Low Carbon Vehicles and Energy Markets

Oxera Energy Markets Group

Oxford

17th September 2009

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Low Carbon Vehicle Partnership

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Accelerating a sustainable shift to low carbon vehicles and fuels in the UK

Stimulating opportunities for UK businesses

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Outline

- The scale of the challenge
- Improving vehicle efficiency
- Impacts on energy markets of alternative pathways to ultra-low carbon
  - Electrification
  - Biofuels
  - Hydrogen fuel cells
- Other measures
- Conclusions

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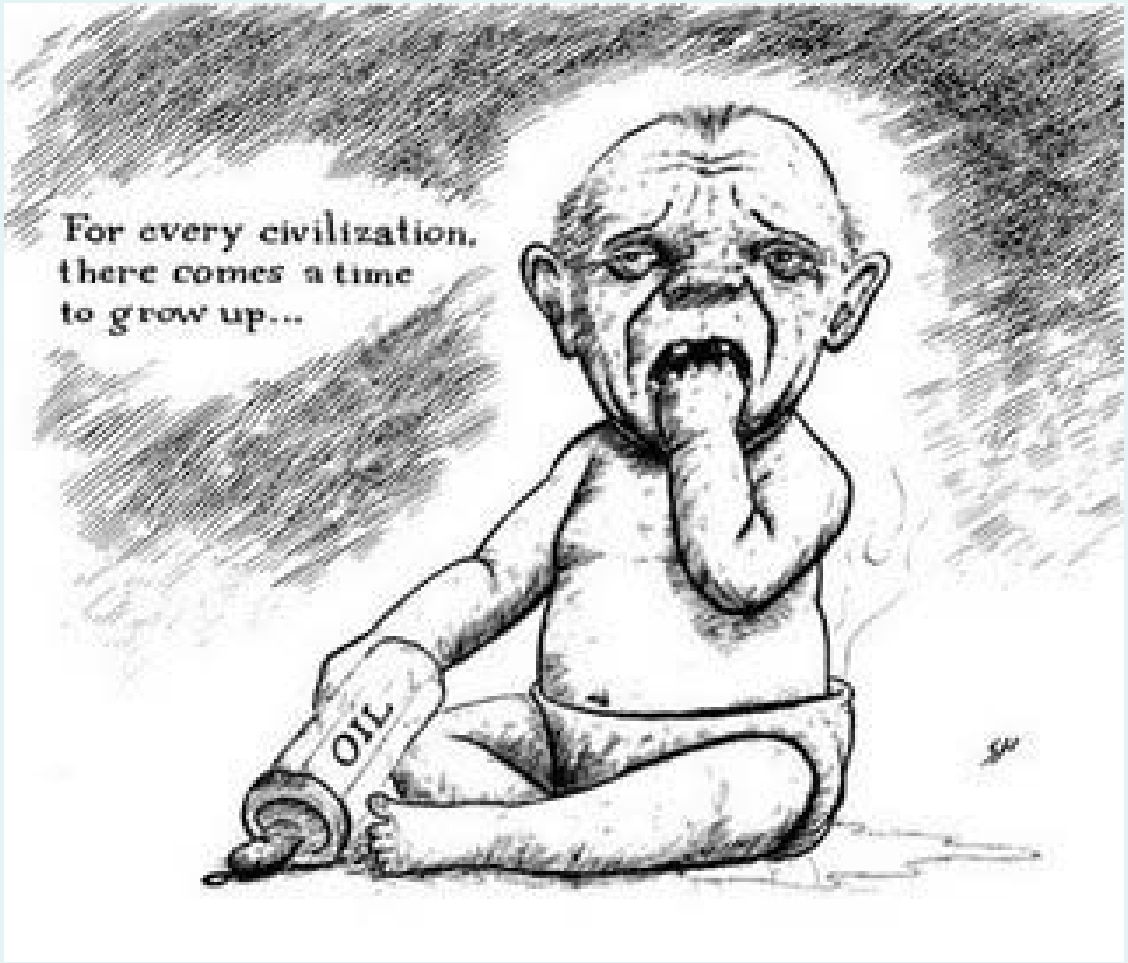
The scale of the challenge



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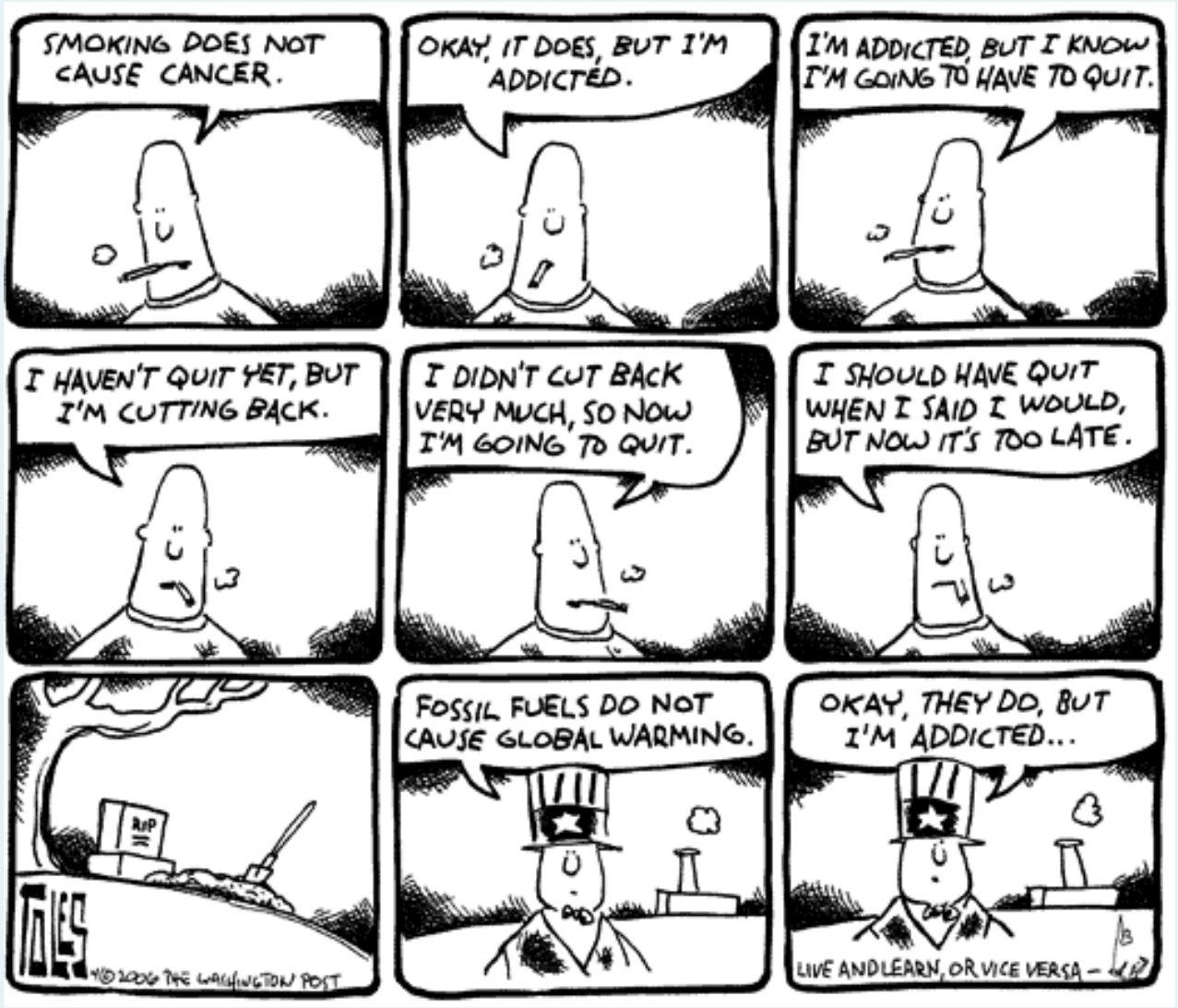
Petroleum accounts for 99% of transport fuel use with widely recognised risks and implications

- Climate Change
- Peak Oil
- Security of supply



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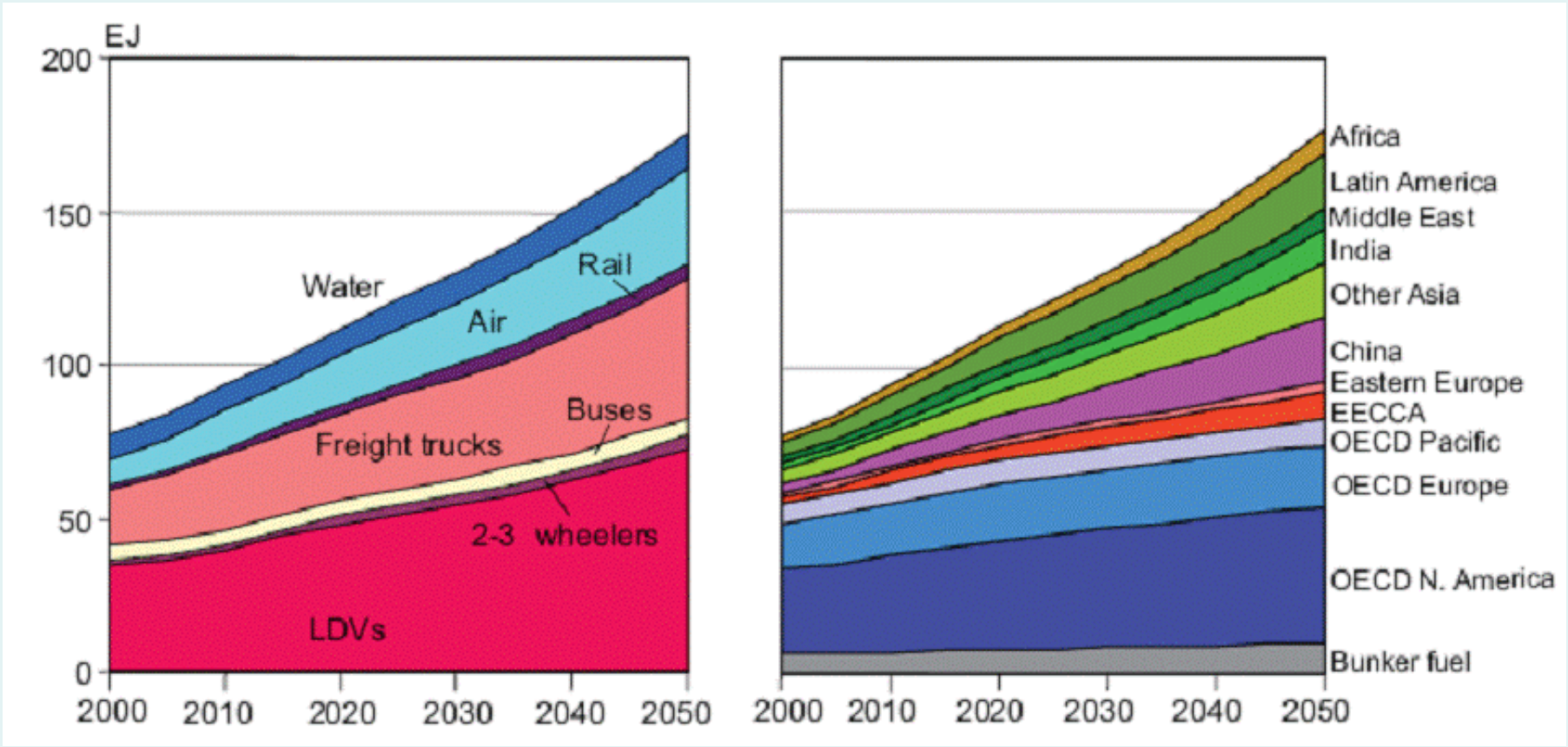
Global energy demand for transport is projected to more than double by 2050



