Decarbonisation of Transport
'The challenge for technology'

Andy Eastlake

Low Carbon Vehicle Partnership – UK

March 2014

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Low Carbon Vehicle Partnership

Connect
Collaborate
Influence

LowCVP – The Low Carbon Vehicle Partnership

The LowCVP is an independent, not-for profit stakeholder partnership funded mainly through government grants and member contributions.

The LowCVP is the only organisation in the UK – or Europe – which brings stakeholders together to facilitate the development of better policy and accelerate the shift to low carbon vehicles and fuels.

"The LowCVP is a unique organisation which is effective in bringing stakeholders with widely differing perspectives together."

Prof Neville Jackson, Chief Technology and Innovation Officer, Ricardo UK Ltd and Chair of the LowCVP Board

LowCVP – Vision, Mission and Aims

- Our aspiration is for "**Sustainable and efficient global mobility with zero life cycle impact**"
- We will work towards this by "**Accelerating a sustainable shift to low carbon vehicles and fuels and stimulating opportunities for UK businesses**"
- Through:
  - **Connecting** stakeholders to build understanding and consensus regarding the optimal pathways to low carbon road transport.
  - **Collaborating** on initiatives that develop the market for low carbon vehicles and fuels.
  - **Influencing** Government and other decision makers on future policy directions and optimal policy mechanisms.

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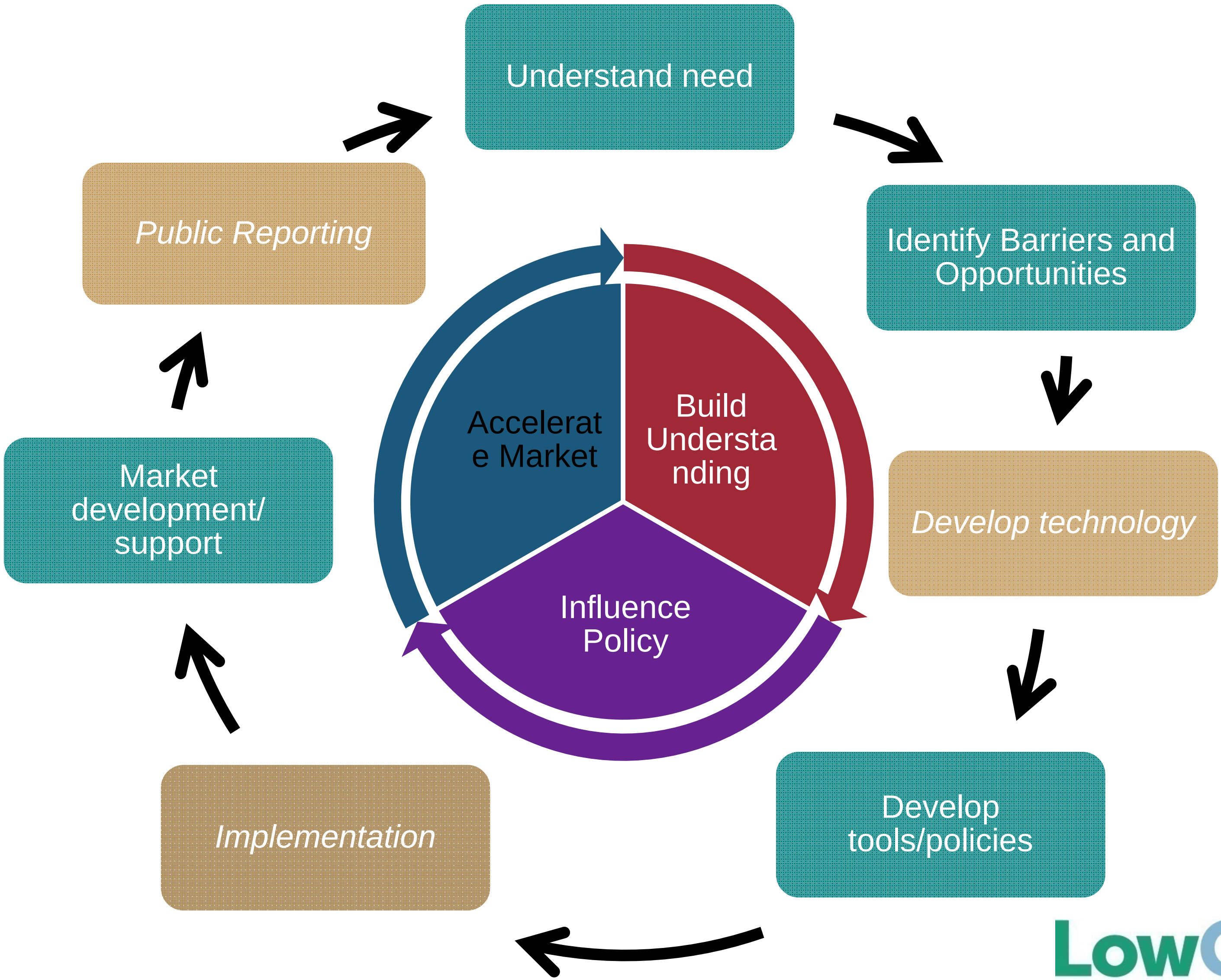
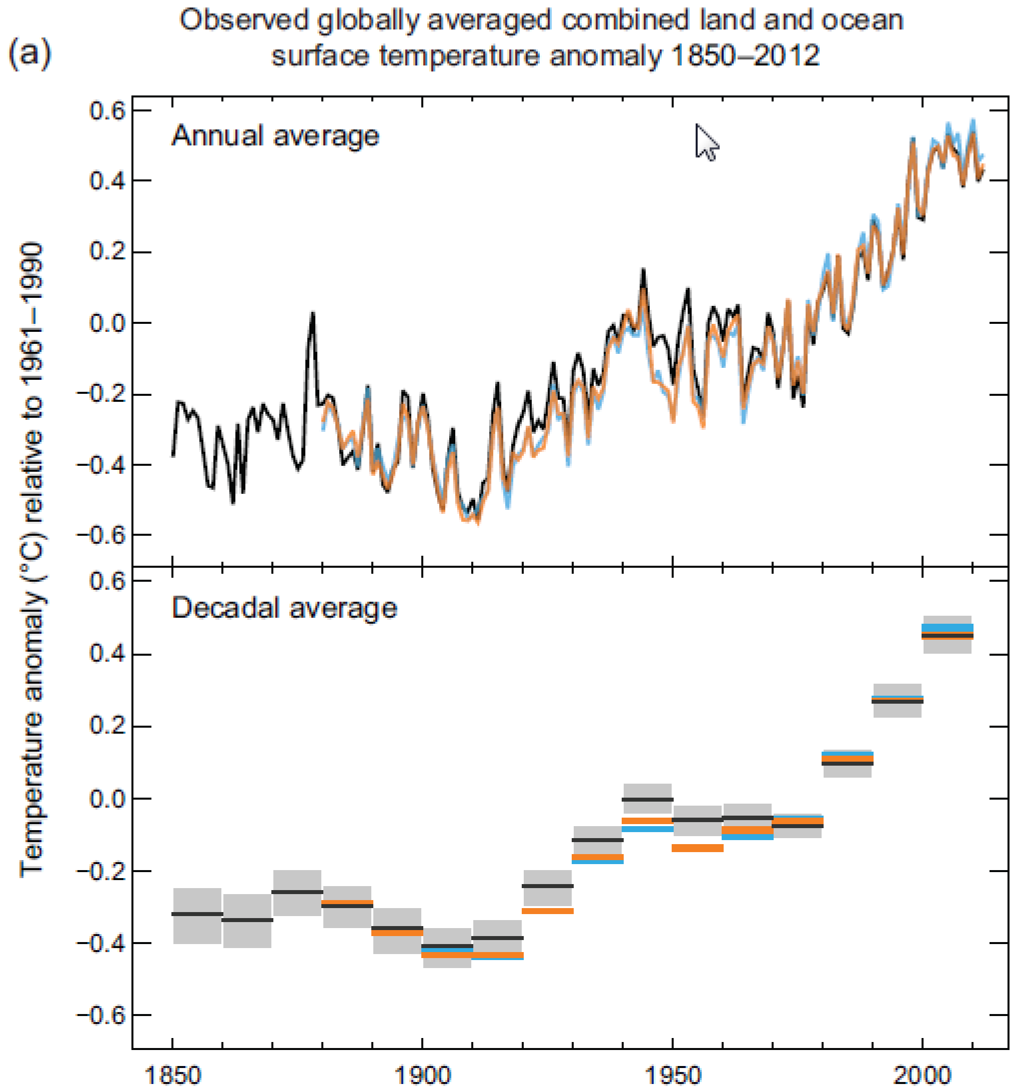
LowCVP activity cycle



Why Decarbonise

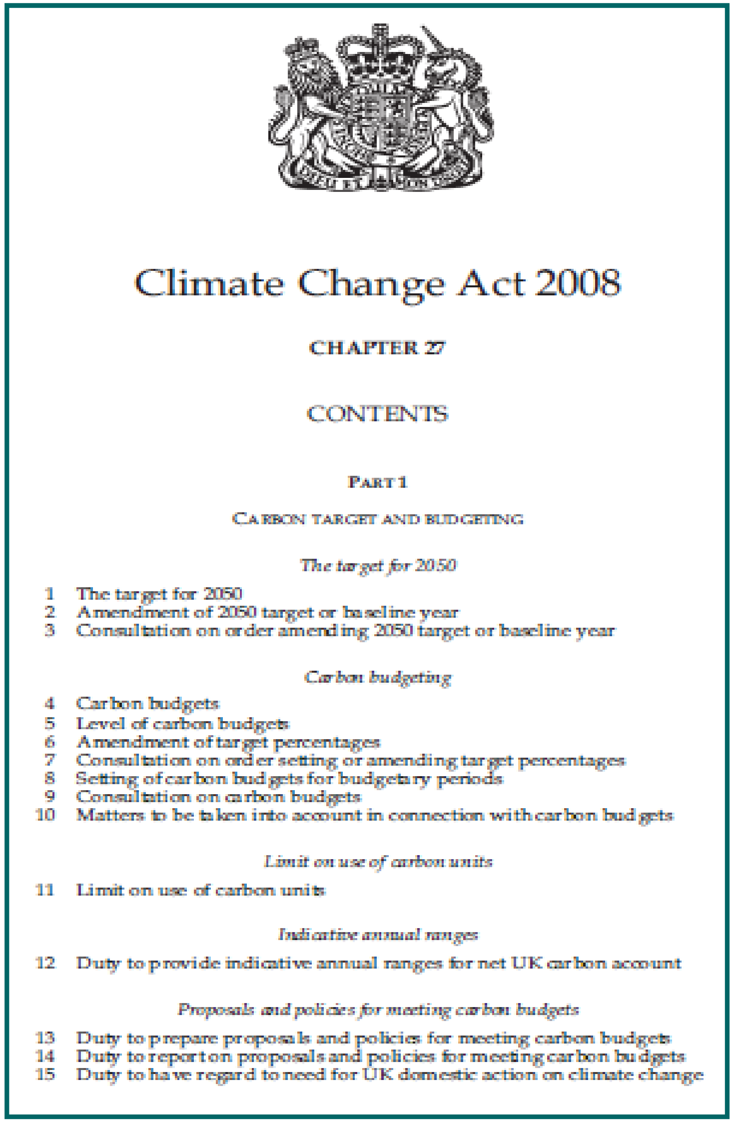
- Rising Temperature
- Extreme weather
- Sea level rise
- Ice melt



It’s the Law!

