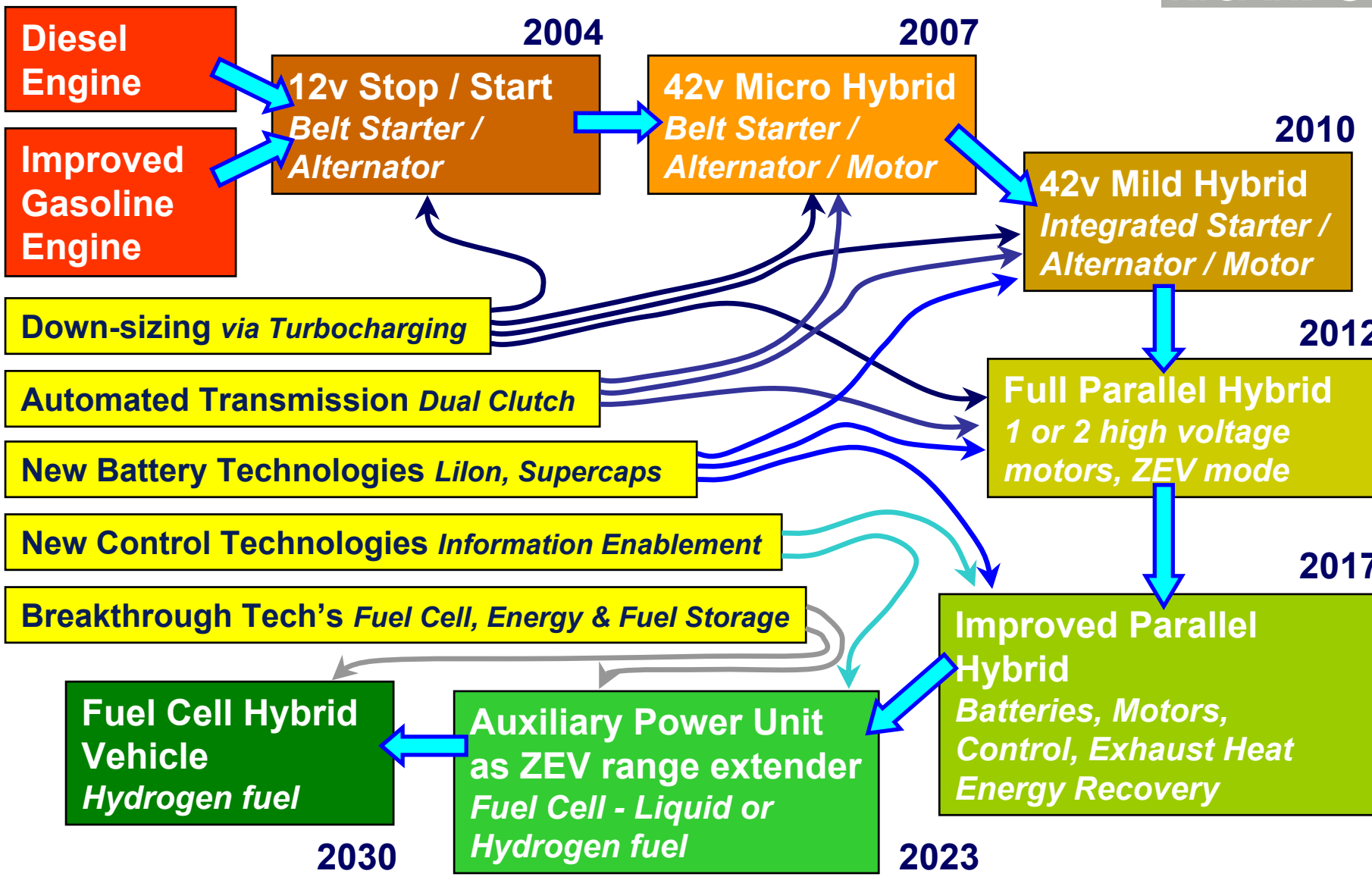



# Hybrids offer a low risk evolutionary path to environmental sustainability, providing attractive products to consumers

- **Advanced conventional powertrain technologies can continue to offer environmental improvements.** However, they alone are not enough to achieve desired levels of $CO_2$ 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