IEA 2008, citing WBCSD 2004

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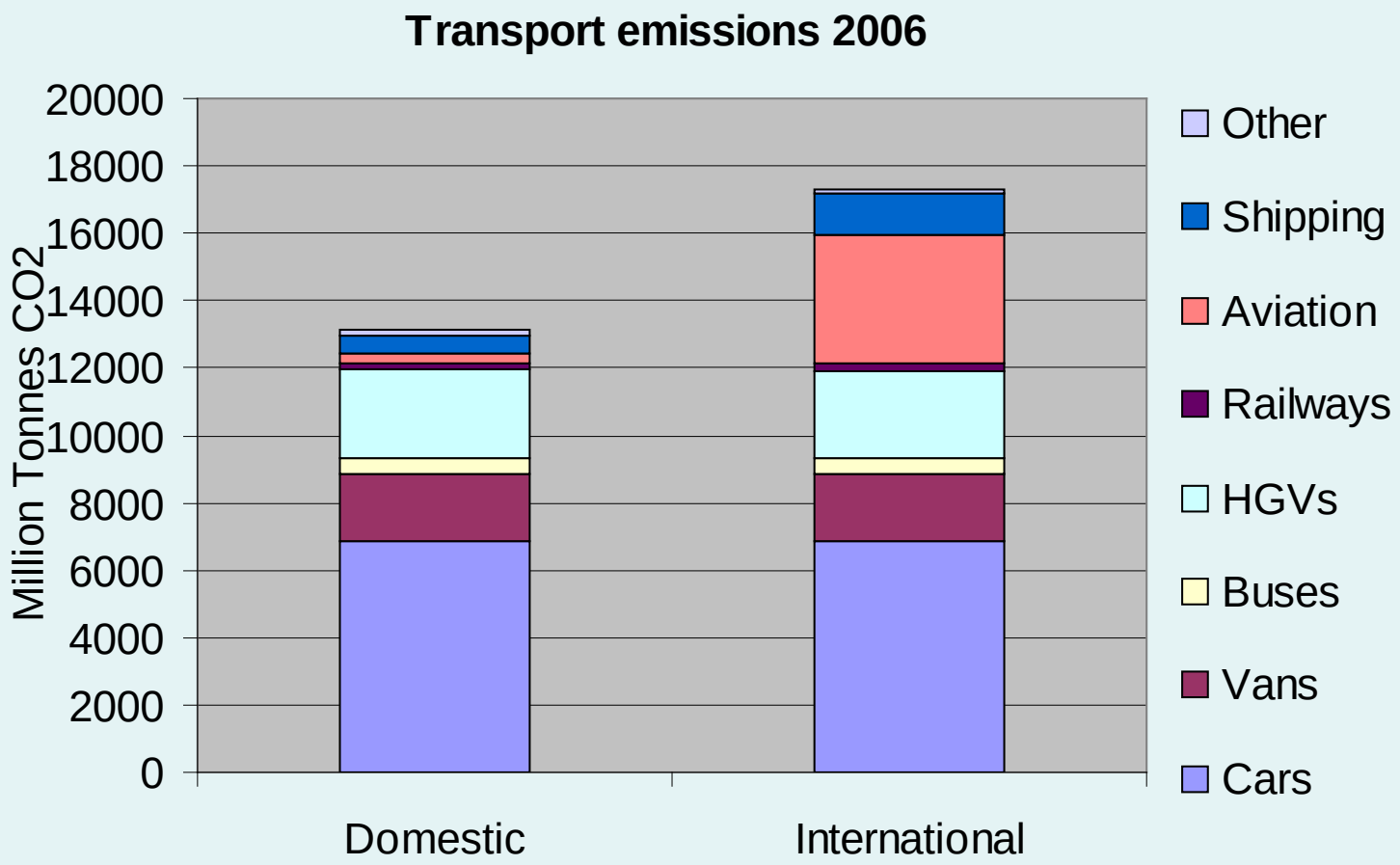
Road transport accounts for 92% of domestic transport emissions – cars 58%; HGVs 20%; vans 11%

Growing aviation emissions also represent a major challenge



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DfT 2009 Low Carbon Transport a Greener Future

Improving vehicle efficiency

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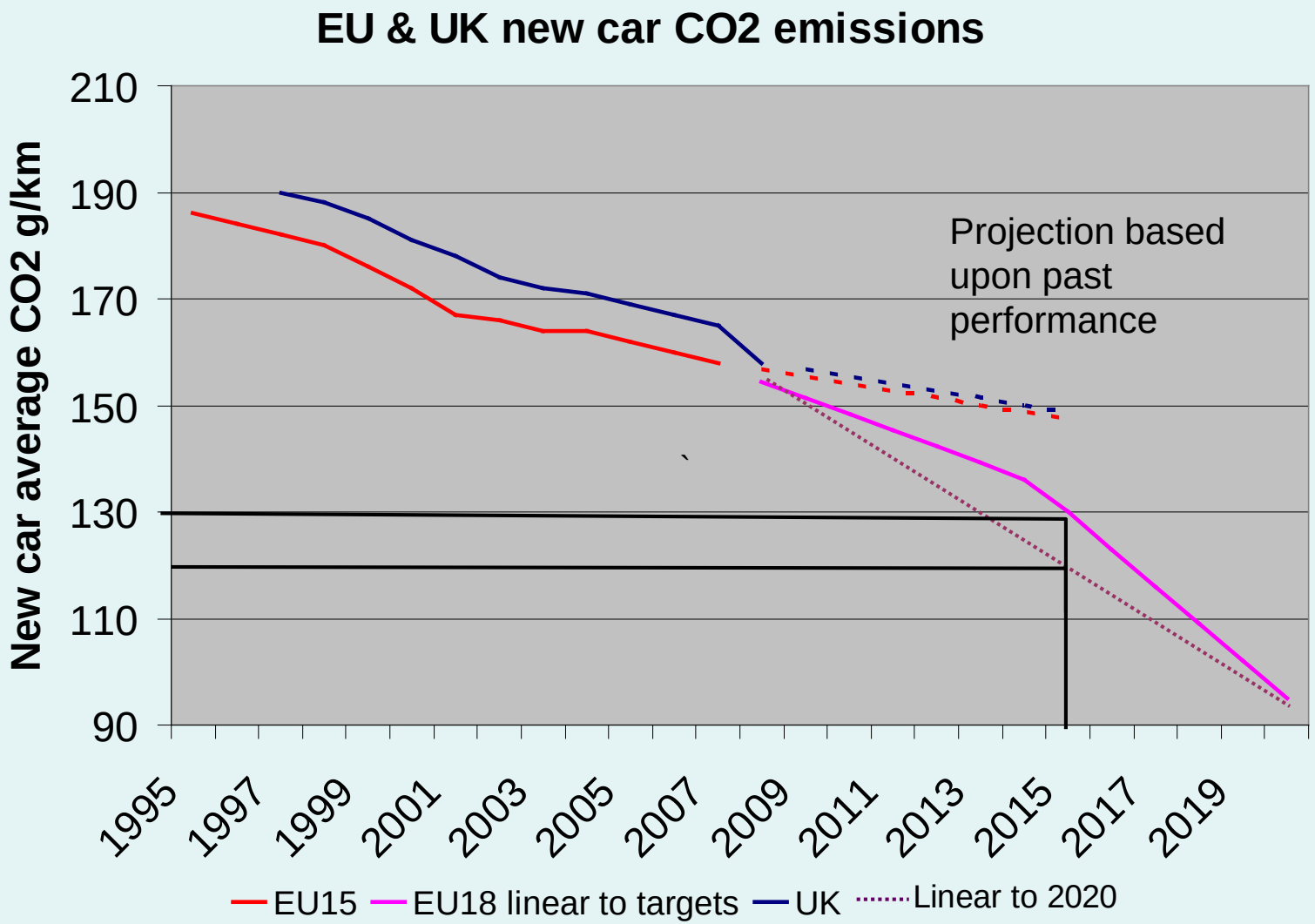
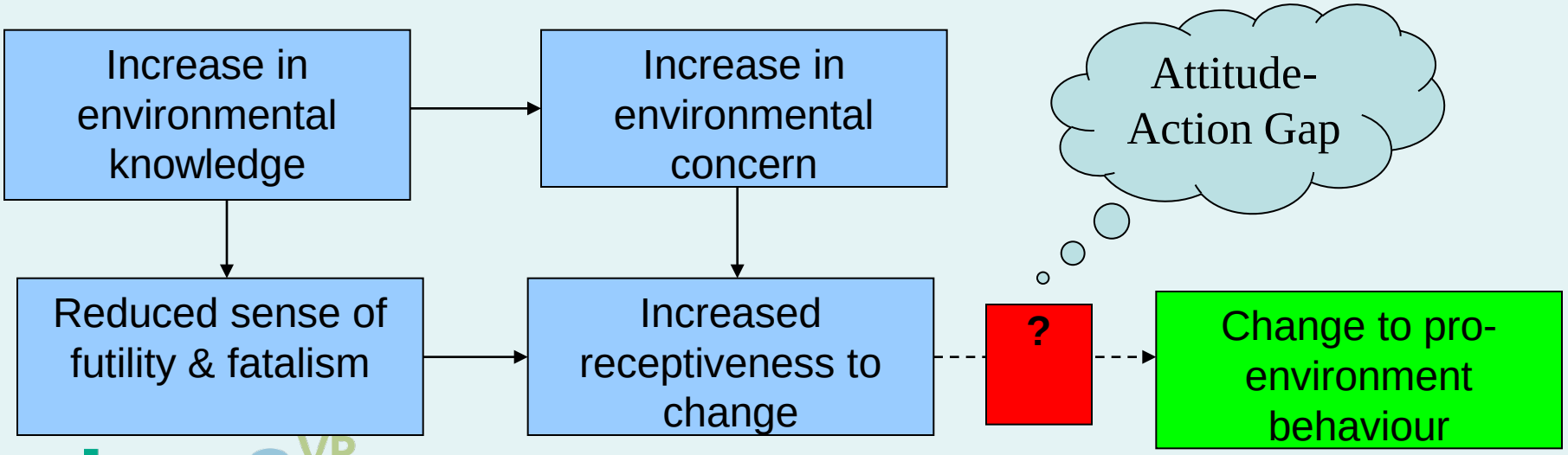
New cars are becoming more efficient – but the rate of progress must be accelerated to achieve targets



Based upon T&E and SMMT data

Accelerating progress depends upon:

- Reversing unsustainable trends in vehicle size, weight and power
- Maintaining consistently high fuel price
- Industry-wide action - regulation
- Increased consumer demand, bridging the attitude action gap, through:
  - Improved customer information
  - Increased desirability of low carbon technologies
  - Stronger incentives
  - Greater model availability