UK signed The Climate Change act in 2008

- Sets binding targets for 2050
- Creates alignment across departments
- Forces all government departments to publish plans regularly
- Creates an independent monitoring body The CCC (Committee on Climate Chage)
- Transcends political changes of government terms
- A series of “Carbon Budgets” for 5 yr objectives



Climate Change Act 2008

CHAPTER 27

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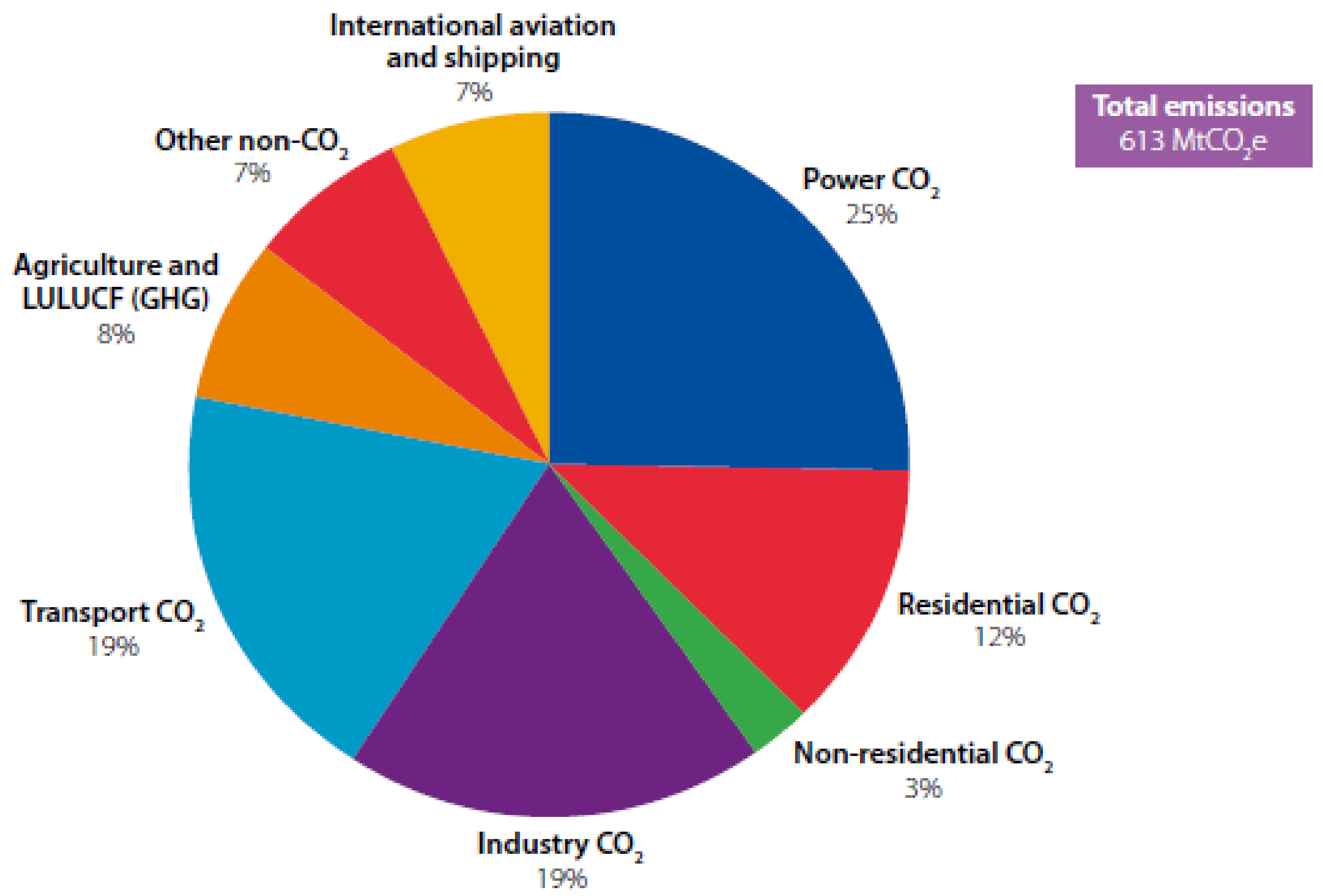
PART 1

CARBON TARGET AND BUDGETING

The target for 2050

What is causing the problem?

Figure 1.1: UK greenhouse gas emissions in 2012



Source: DECC (2013) Provisional emissions estimates; NAEI (2013) Final emissions estimates.
Notes: International aviation and shipping are currently not included in carbon budgets.

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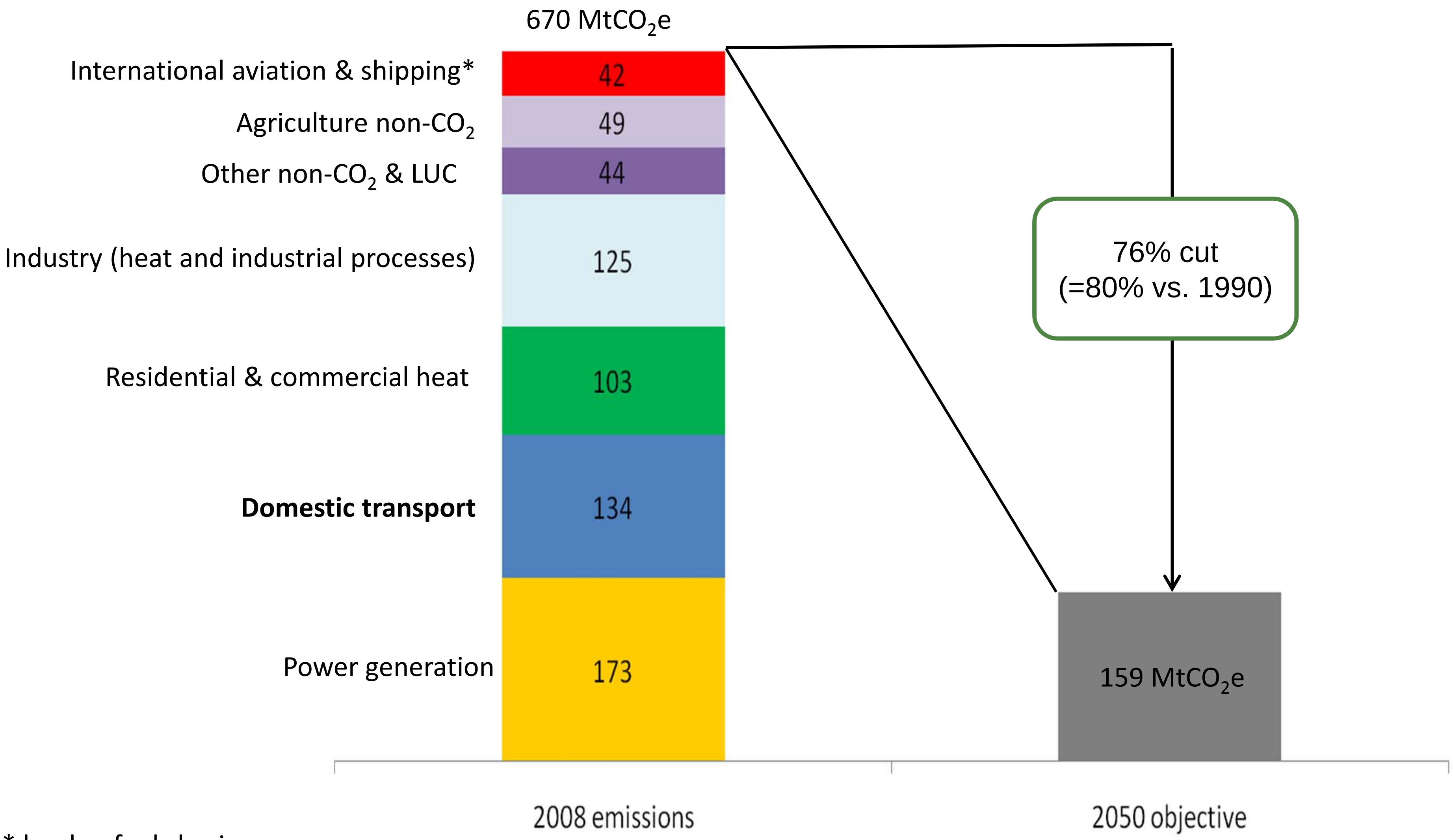
The 2050 target for UK is very challenging

(source CCC)

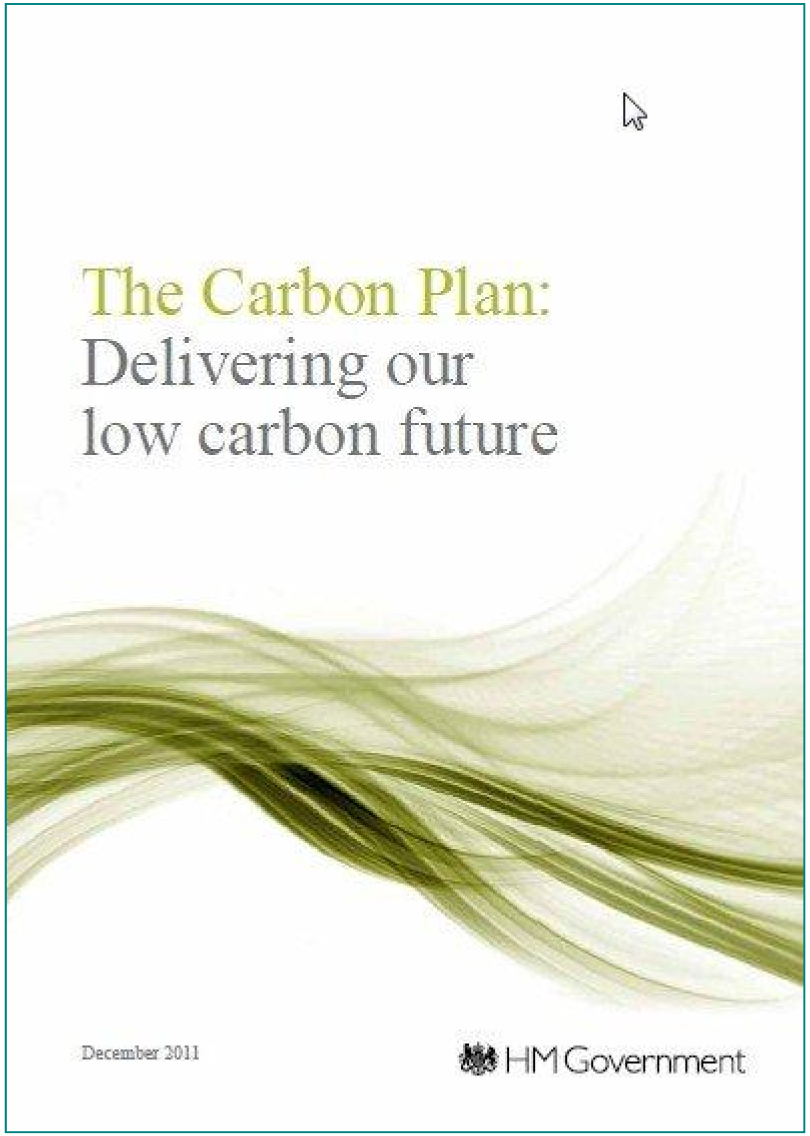


* bunker fuels basis

The government strategy

Identifying the range of energy pathways required to deliver the Government Carbon plan targets

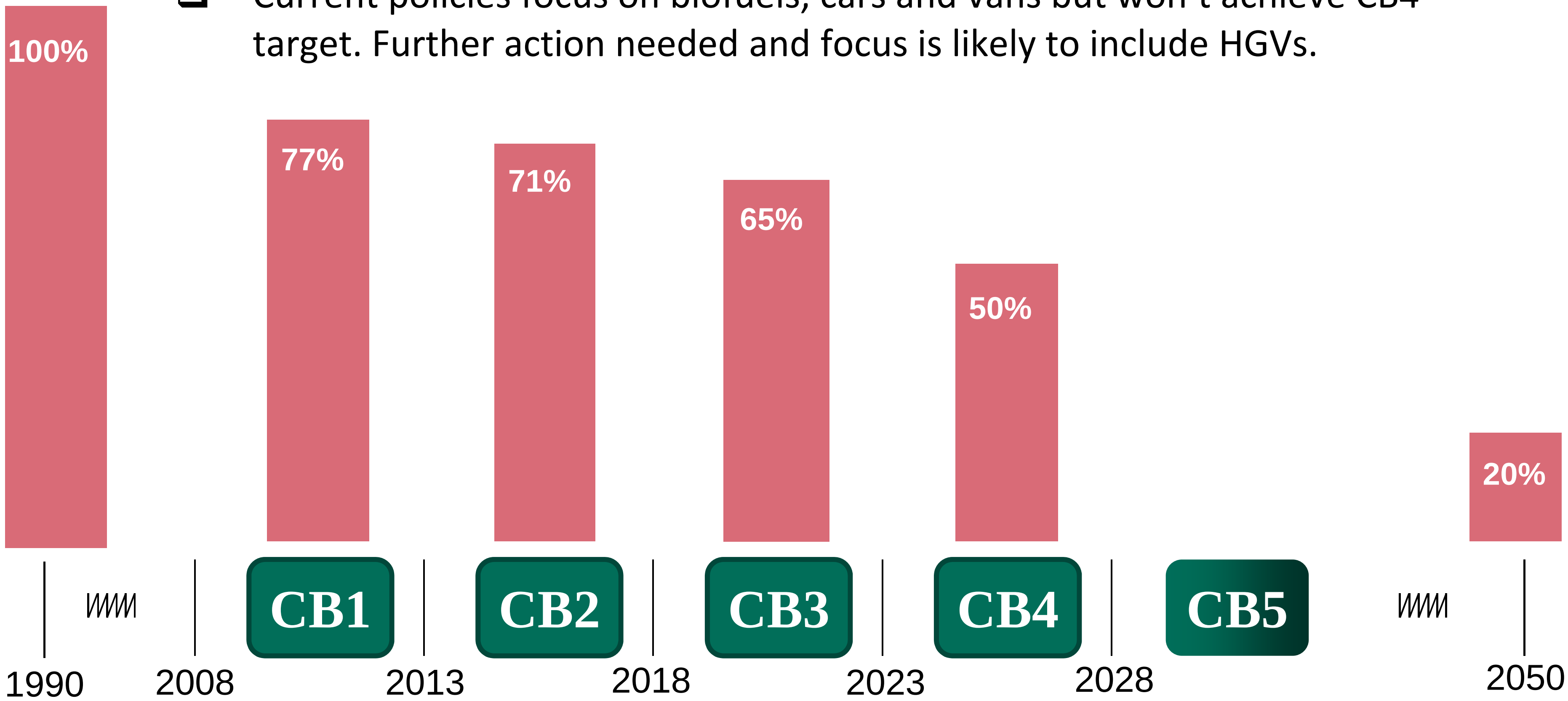
Review the existing data and fill in the gaps for other energy systems