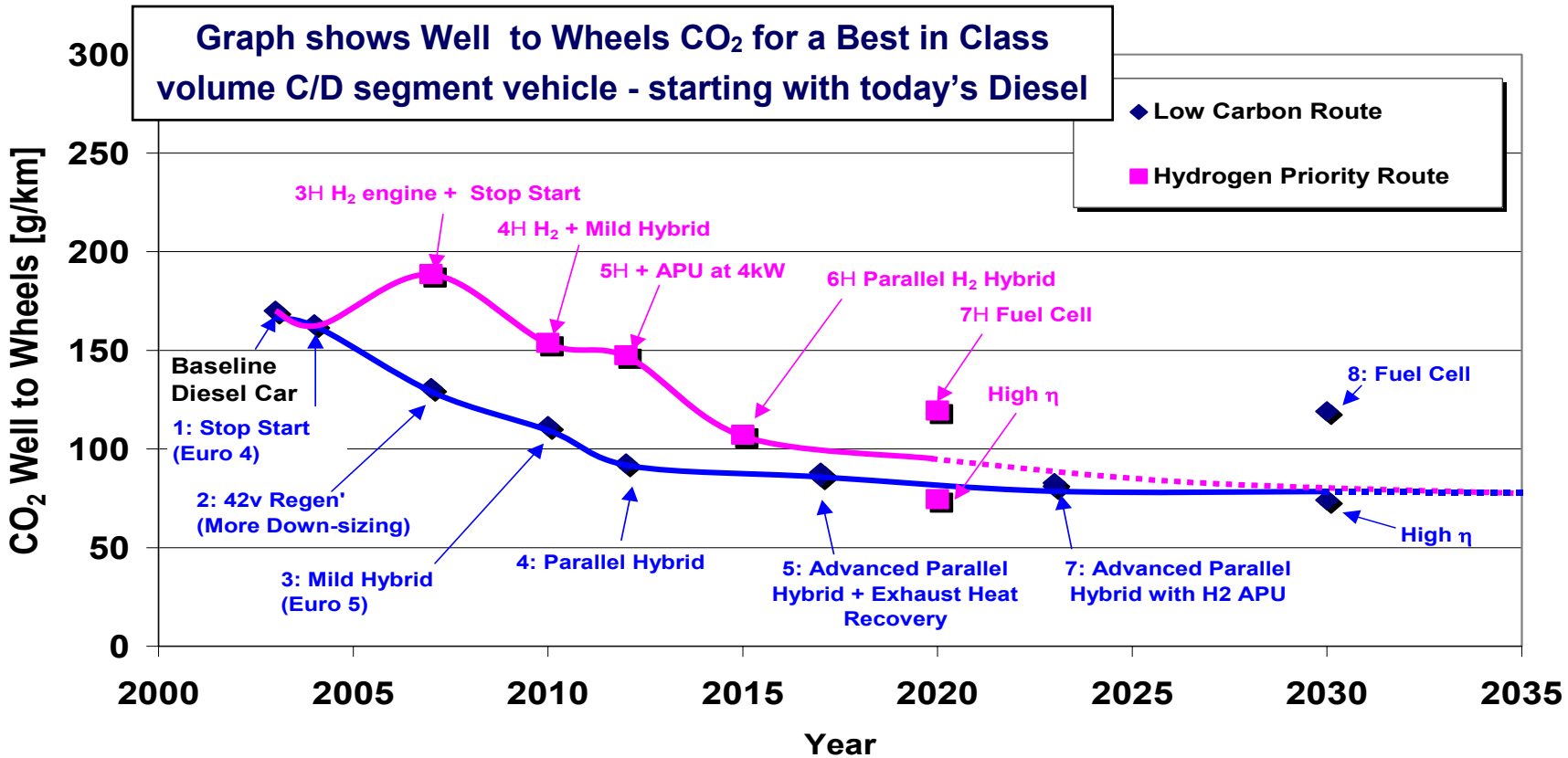
- **Technology is required which complements the evolution of conventional powertrains,** while enabling further efficiency gains until a global sustainable energy infrastructure is available
  - This technology must be attractive to customers and cost-effective
- **In an environment where $CO_2$ reduction is a major goal, evolutionary introduction of Hybrid technology meets these needs**

# 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



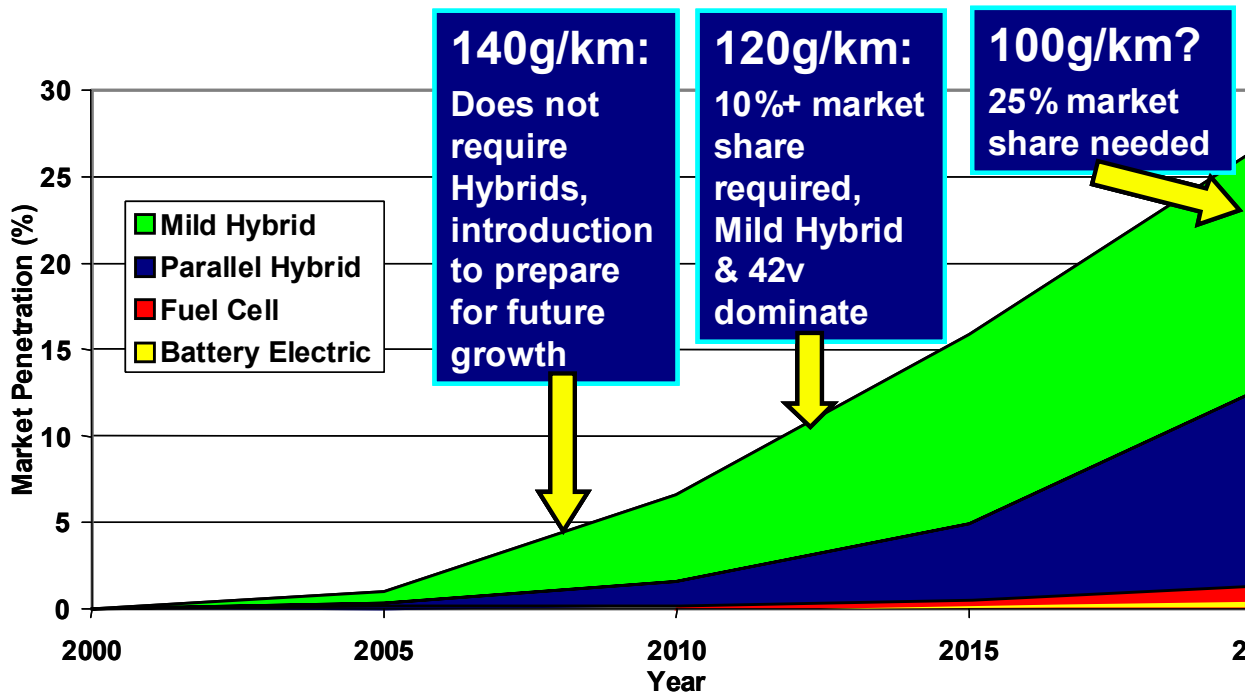
# In Europe, the Hybrid has a role as a volume low-carbon vehicle, not a niche product