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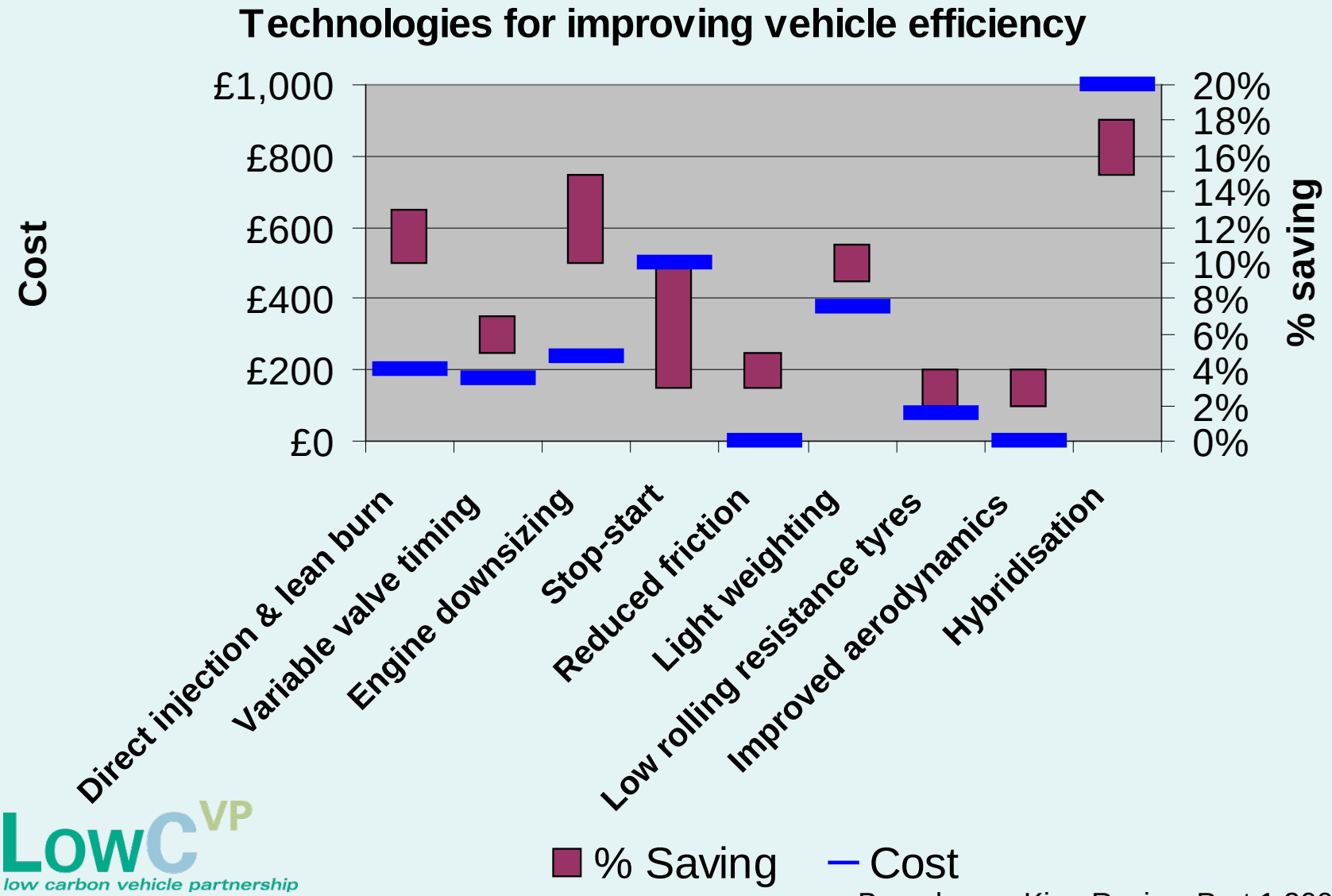
A range of existing technologies are available to reduce CO2 emissions – at a cost



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Based upon King Review Part 1 2008

There are now a range of low emission models in every market segment

Smart for two

Prius 3

Volvo S80

Lexus RH450

VW Passat

Volvo V50

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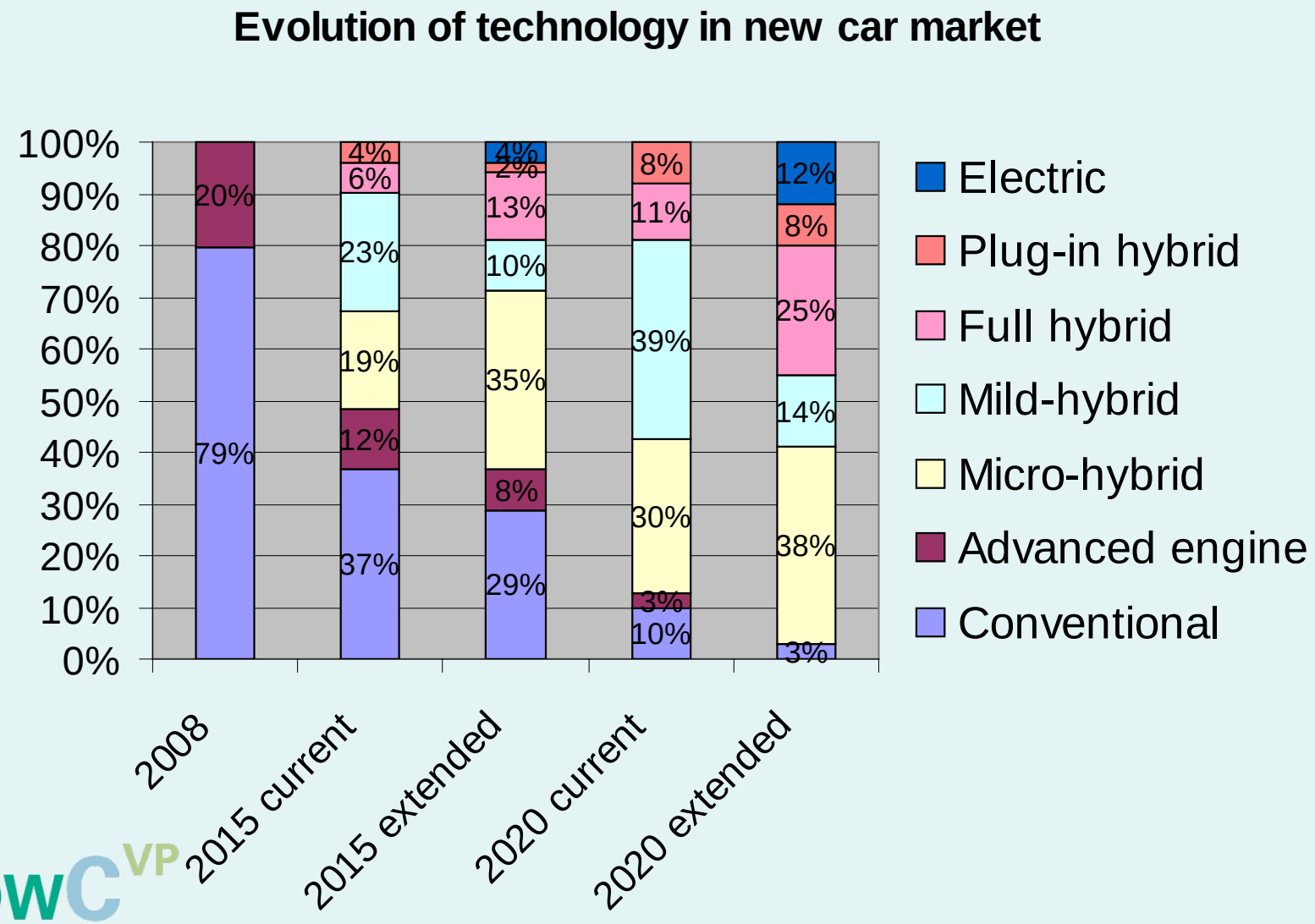
To 2020, most emissions reductions will be through improvements to existing ICEs vehicles



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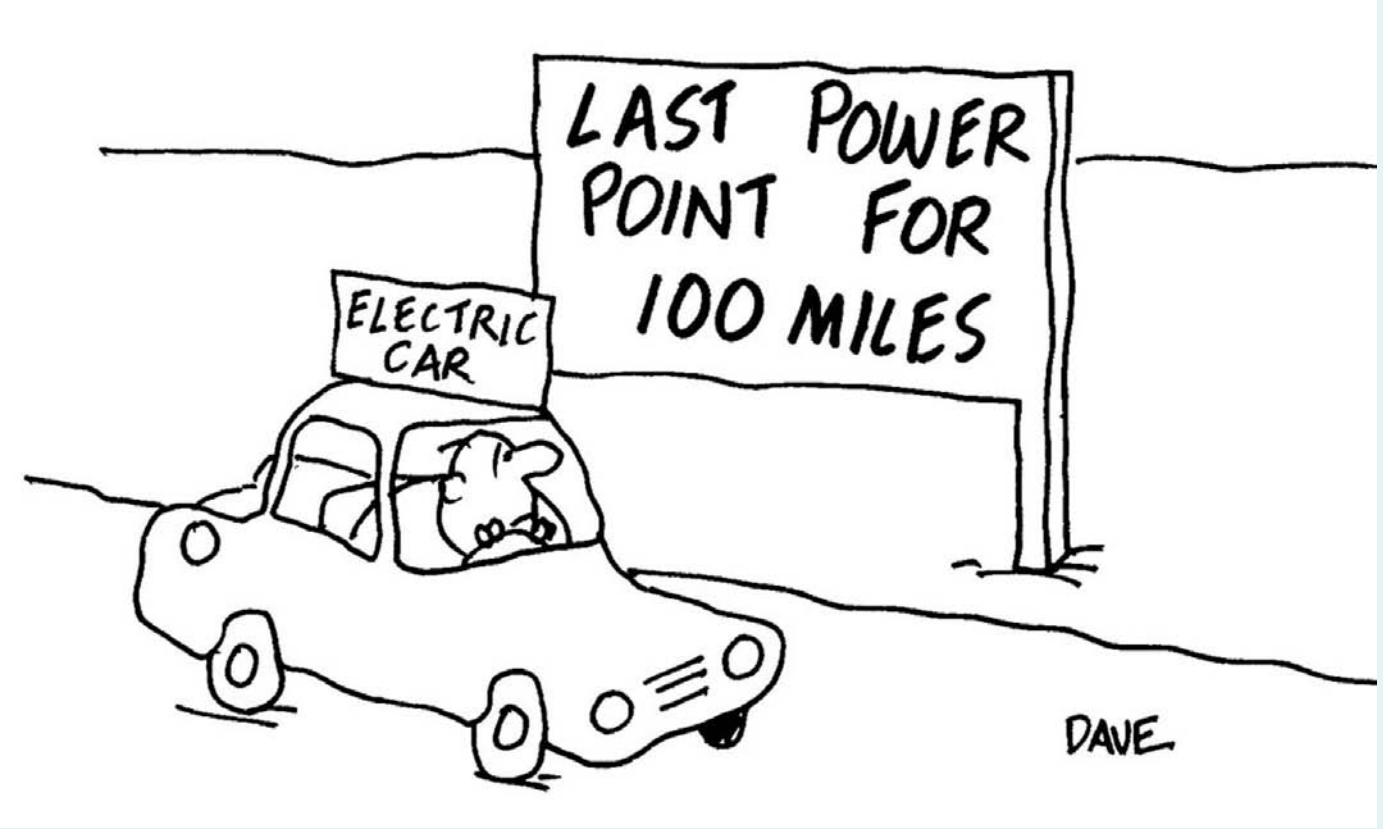
Alternative pathways to ultra-low carbon vehicles -

Electrification of transport



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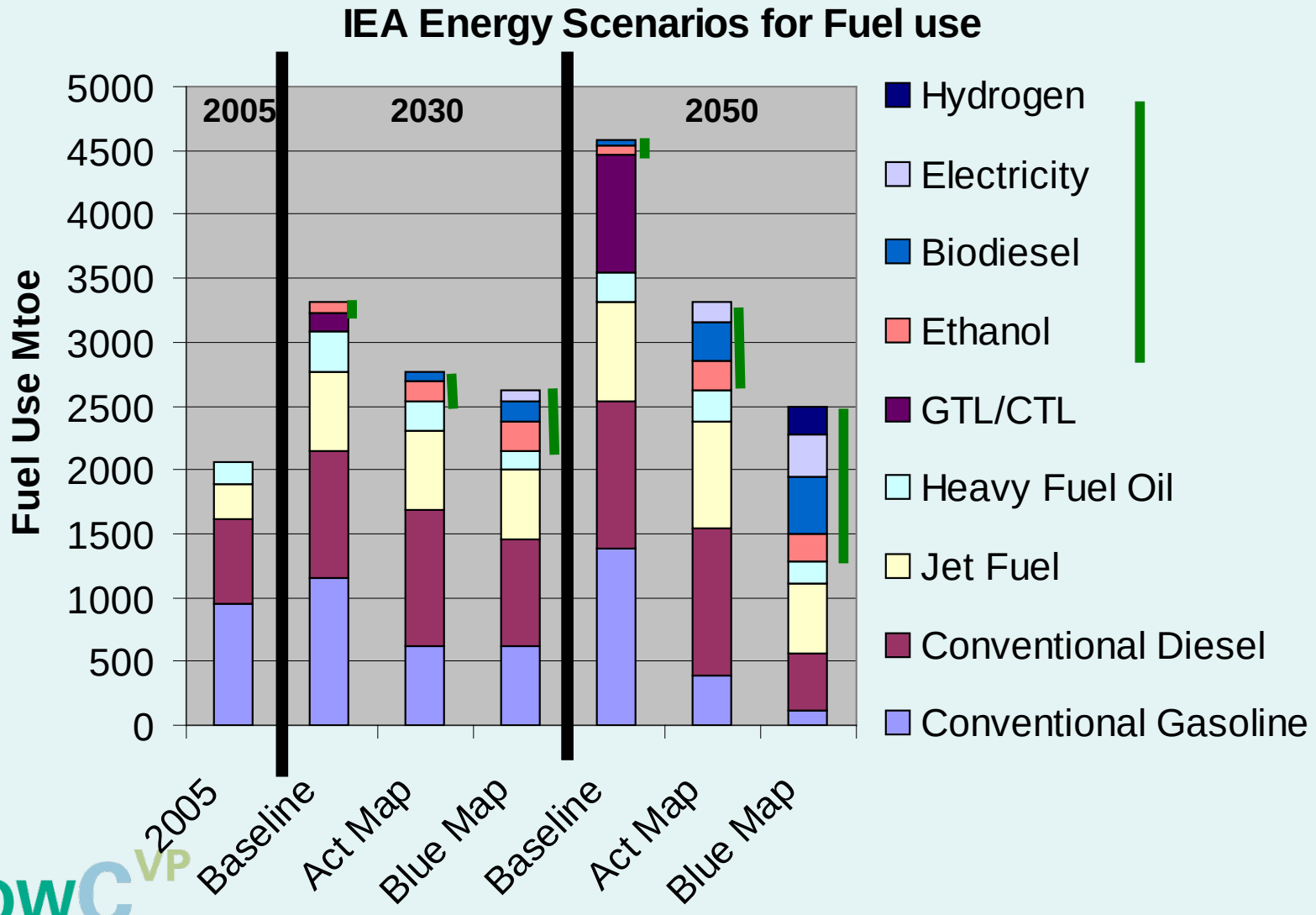
Beyond 2020 IEA scenarios show an increasing penetration of renewable transport fuels to meet increasing demand