UK is committed to reducing GHG emissions by 80% by 2050 compared to 1990 through a series of "carbon budgets"

The overall goal:

- 80% GHG reduction below 1990 levels by 2050
- Carbon budgets set interim targets
- Surface transport will need to be 'near zero' GHG by 2050
- Current policies focus on biofuels, cars and vans but won't achieve CB4 target. Further action needed and focus is likely to include HGVs.



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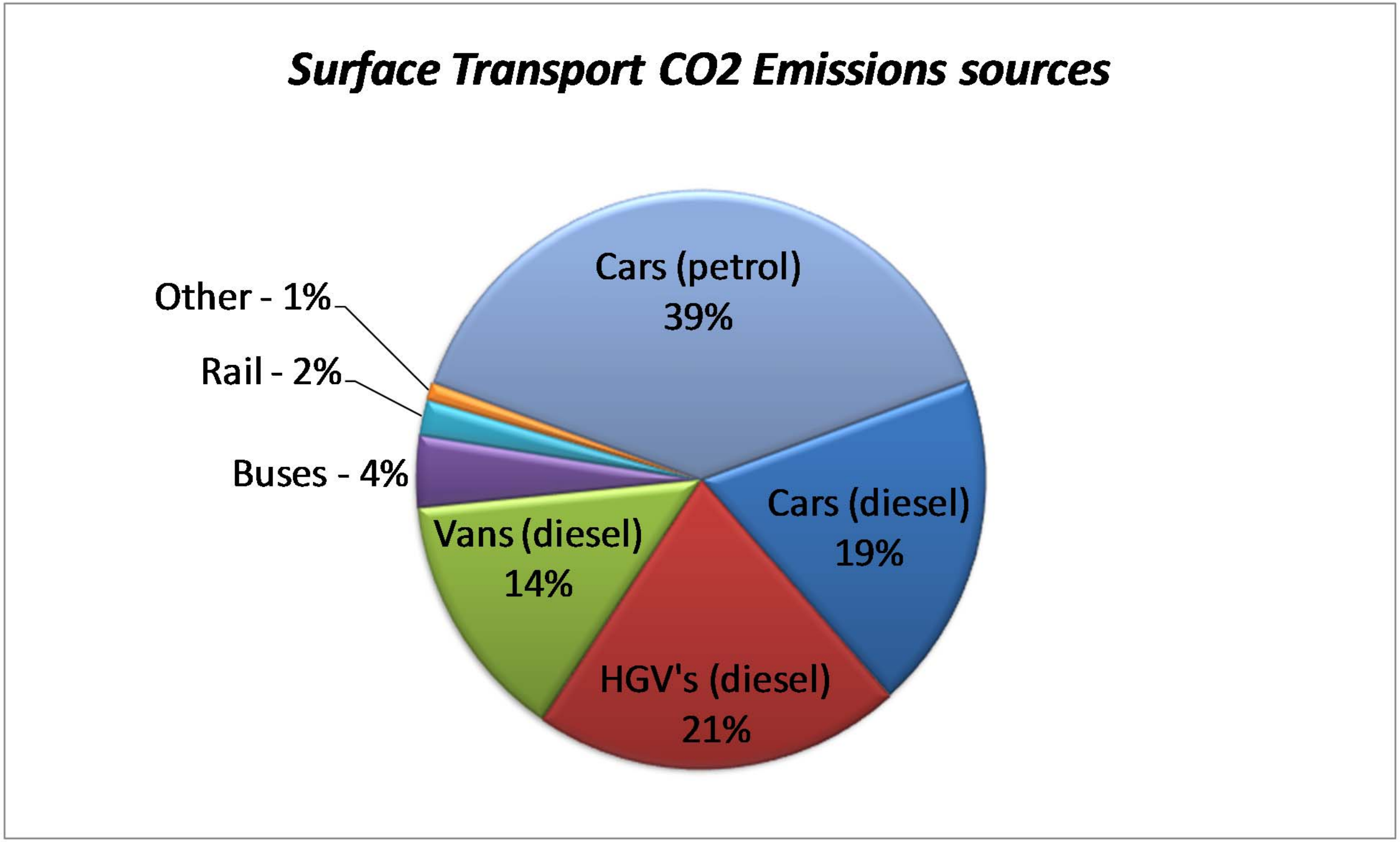
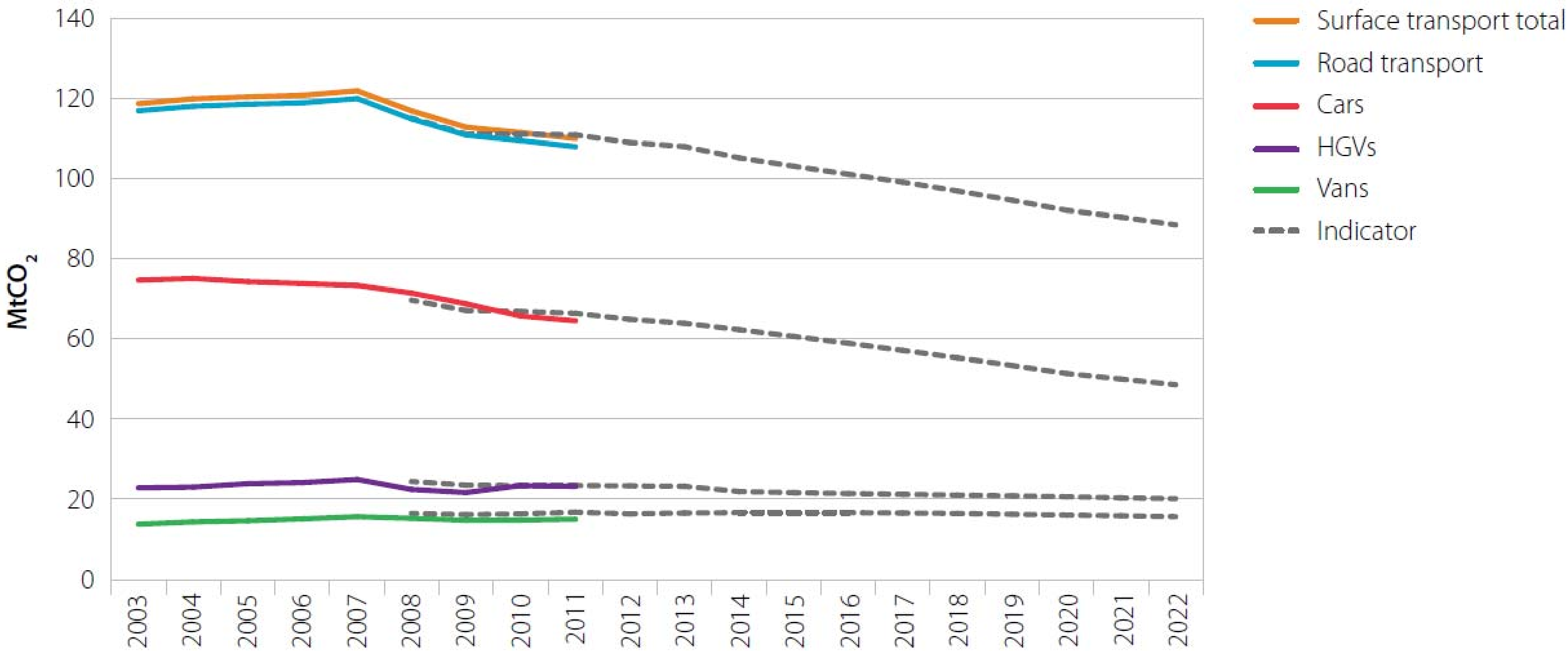
Petrol and diesel currently account for the vast majority of surface transport emissions (99.7%).



Surface transport emissions fell by 1.3% in 2011. (source CCC)



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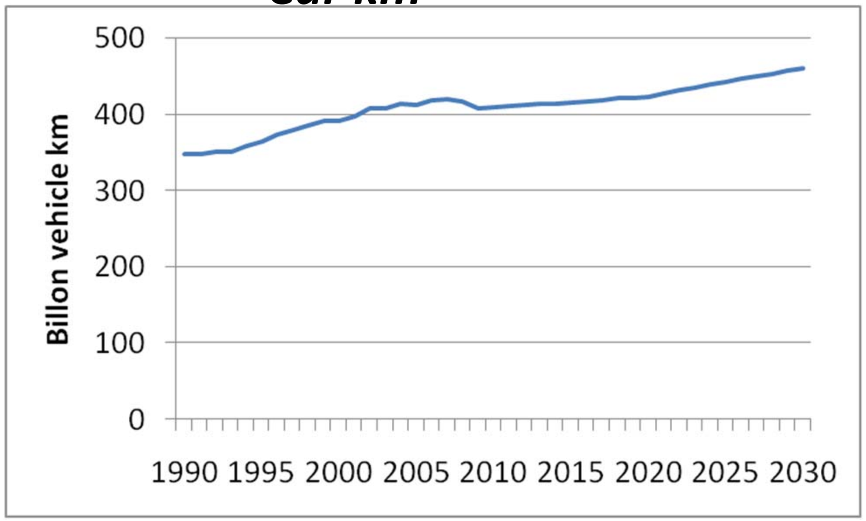
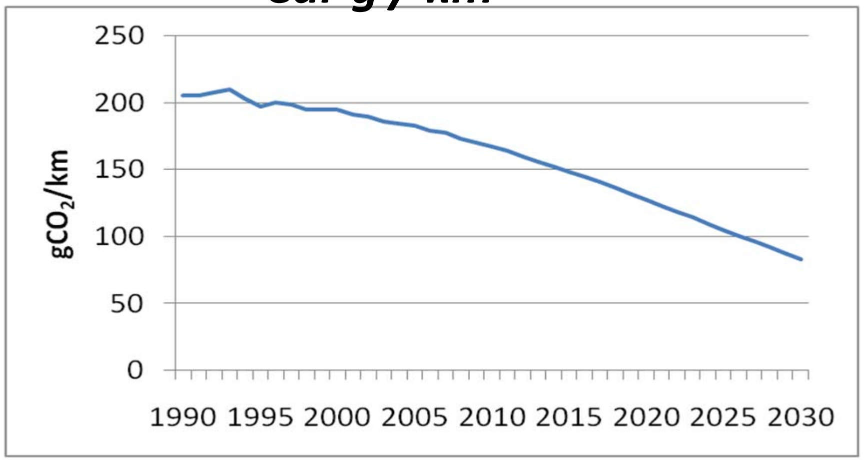
Transport: Emissions reduction will come from reducing g/km, while km likely to increase (Source CCC)