**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

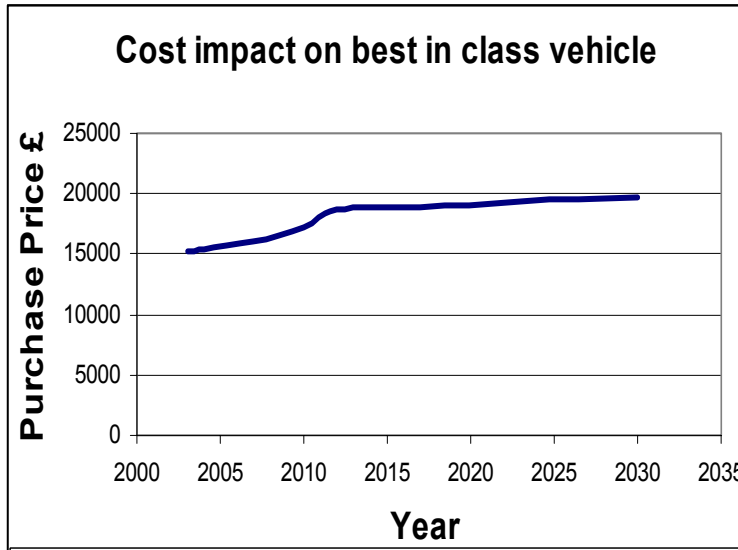
**Hybrid Sales** will grow if they offer improved economy and ***Performance***

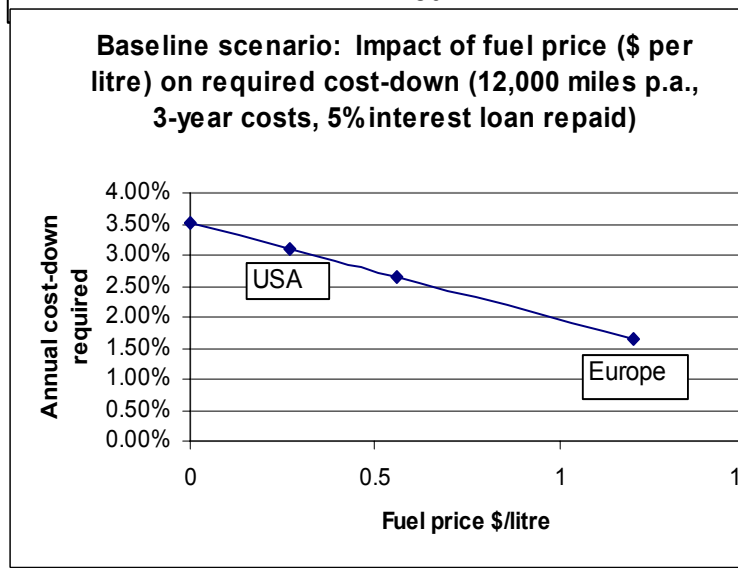
**Diesel powertrains** will be the basis of many of these vehicles



# Cost is a major issue, but can be balanced by fuel savings, differential incentives and cost reduction as volumes rise

- **25% increase in price of best-in-class vehicle** is possible by 2030 without cost reduction measures - caused by >2x increase in average power-train cost
- **Cost-neutral ownership case** over 3 years can be maintained if:
  - **Re-sale value and running costs** are as good as a conventional vehicle
  - Owners can be persuaded to consider **3-year costs** including fuel
  - Cost of extra **emission control** can be minimised
  - **Differential purchase incentive** (e.g. UK's $CO_2$-based "Company Car" taxation scheme) can be sustained
  - **Cost reduction** can be sustained as volumes of new technology grow



# 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 $CO_2$, 0-100km/h in 12 sec

HYTRANS - 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

**Low Carbon Vehicle Partnership** - Industry stakeholder collaboration

**Foresight Vehicle** - Technology Roadmapping and Industry / Academia research


## Where does this Roadmap take us?

To desirable vehicles with half today's $CO_2$

To the transition point to the Hydrogen economy

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

More than 763 miles