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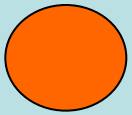
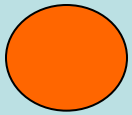
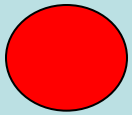
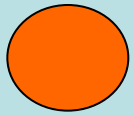
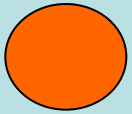
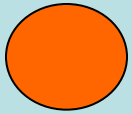
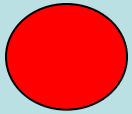
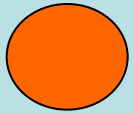
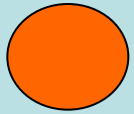
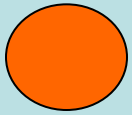
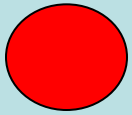
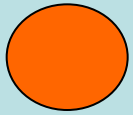
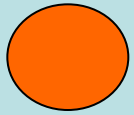
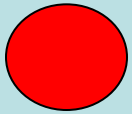
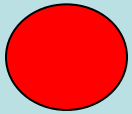
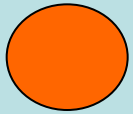
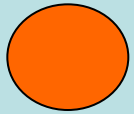
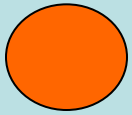
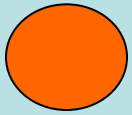
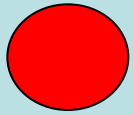
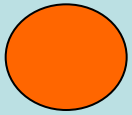
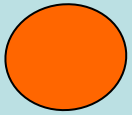
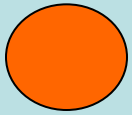
IEA 2008, Energy Technology Perspectives

To 2020 the challenge is to ready the market for renewable fuels – but which option?

	1st G Bio	2nd G Bio	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

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 RD&D
- Investment & commitment from global OEMs

But … early visionary vehicles do not create a mass market

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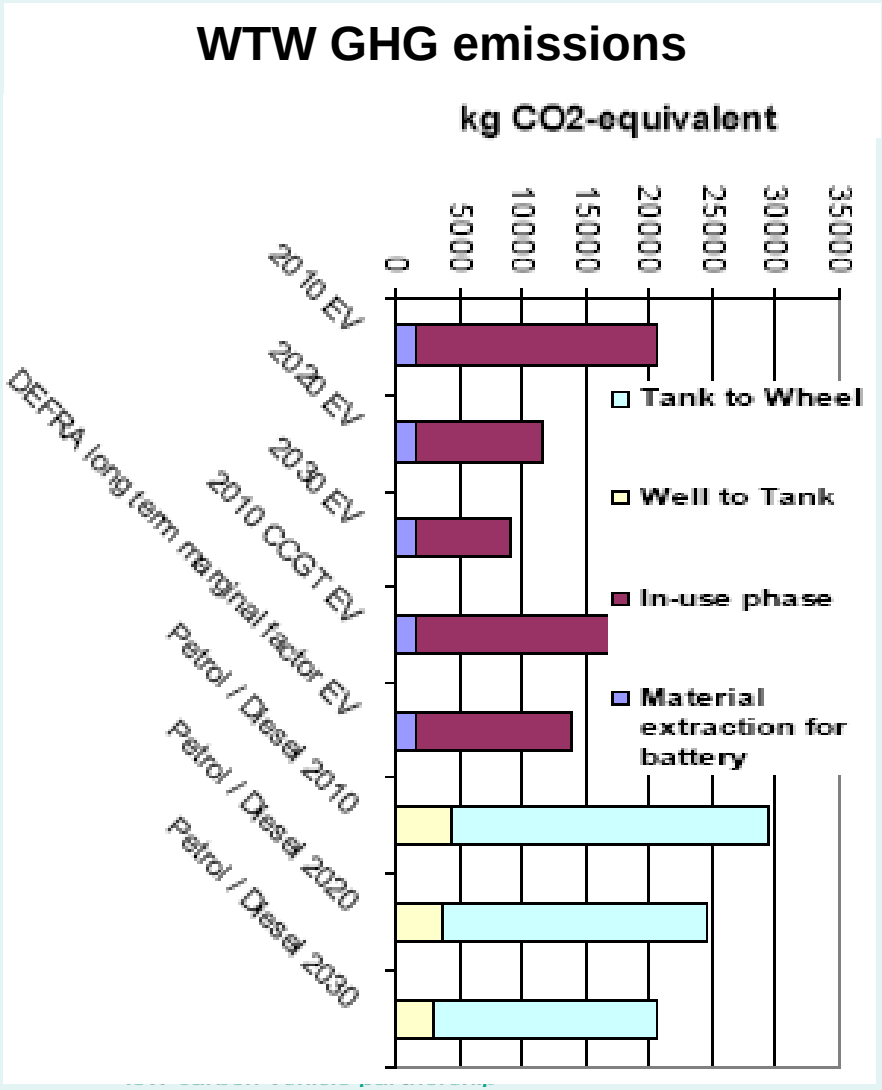
EVs deliver CO2 benefits over ICEs with minimal grid impacts



- EV share of national electricity production
  - 2020 0.1 – 2%
  - 2030 1 – 8%
- Smart metering and differential pricing can discourage peak demands
- Could create night-time base load for renewables
  - Flattening of daily demand profile will create efficiencies for generators
- Some local grid reinforcement may be needed in peak uptake locations

Cenex / Arup 2008

There are substantial technical and commercial barriers making widespread, rapid consumer uptake unlikely

- Battery performance limits range
- Battery cost constrains market
- Battery reliability / lifetime uncertain
- Recharging infrastructure currently unavailable
- Vehicle availability minimal
- Pathway to profit highly uncertain
- Widespread consumer acceptability low
- Safety concerns must be allayed
- Immature supply chain

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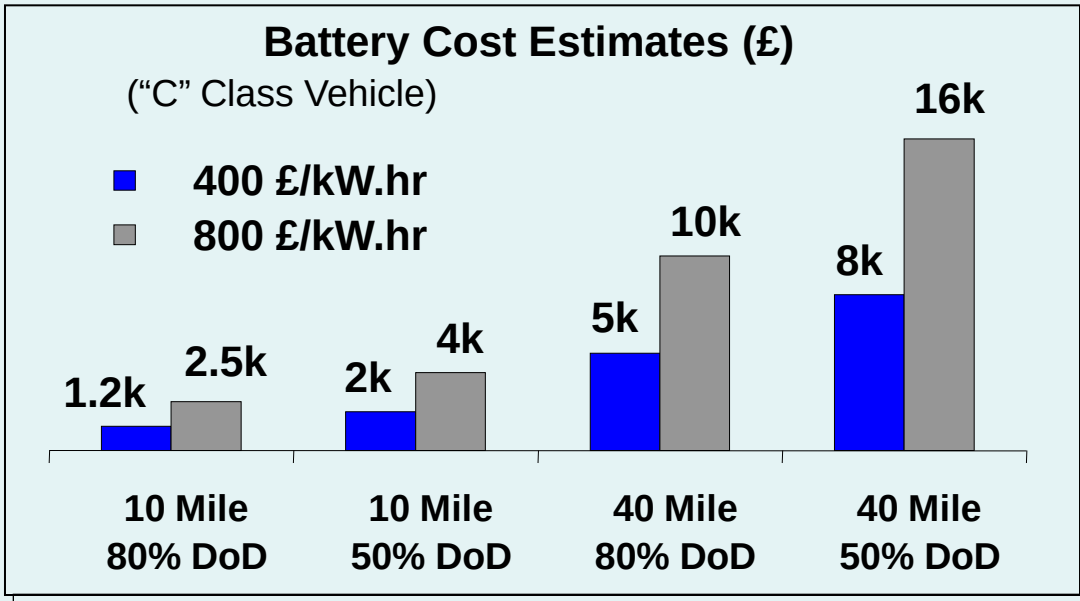
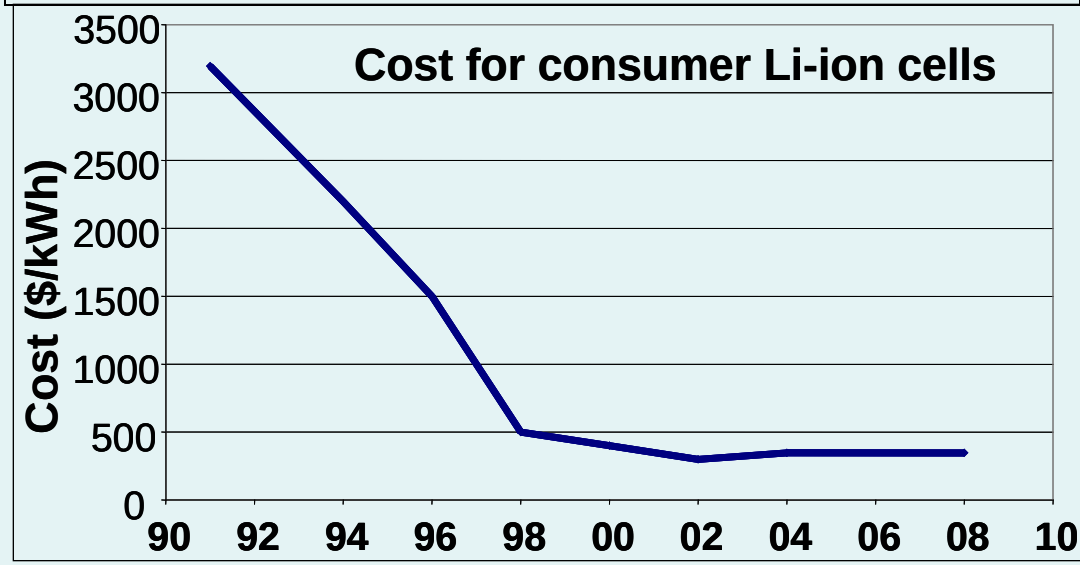
There are complex interactions between vehicle range & battery depth of discharge, lifetime & cost

- Li-ion currently c$2000/kwh
- **Outlook** battery price for automotive applications c$1000/kwh
- Cost must be reduced to c$400/kwh for EV city cars to be competitive
- PHEV applications more likely outside city applications
- Cell price stable - high cost of raw materials