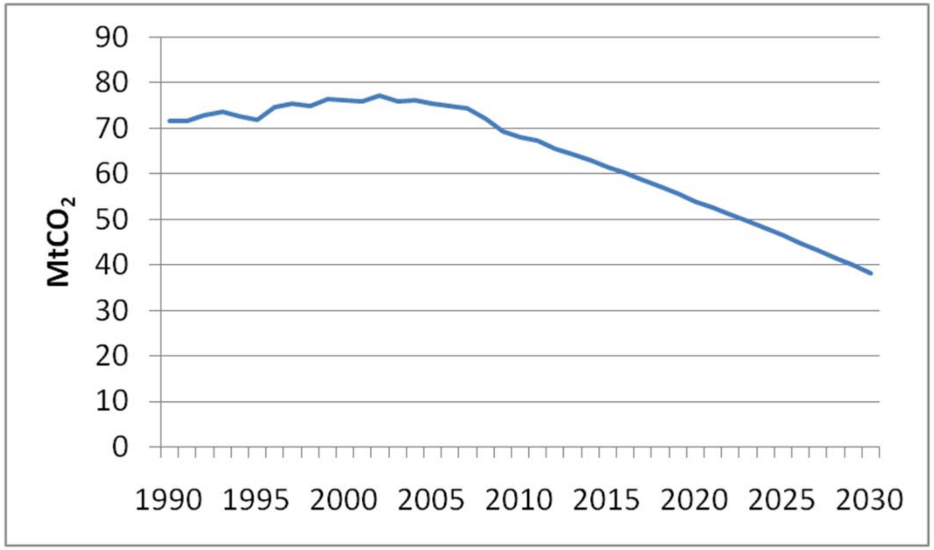
Car km



Car g / km



Car emissions



Vans: 17% emissions reduction to 2030
HGVs: 33% emissions reduction to 2030

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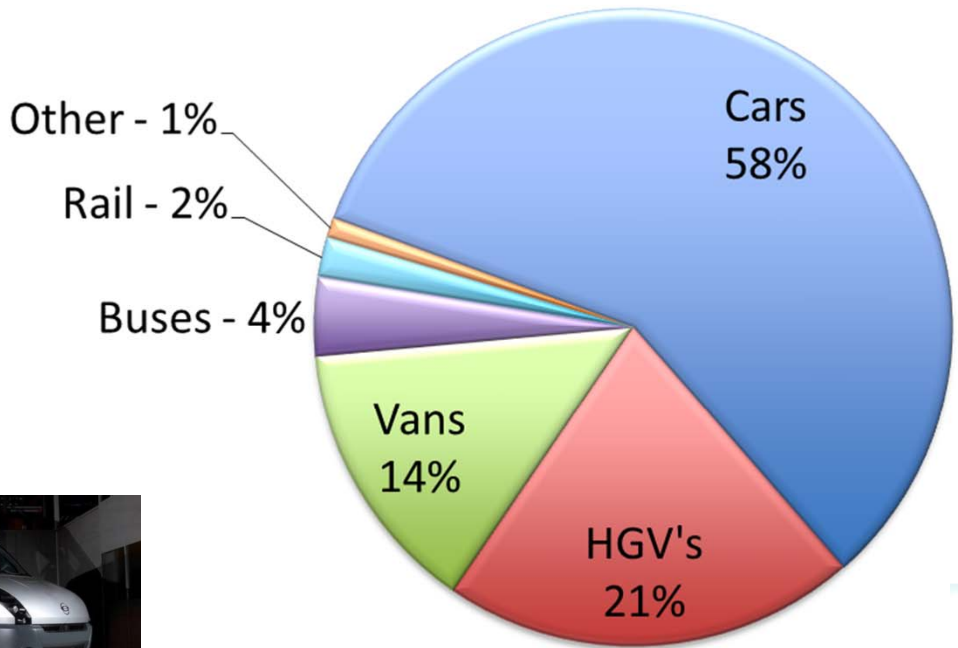
A wide range of innovative vehicle technology options to reduce carbon are emerging on the market

Core progress made through improvements in vehicle efficiency and with low blend Biofuels



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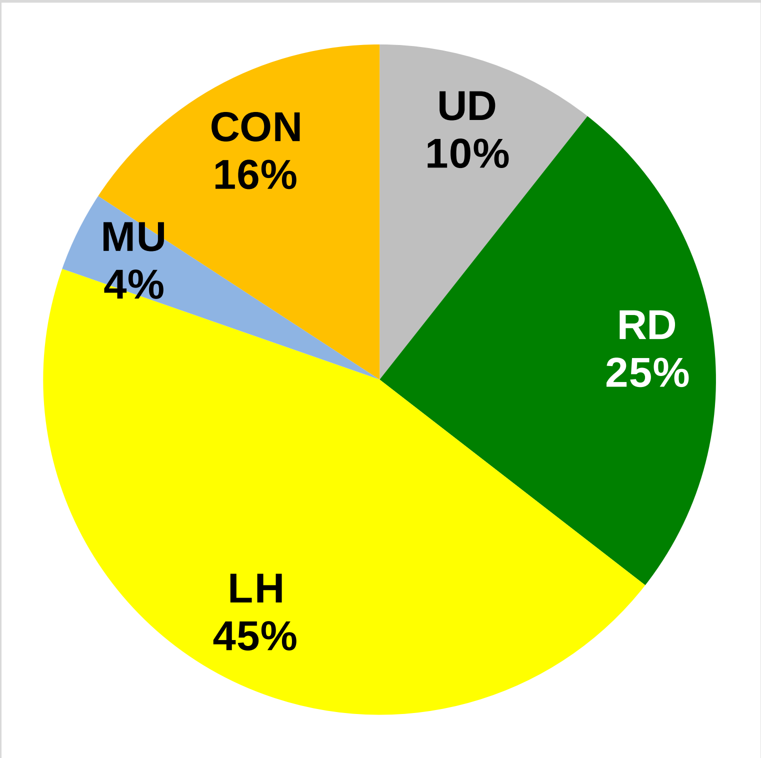
Decarbonising Road Freight – the opportunities

- Research on behalf of DfT
- Joint report published 3rd Dec ‘12
- LowCVP/Transport KTN/SMMT
- Supported by Industry bodies
  - CiLT
  - FTA
  - RHA

Where does the HGV CO2 come from



Ranking of duty cycles by CO_2 emissions share:

1. **LH Long haul (44-46 %)**
2. **RD Regional Delivery (24-25 %)**
3. **CON Construction (15-16 %)**
4. **UD Urban Delivery (10-12 %)**
5. **MU Municipal Utility (4 %)**

The ranges indicate the variation due to low, central and high distance estimates.

70% of fuel is used in Long Haul and Regional Delivery operation in Larger Trucks

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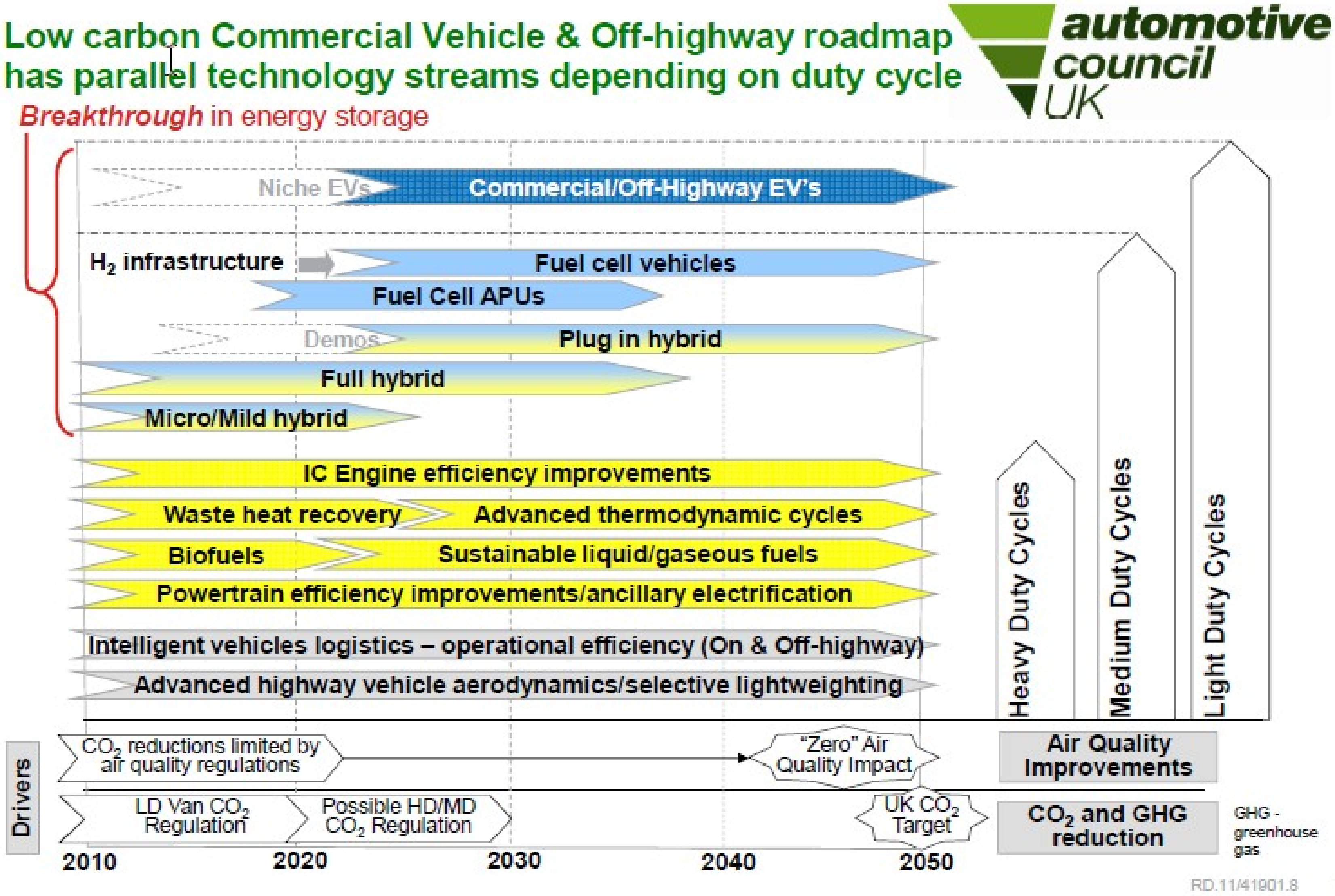
Recommended technologies & fuels

	Technology / fuel	Applicable duty cycles	Total UK HGV WTW CO_2e saving potential*	Additional considerations
1	Dedicated natural gas engines	All	5-16% (methane) 61-65% (biomethane)	Significant particulate emission & noise reduction benefits. CO_2 reduction benefit substantially greater when running on biomethane.
2	Dual fuel engines	Long haul, regional delivery and construction	13% (methane) 33% (biomethane)	Some particulate emissions & noise reduction benefits when running on gas. Payback and CO_2 savings very dependent on gas substitution rates (higher for higher speed duty cycles). CO_2 reduction benefit substantially greater when running on biomethane.
3	Aerodynamic improvements	Long haul, regional delivery and construction	5-6%	Benefits dependent on correct fitting / adjustment / average duty cycle speeds. Does not suit some body types / operations.
4	Pure electric vehicles	Urban delivery	5%	Highest local air quality and noise reduction benefits. Lifecycle impacts of batteries need to be considered. Currently maximum available GVW is 12 tonnes.
5	Hybrid electric / hydraulic hybrid / flywheel hybrid vehicles	Urban delivery and municipal utility	3-4%	Air quality and noise reduction benefits particularly if able to run in electric only mode. Lifecycle impacts of batteries need to be considered. Flywheel hybrids are not yet commercially available, but are expected to offer a lighter weight and possibly lower cost alternative to battery-electric hybrids.
6	Low rolling resistance tyres / single wide tyres	All	1-5%	Lower rolling resistance tyres are available for all duty cycles. May have slightly shorter lifespan than standard tyres but CO_2 savings expected to outweigh any negative environmental impact.

*The overall % saving of total UK HGV CO_2 emissions if technology/fuel applied to all relevant vehicles/duty cycles.

Road Freight road map



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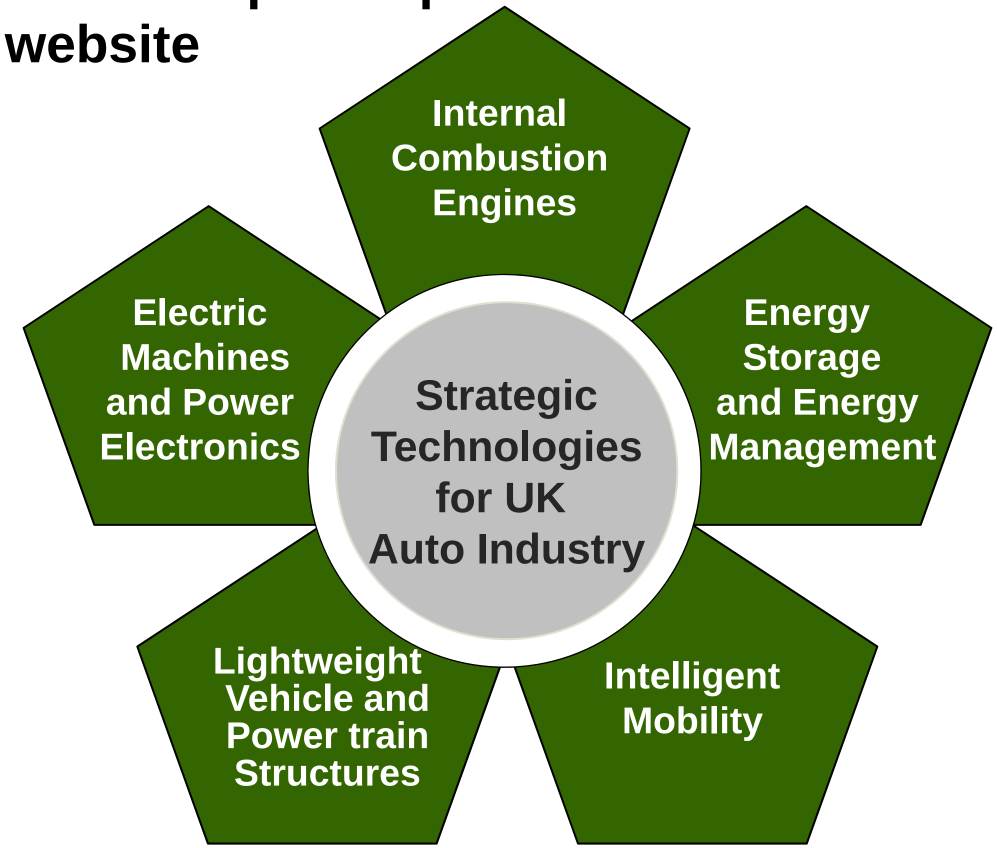
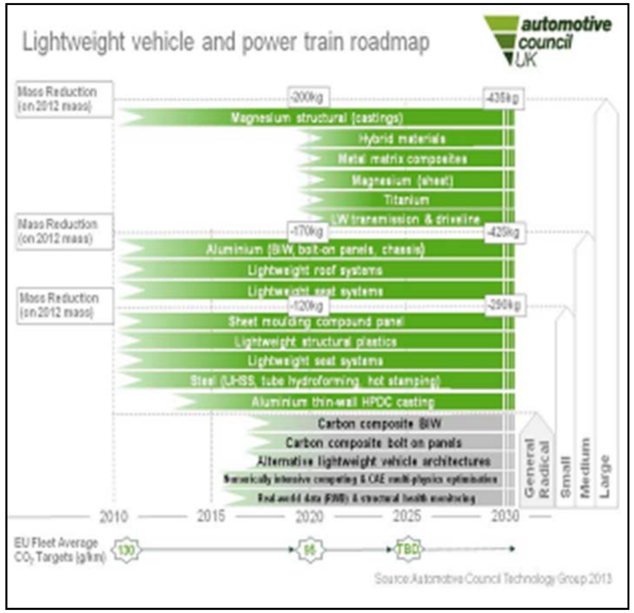
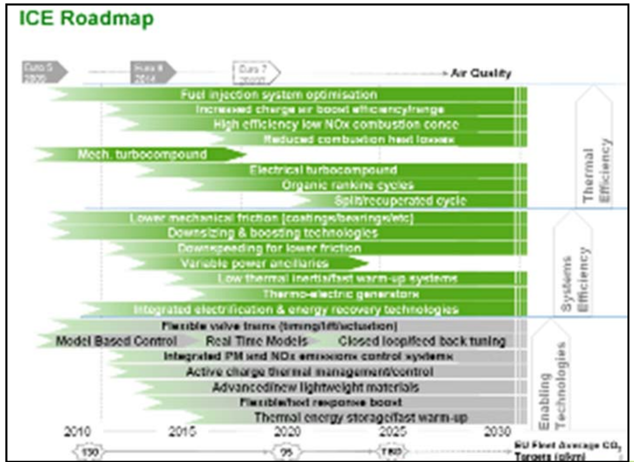
Technology Roadmaps

- **Strategic Technology Roadmaps have been developed, were approved by Automotive Council and announced at LCV 2013**
- **Roadmaps are published on the AC website**







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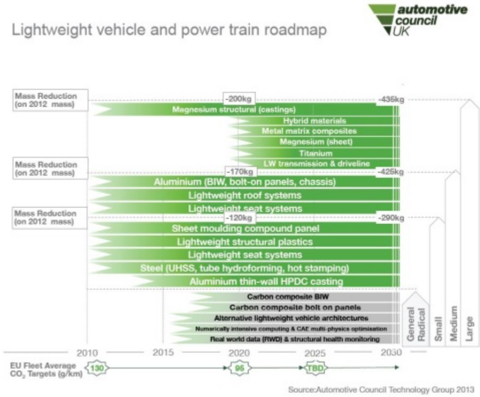
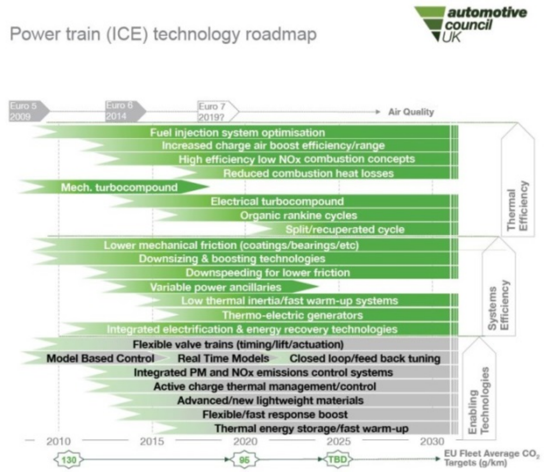
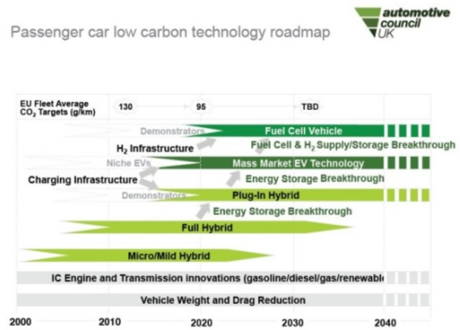
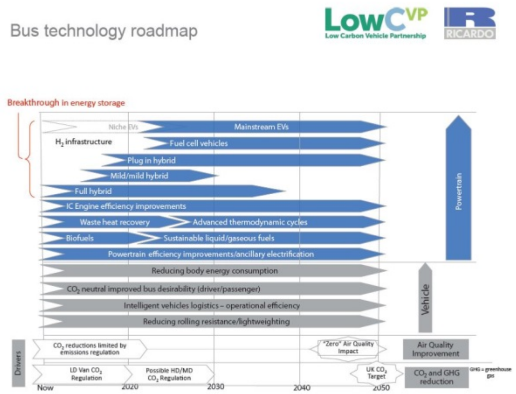
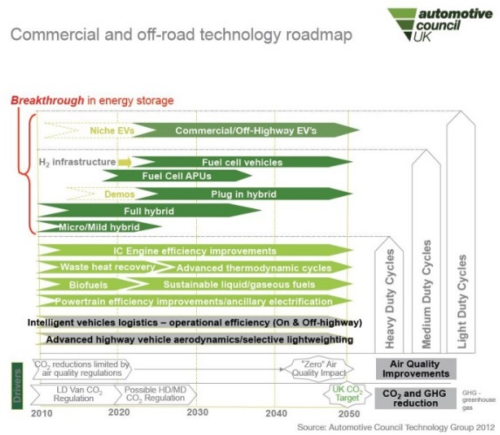
Range of roadmaps for technology areas











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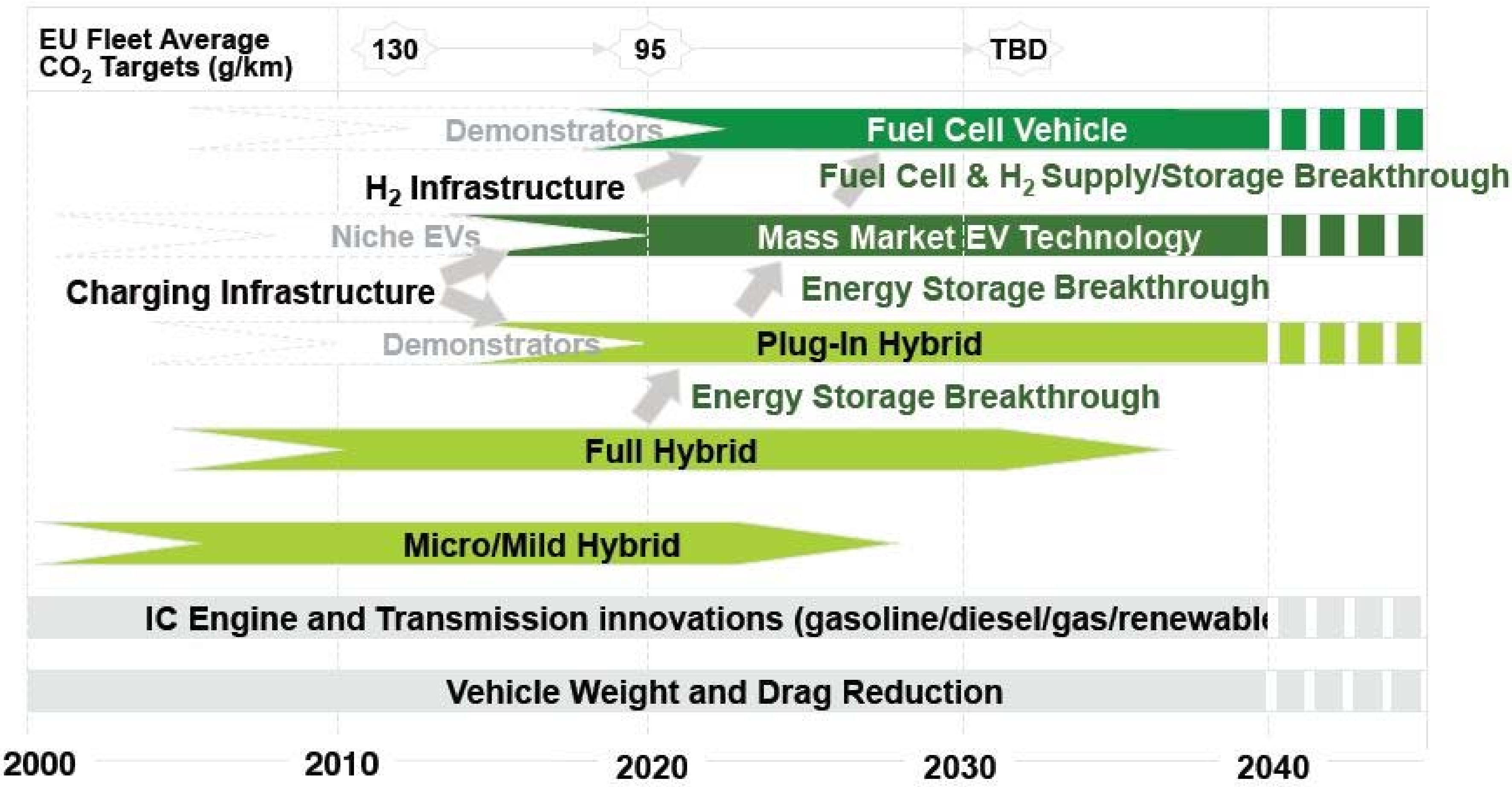
Passenger car low carbon technology roadmap