- Technology breakthrough necessary for widespread adoption





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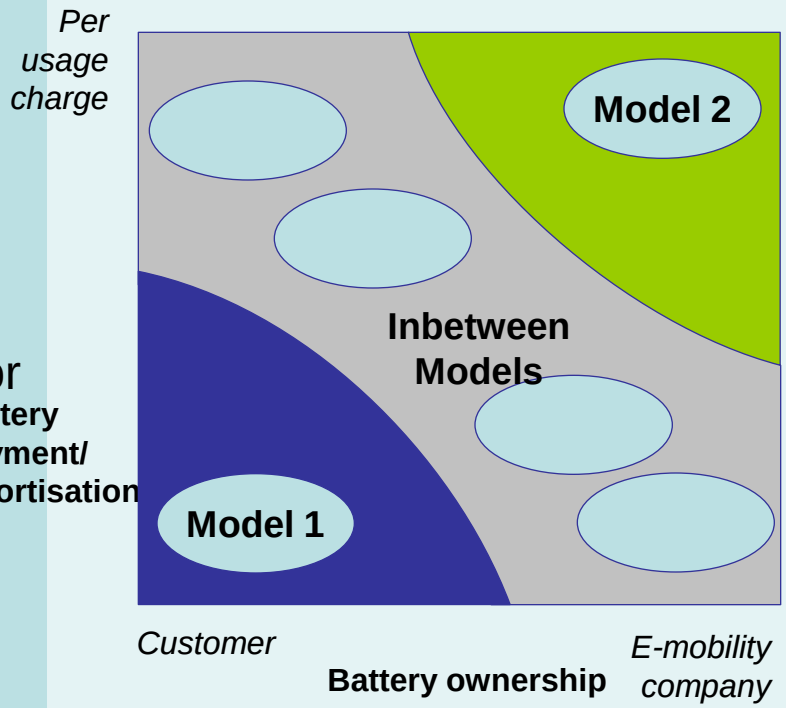
A range of business models are being considered – the pathways to profit remains uncertain

Model 1

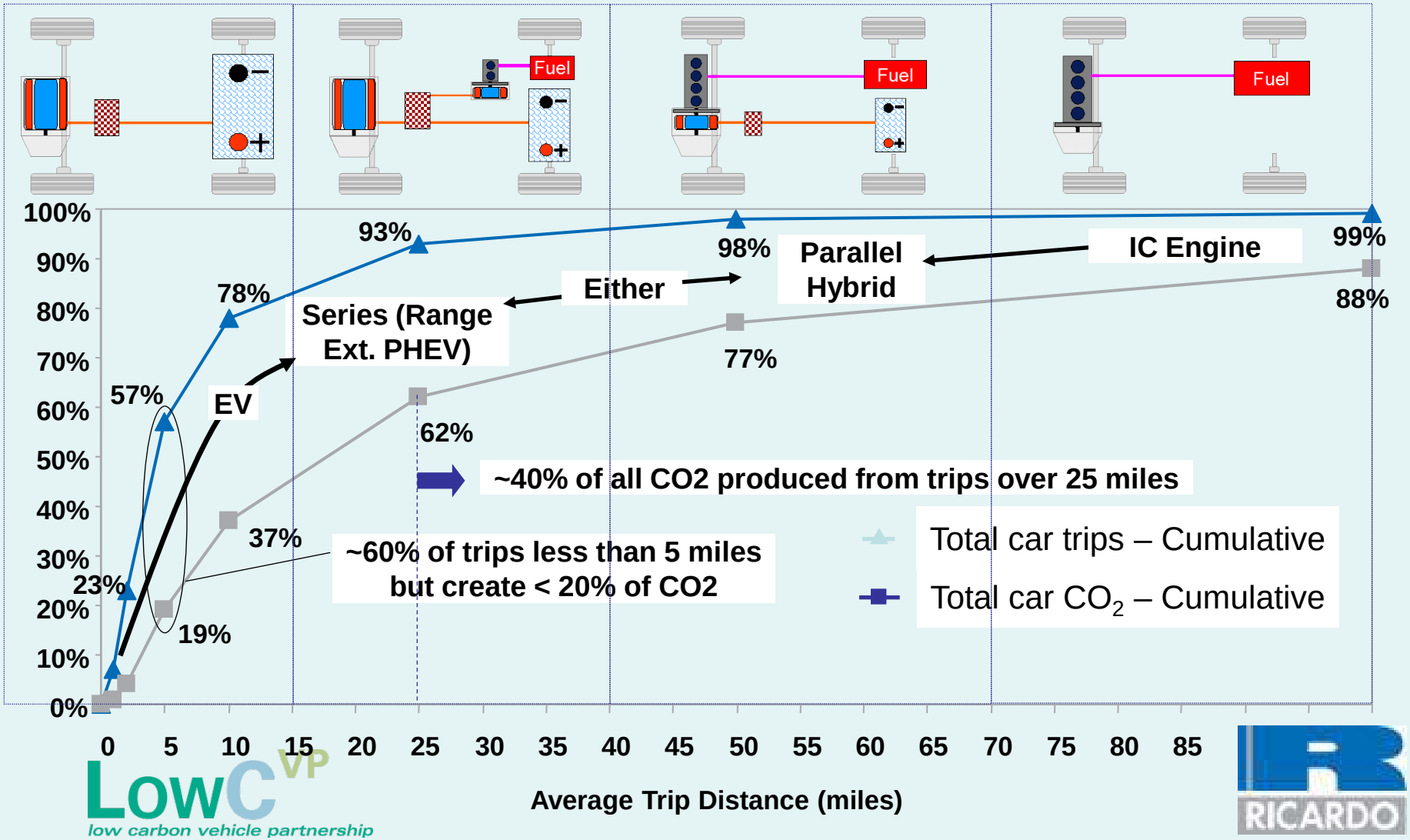
- Vehicle manufacturer sets battery standard for its own vehicle range and markets vehicle including battery
- Utility company sets up charging infrastructure
- Customer buys vehicle including battery and charges battery at charging station (home, e-charging station, …) and pays for electricity consumption only

Model 2

- E-mobility company sets the battery standard and owns the battery
- E-mobility company sets up charging and battery exchange infrastructure
- Customer charges battery at charging station or swaps complete battery
- Customer pays for electricity consumption and battery amortisation



Technology will be tailored to the application: EV for city use, PHEV or parallel hybrid for medium length journeys; IC for long journeys



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RICARDO

Strong UK Government support programme for electrification of transport

- Creation Office of Low Emission Vehicles
- £250M purchase support fund for cars
  - 2011-14
  - £5k per vehicle
- 140M Low Carbon Vehicle Innovation Platform
- £30M infrastructure support
  - Plugged-in-Places
- £5M Ultra-low carbon car competition
  - 340 vehicles
  - Joint cities demo programme
- £20M public procurement support for electric vans

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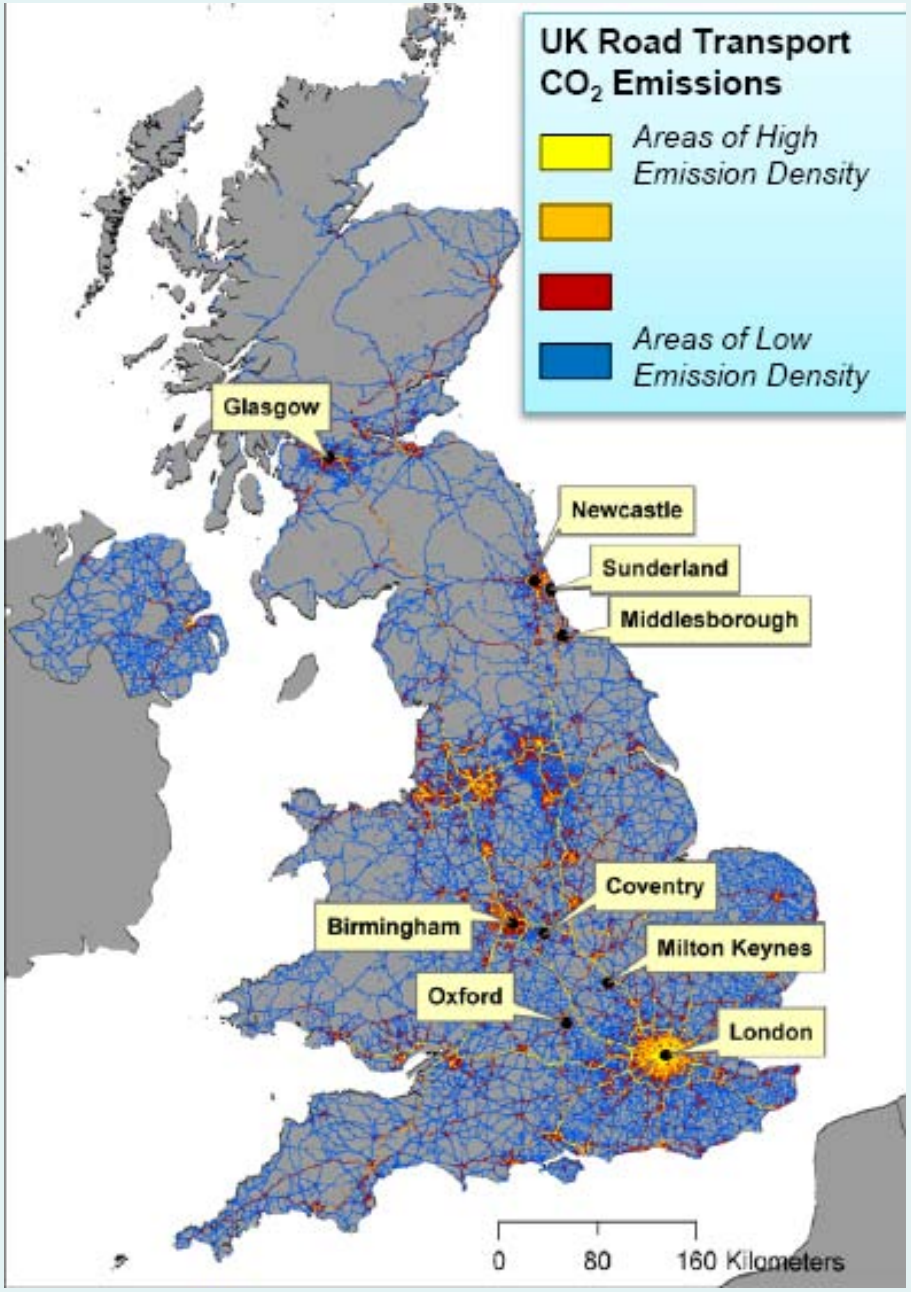
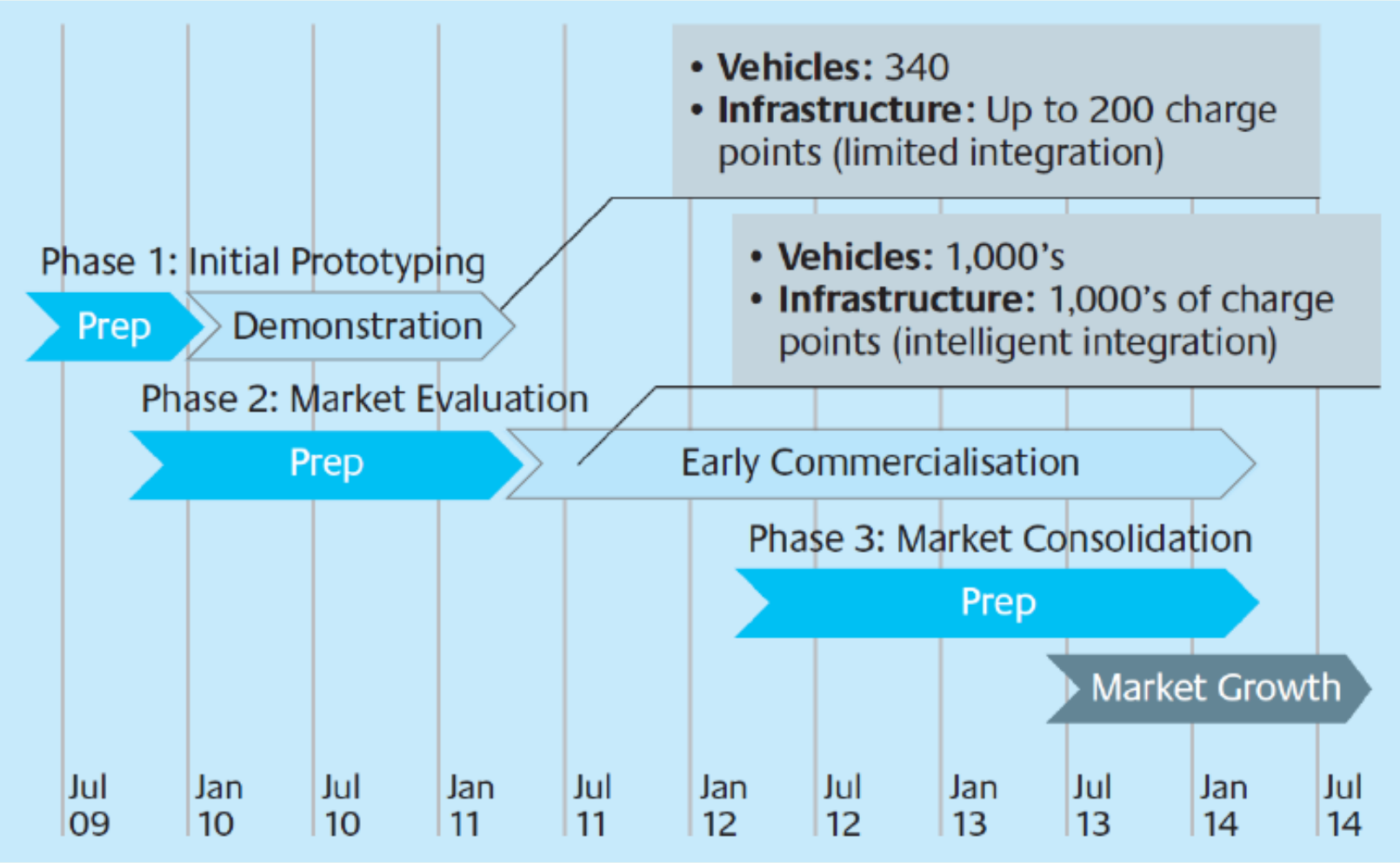


ETI 2009

UK proposals for electrification of transport through "Test Bed UK"



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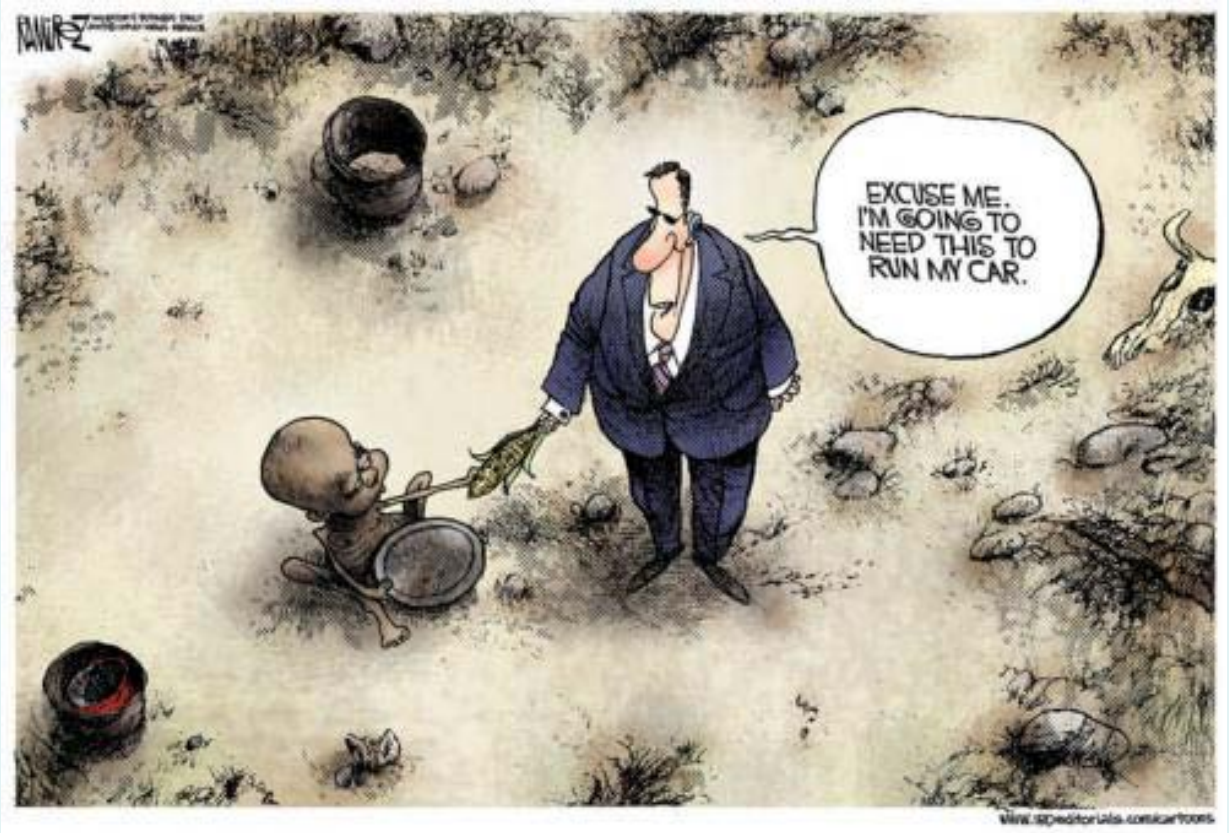
Alternative pathways to ultra-low carbon vehicles -

Biofuels & hydrogen fuel cells



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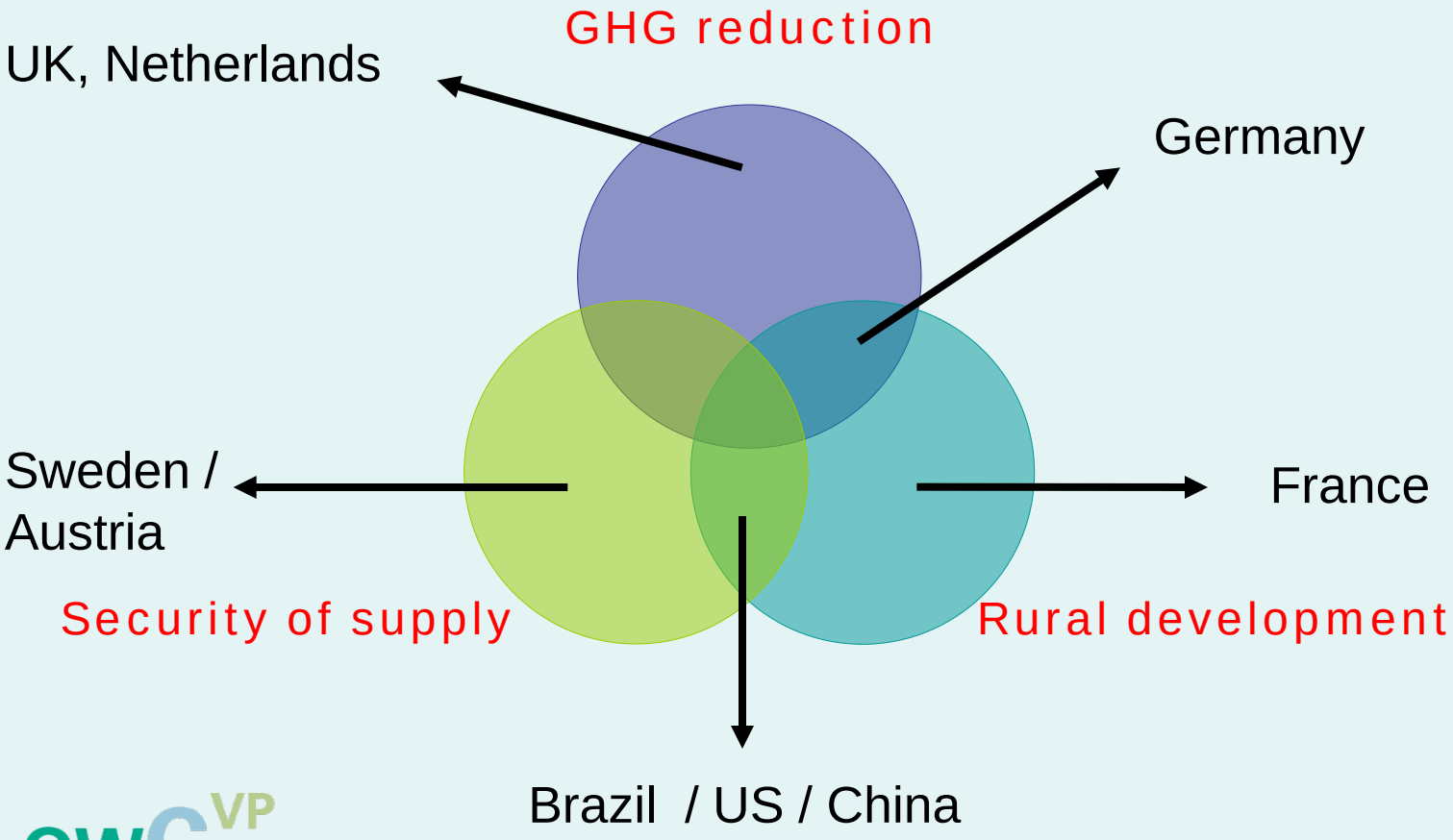
3 policy drivers, 1 outcome .... increasing global biofuel demand

Principal biofuel policy drivers



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There are more & less sustainable ways of producing biofuel feedstocks

Fully sustainable

Algal biofuel production
>90% GHG-saving
No indirect effects

British Sugar Wissingham
Ethanol from sugar beat
c60% GHG-saving
Indirect effects possible

US Corn
Minimal GHG-benefits
Significant indirect effects

Matto Grosso – Brazil
Deforestation for soy
GHG-emissions

Totally unsustainable

Regulation and advanced fuels will reduce sustainability concerns

- EU Renewable Energy Directive - target of 10% renewable energy in transport by 2020

- Biofuels must fulfil the sustainability criteria
  - minimum GHG savings of 35%, rising to 60% by 2018
  - not from land with high biodiversity, primary forest, carbon stocks, wetlands
  - information on measures taken for soil, water and air protection – comitology

- Incentivises second generation biofuels
  - “wastes, residues, non-food cellulosic material, and ligno-cellulosic material shall be considered to be twice that made by other biofuels.” (and electric vehicles)