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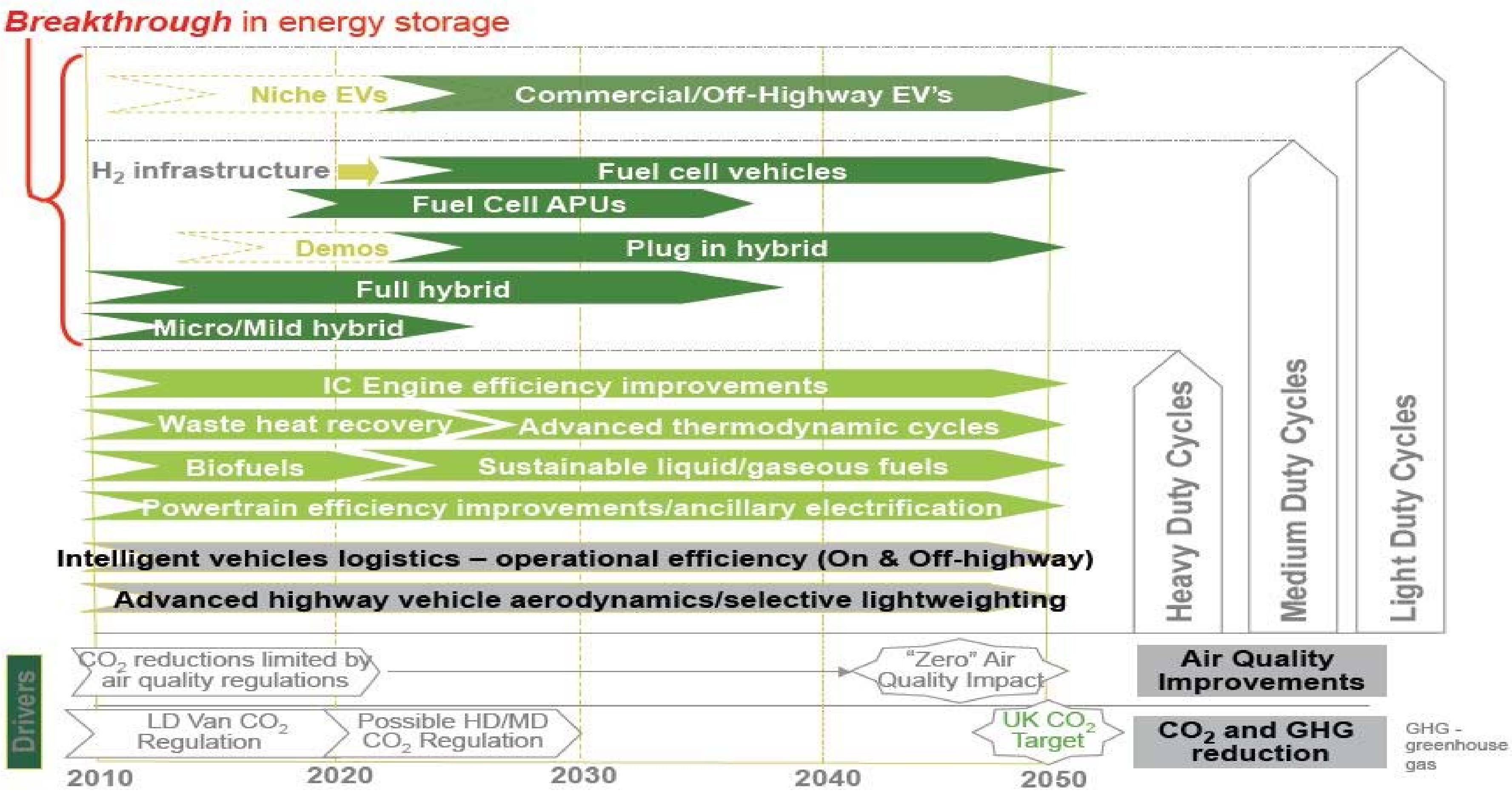
Commercial and off-road technology roadmap



Source: Automotive Council Technology Group 2012

Penetration of technology is slow

SMMT Motor industry facts 2013

New technology is a key carbon reduction strategy (eg new car CO_2 progress, EV's)

Annual sales of new vehicles as percentage of road fleet:- - average sales % over last 10yrs

- Cars 7.3%
- Vans 8.2%
- Trucks 8.5%
- Bus 4.1%

Existing vehicles will remain in the fleet for many years and fuel must remain compatible

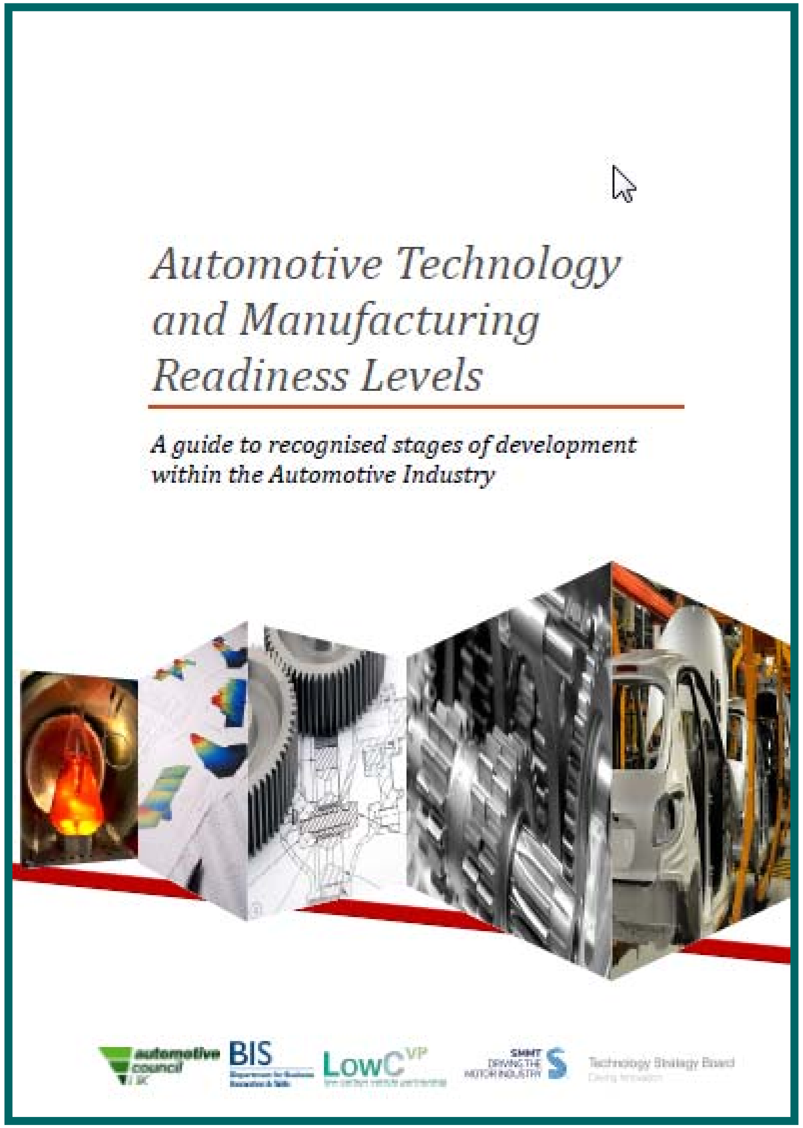
Sales of plug-in cars doubled in 2012 but were just 2254 in a new car market of over 2M (and total fleet of 31.5M)

Talking the same language

A key challenge has been to get all stakeholders to use common language and common understanding/expectations of technology maturity

Guide developed by LowCVP, Auto Council, BIS, SMMT, TSB.

Identifies language and is now used to define positioning for major initiatives



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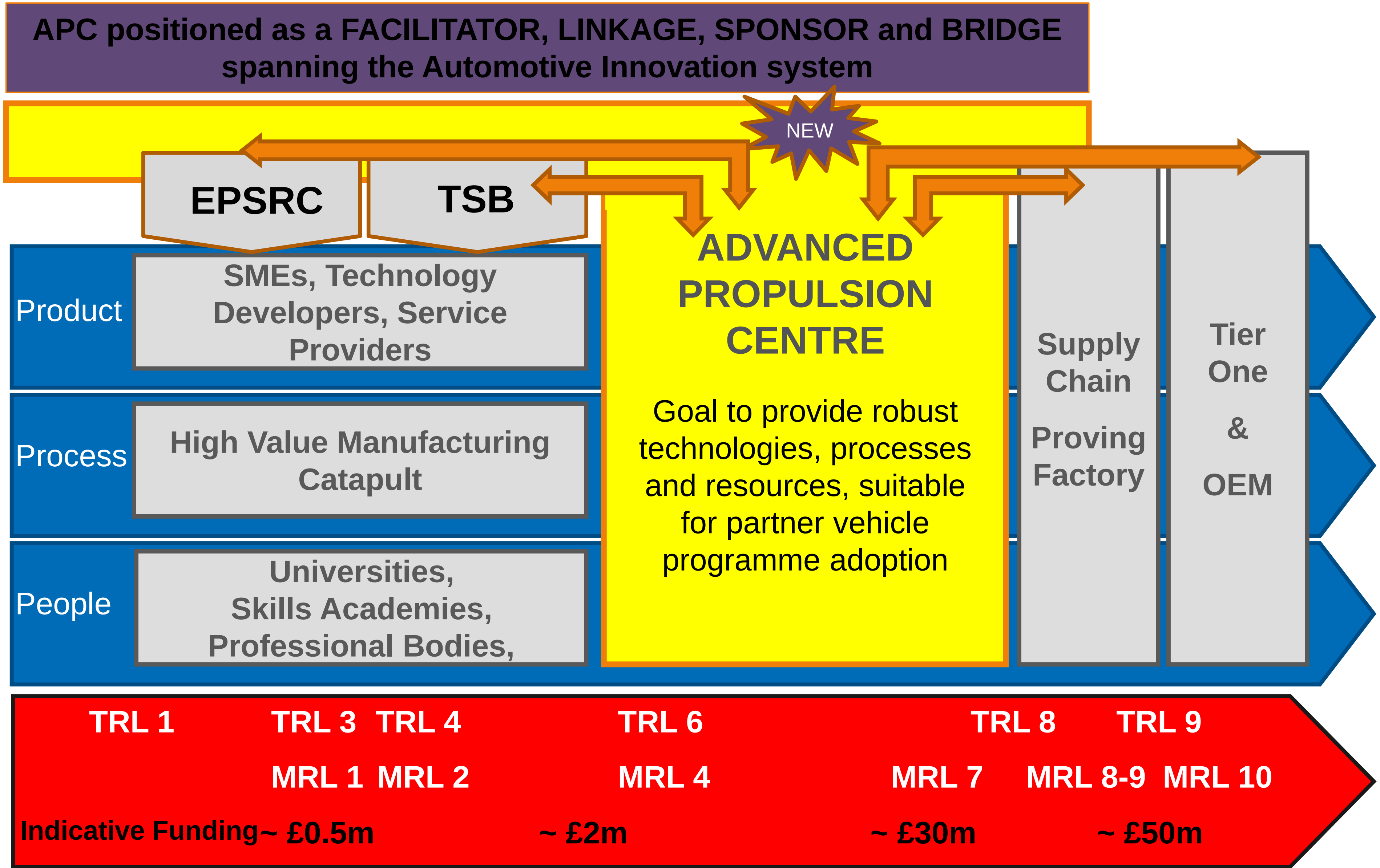
Automotive R&D Value-Chain