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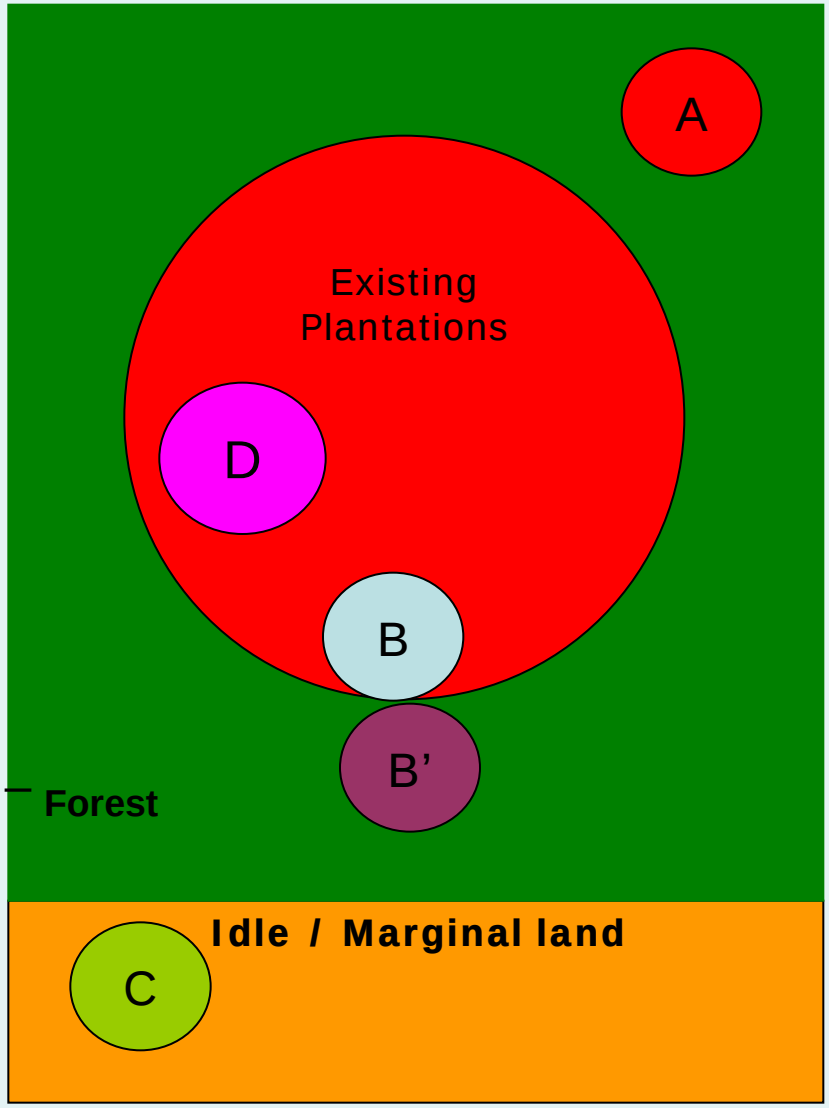
Indirect effects on land use and food prices have emerged as a key concern and future legislative driver

A — Direct Land use change

B — Indirect Land use change

C — Non-agricultural land - No land use change

D — Productivity improvement – No land use change



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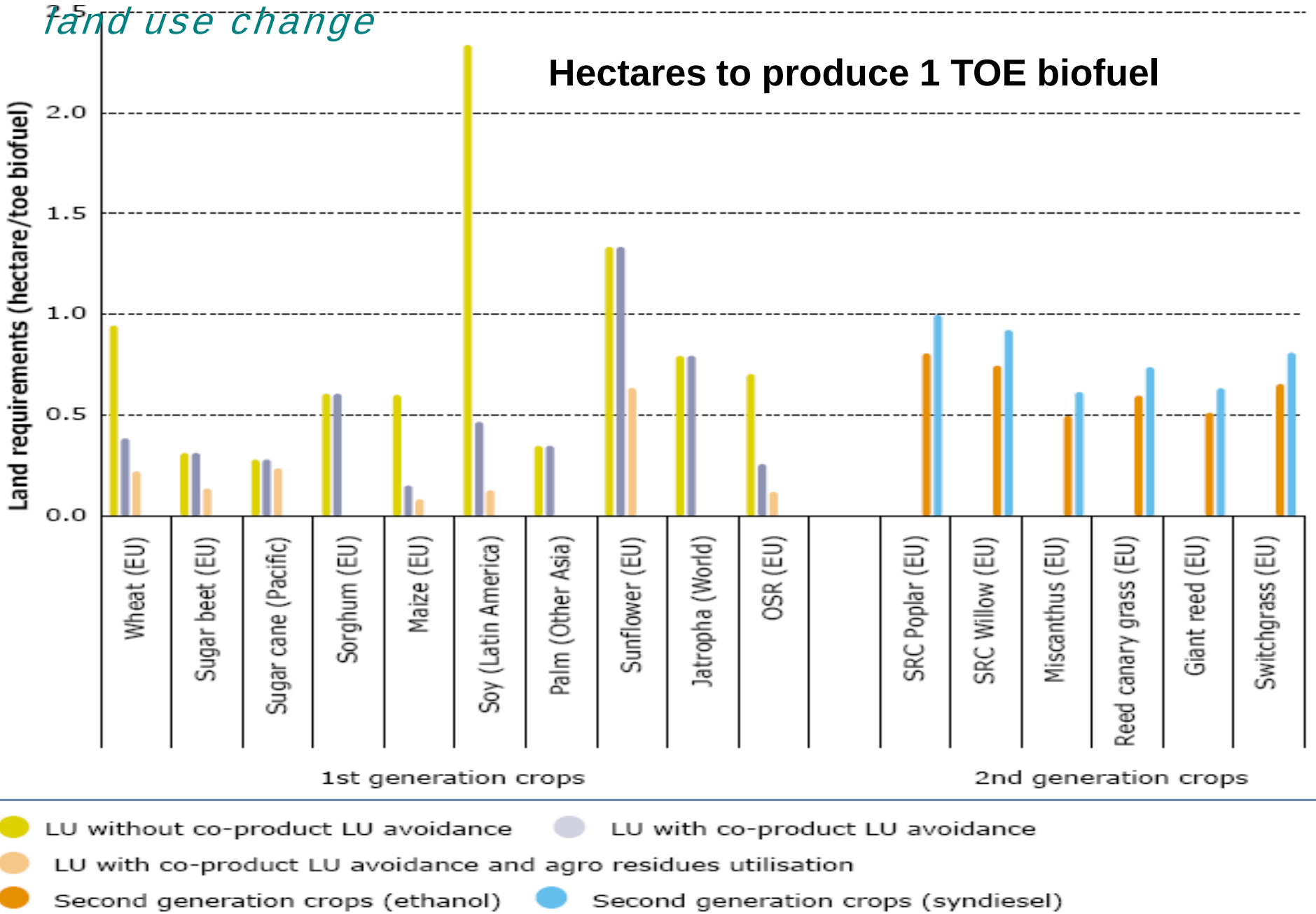
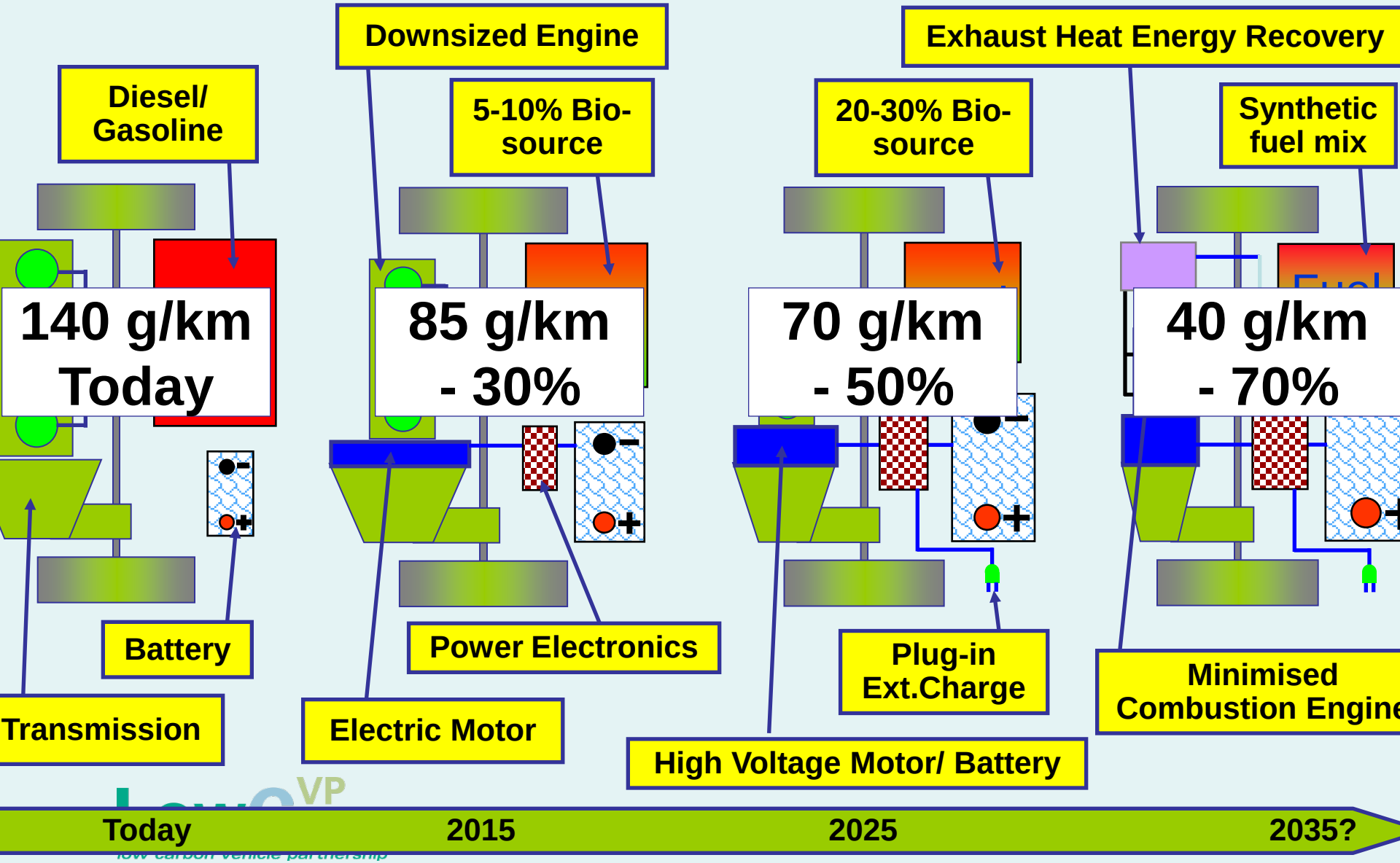
Advanced fuels and energy crops also generate indirect land use change



Efficient powertrains using advanced low carbon liquid fuels provide an alternative route to ultra-low carbon



Hydrogen fuel cell vehicles offer significant, but still distant prospects

Key challenges:

- Higher costs per unit of energy
  - Adequate price of carbon mitigation
- Supply of renewable hydrogen
- Development of refuelling infrastructure and practical storage
  - Chicken and egg supply problem
- Supply of a range of affordable vehicles
  - Fuel cell costs, durability and reliability
- Improving public acceptability
- Alternative LC-options
- RD&D funding

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Preparing the market for renewable fuels requires:

- Coordinated support throughout the innovation chain
- Tackling market failures & supporting niche applications
- Long-term commitments to promising alternatives
- Adequate incentives to reward low carbon
- Bridging the customer attitude-action gap
- Preparing for the rebound effect and changes to transport fuel tax revenues

"It has very low emissions - it's impossible to find a garage selling the fuel."

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Fuel duty revenues

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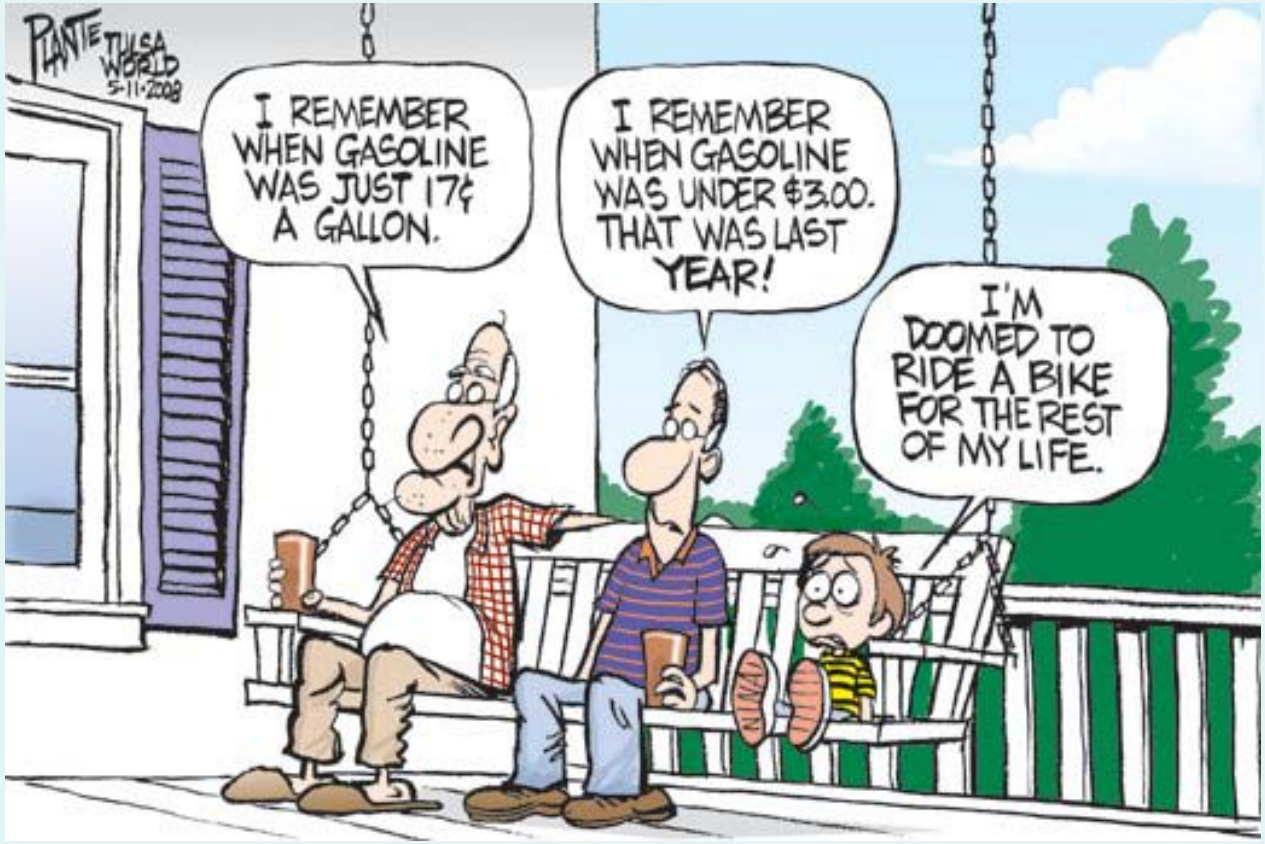
Other measures & conclusions