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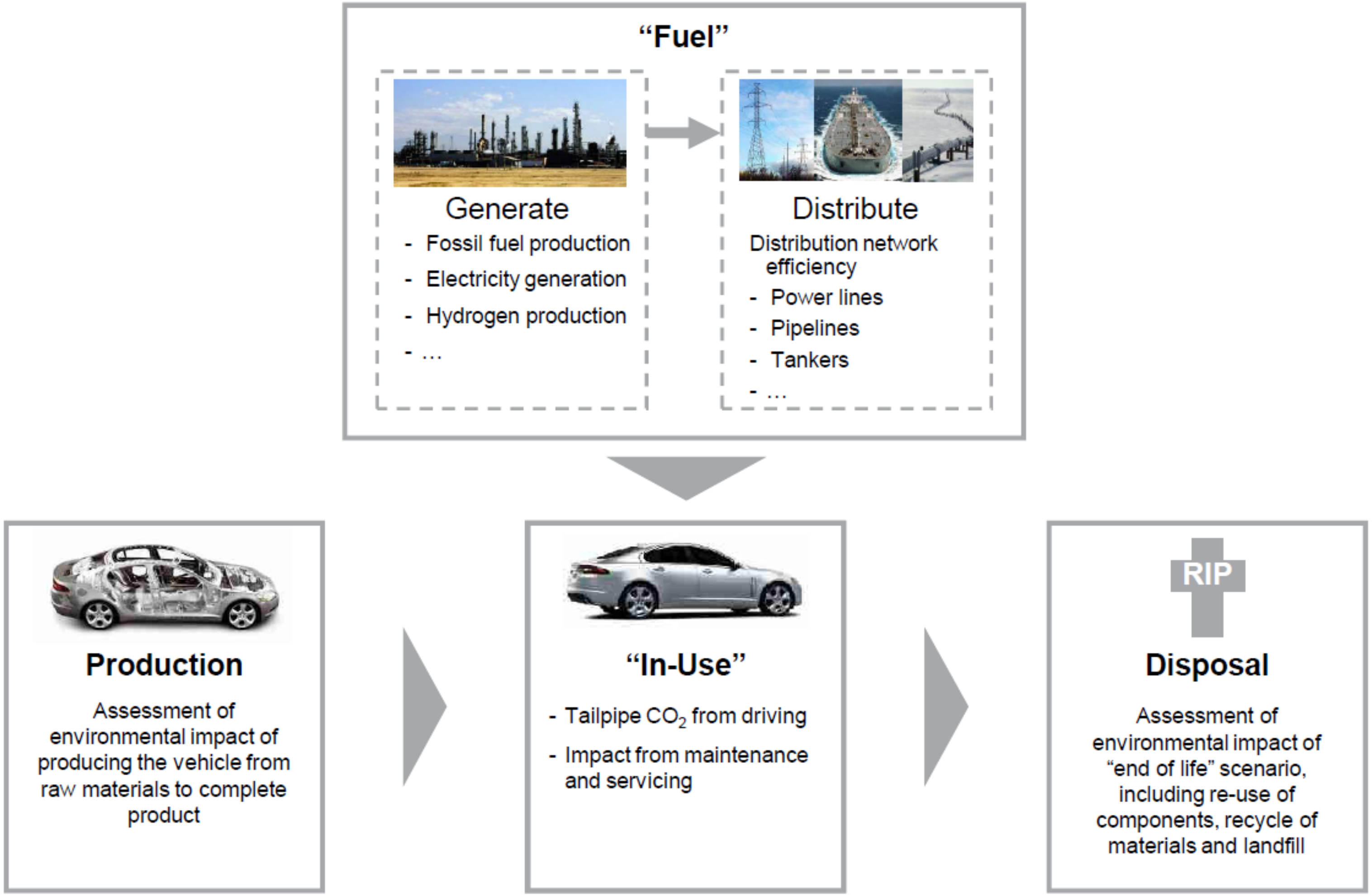
Carbon comes from more than just the tailpipe

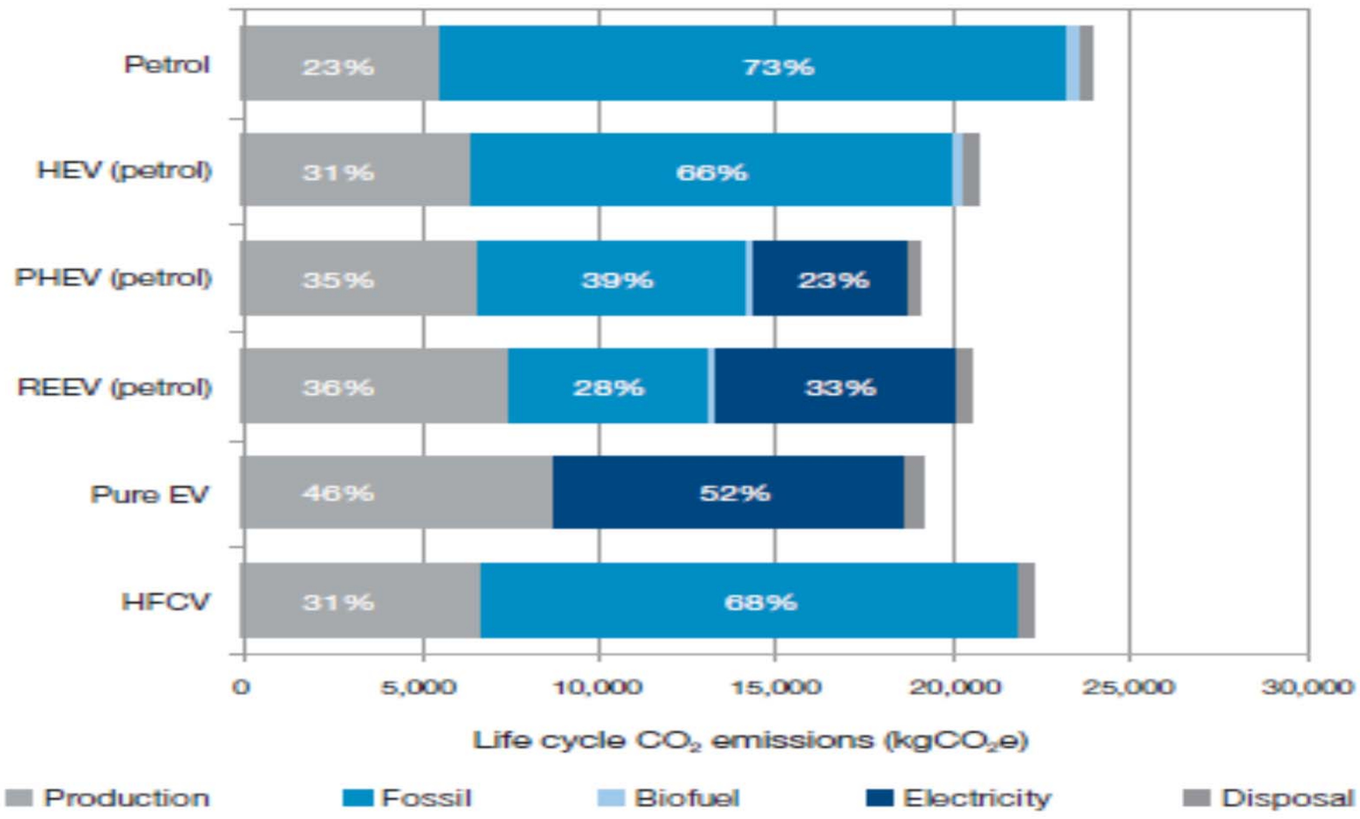
A vehicle's life cycle can be divided into four "blocks" – production of the vehicle, production of the fuel, "in-use", and disposal



Source: Ricardo

The way we measure carbon impact needs to change in 2011 – LowCVP highlighted technology variations

Figure 2.4: Life cycle CO_2e emissions for various medium-sized vehicle technologies in 2015



Source: Ricardo (2011)

Preparing for a Life Cycle CO_2 Measure – Report for LowCVP 2011

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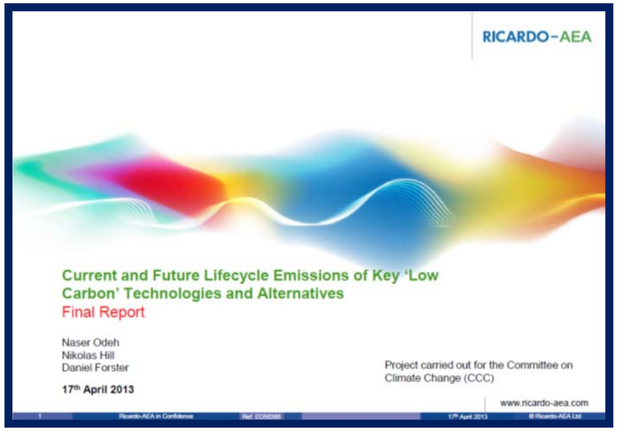
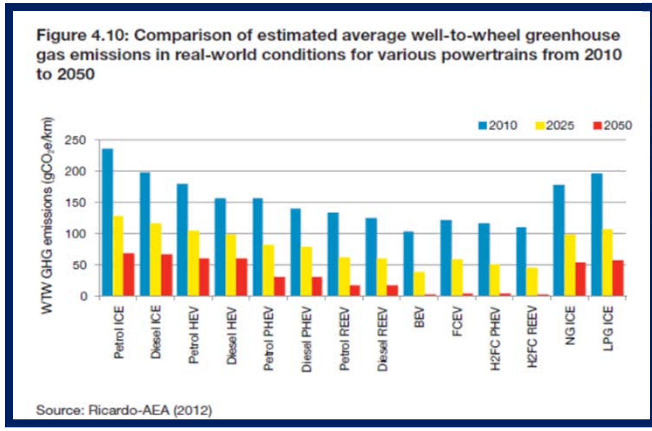
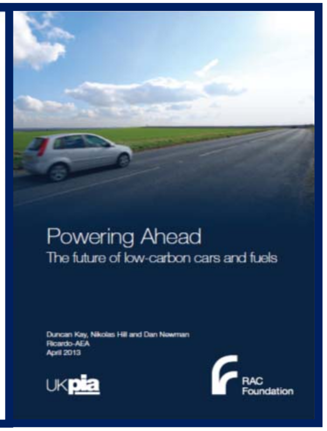
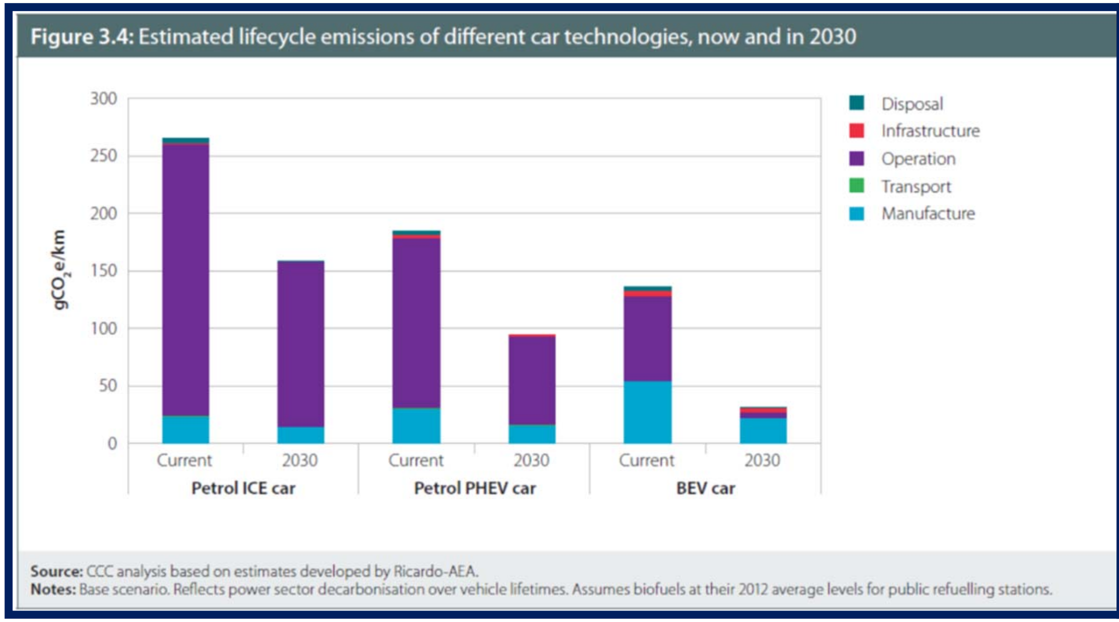
In 2013 – LCA analysis gathers momentum