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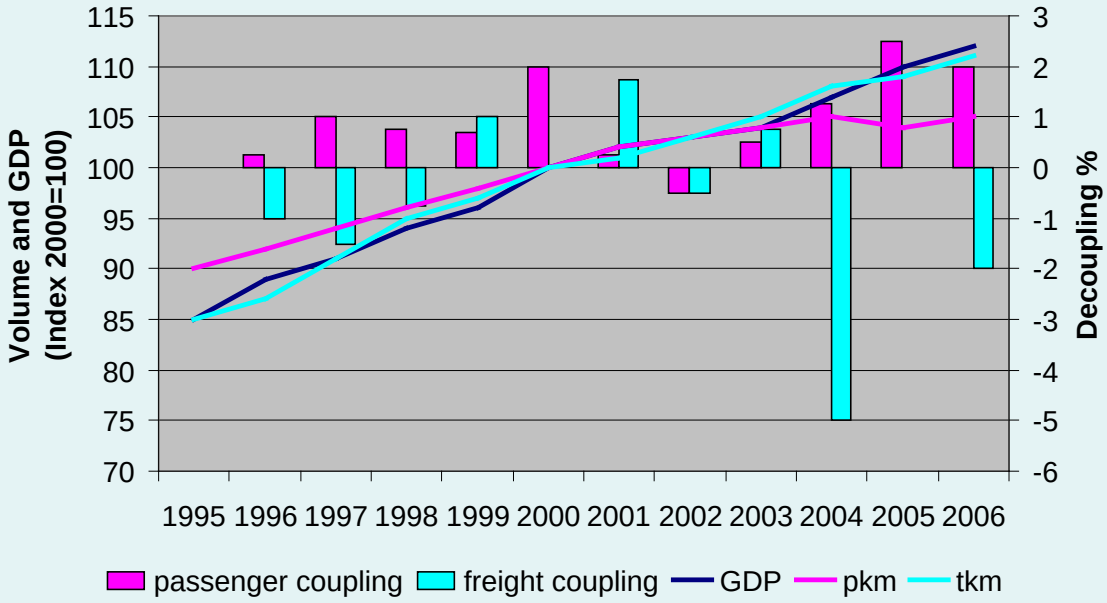
Technology can only be part of the solution - demand management and mode shift are also needed to delink transport demand & growth; & manage rebound effects

- Smarter driving improved driver behaviour
- Reduced vehicle use
- Better freight distribution
- Modal shift
- Land-use planning
- Tele-working

EU trends in freight and passenger transport compared to GDP



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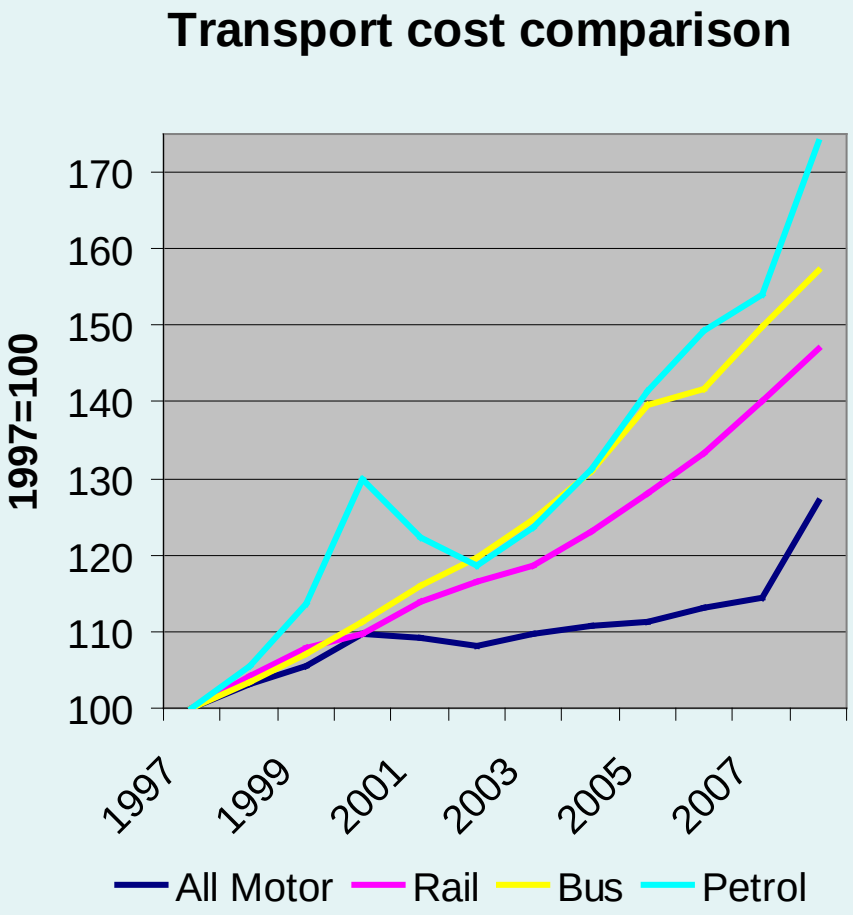
High fuel prices stimulate lower carbon and reduced demand for transport - but not necessarily mode shift



- High fuel prices <u>short term</u> lead to
  - Fewer journeys
  - Shorter journeys
  - More efficient driving
  - Lower speeds
  - Mode shift
- High fuel prices <u>long-term</u> lead to
  - Trip destination changes
  - Location changes
  - More efficient vehicles
- High fuel prices reduce technology payback times
- Public transport has become increasingly expensive compared to motoring

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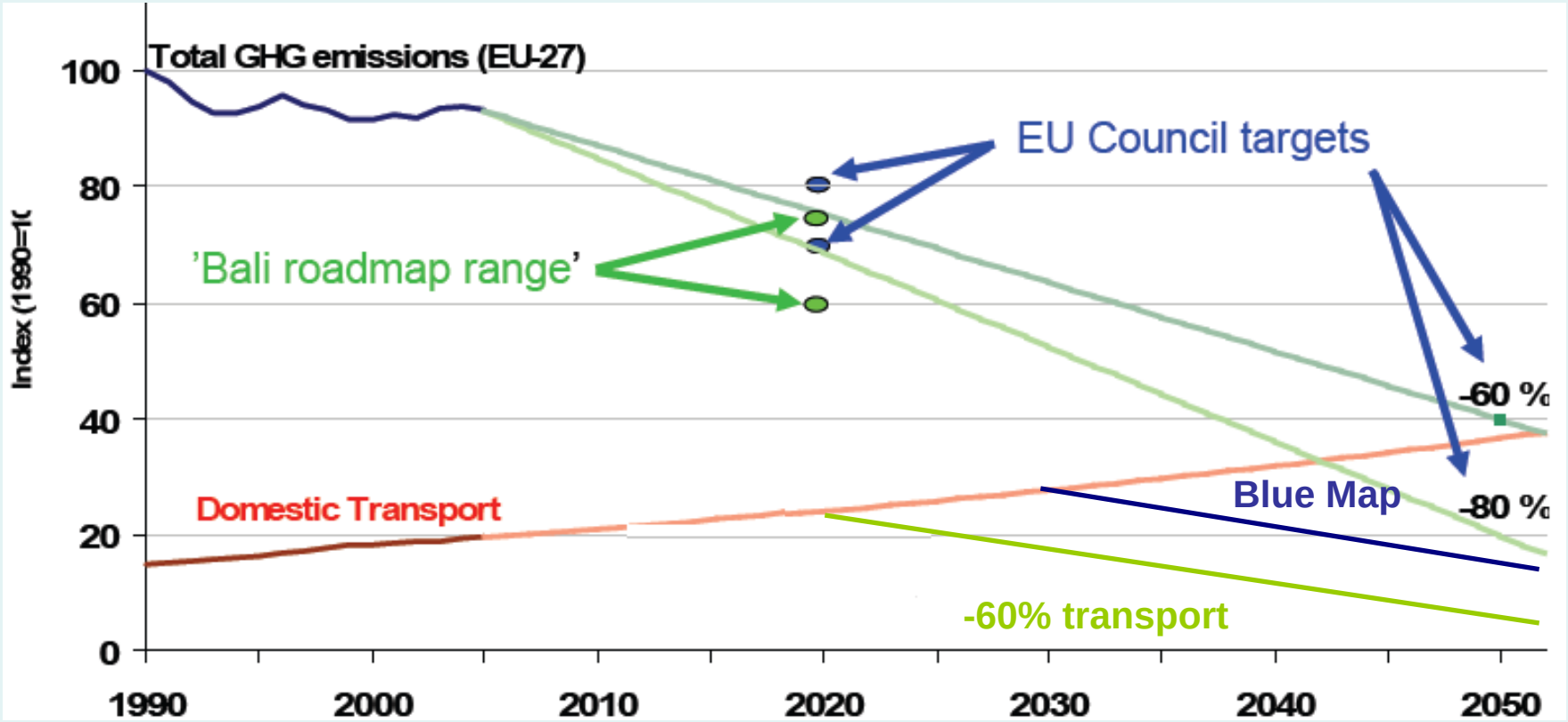
Based upon DfT 2008

EU domestic transport emissions will consume the CO2 budget on current trends – Even ambitious emission reductions may not leave sufficient headroom for other sectors



Adapted from EEA 2009 & TNO 2009

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Messages – There are no silver bullets

- We must wean ourselves off our petroleum dependency
- In the next 10-years deploying existing technology to improve vehicle efficiency is the priority, accelerated by:
  - Reversing unsustainable vehicle characteristics trends; consistently high fuel prices; legislation; and, increased consumer demand
- Beyond 2020 renewable fuels will play an increasing important role
- Barriers to electrification of transport are unlikely to be resolved quickly; share of electric and plug-in hybrid vehicles will become important 2020+
- Biofuels will make-up an increasing proportion of liquid fuels-
  - Ultimately may be used with PHEVs and HGVs
- Hydrogen fuel cell vehicles may ultimately compete –
  - Unlikely to have significant market share before 2030
- Technology is only part of the solution – demand management and building public transport infrastructure to encourage modal shift is crucial

2000

2004

2006

2008

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Any Questions?

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The Low Carbon Vehicle Partnership

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There are now a range of low emission models in every market segment

Smart for two
88g/km

Prius 3
89g/km

Volvo S80
129g/km

Lexus RH450
148g/km

VW Passat
118g/km

Volvo V50
104g/km

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