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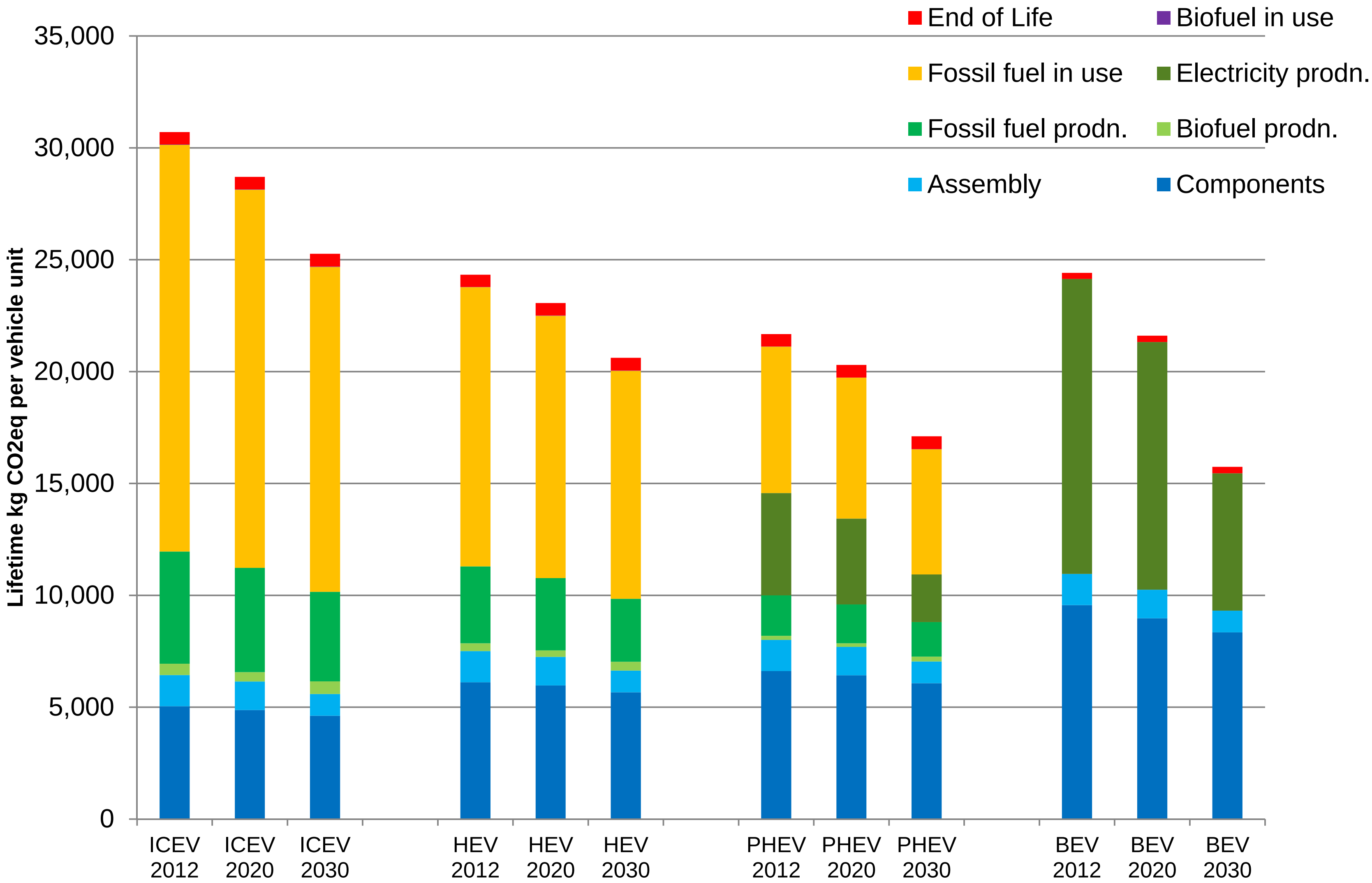
LowCVP Report 2013 on Life Cycle assessment

Building on the previous LowCVP work:-

- To study how the change in technology will affect the life-cycle impact
- To identify the most carbon intensive phases of a vehicle life now and in the future
- To review key areas of sensitivity in input assumptions

- Considers four technology options
- (Petrol only) ICEV, HEV, PHEV, BEV
- From 2012, forecast for 2020, 2030
- Identifies potential of ‘best’ case options

Life-cycle impact improves with time.



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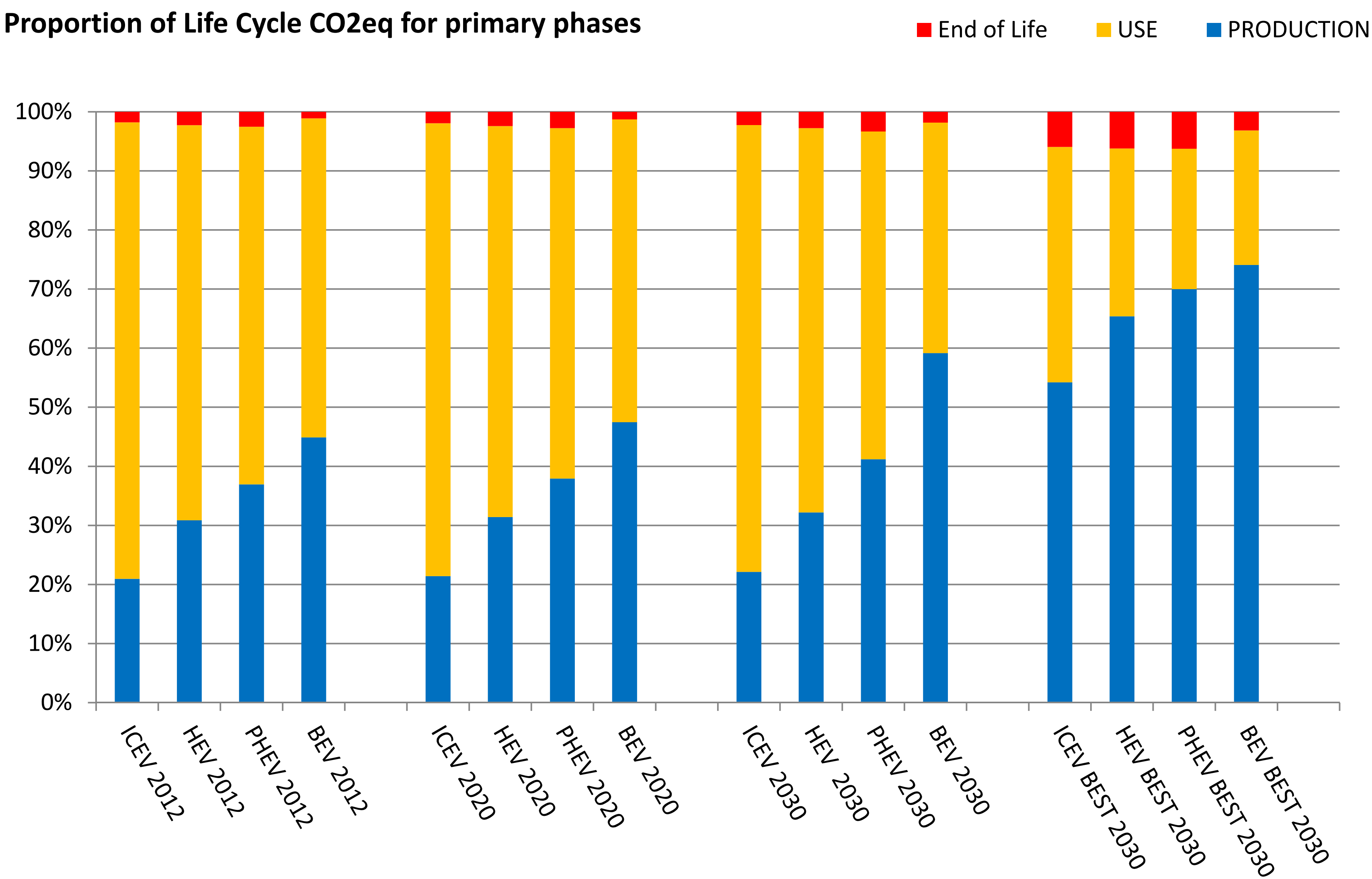
In-use phase still dominates before 2030



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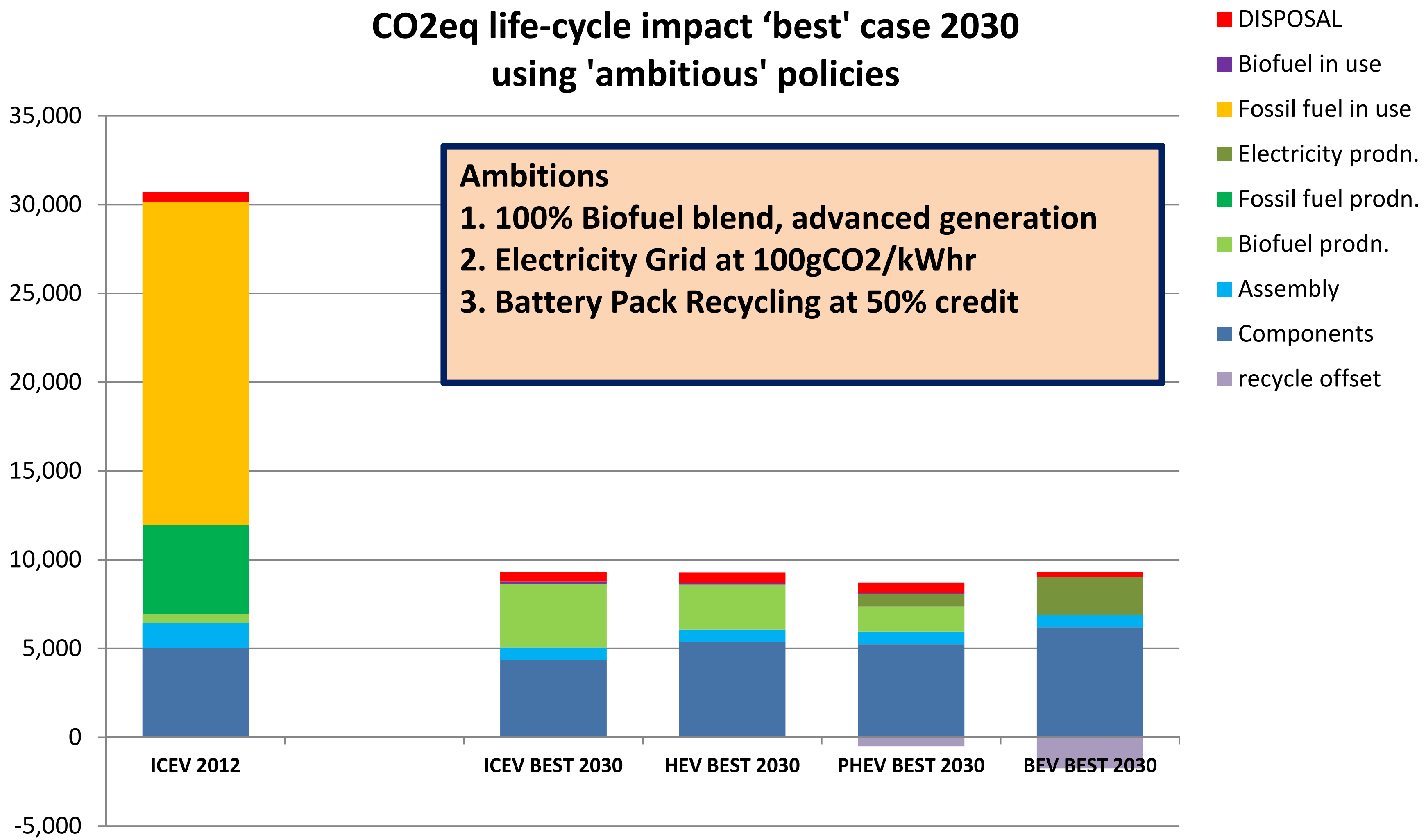
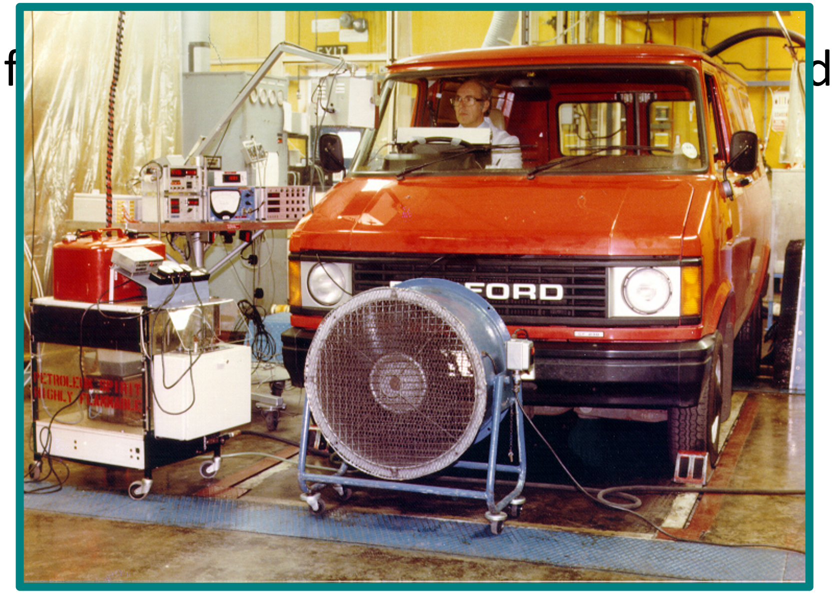
Ambitious policies could deliver >65% reductions by 2030 for all technologies



*100g/CO2/kWr relates to electricity generation at the point of consumption

How is Carbon measured

Starting in early 1970's the basic method f … d broadly stable to this day.



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BUT … real world fuel use higher than test

Recent reports have noted that consumers fuel consumption typically exceeds test cycle results by an average of 25%

- ICCT report May 2013 –25% average increase based on users own data input
- Emissions Analytics/WhatCar? True mpg - 25% higher

Interestingly the results are very consistent even though some data are from a large dataset of users own fuel measurements and other from on-road testing using Portable Emissions Measurement System (PEMS)

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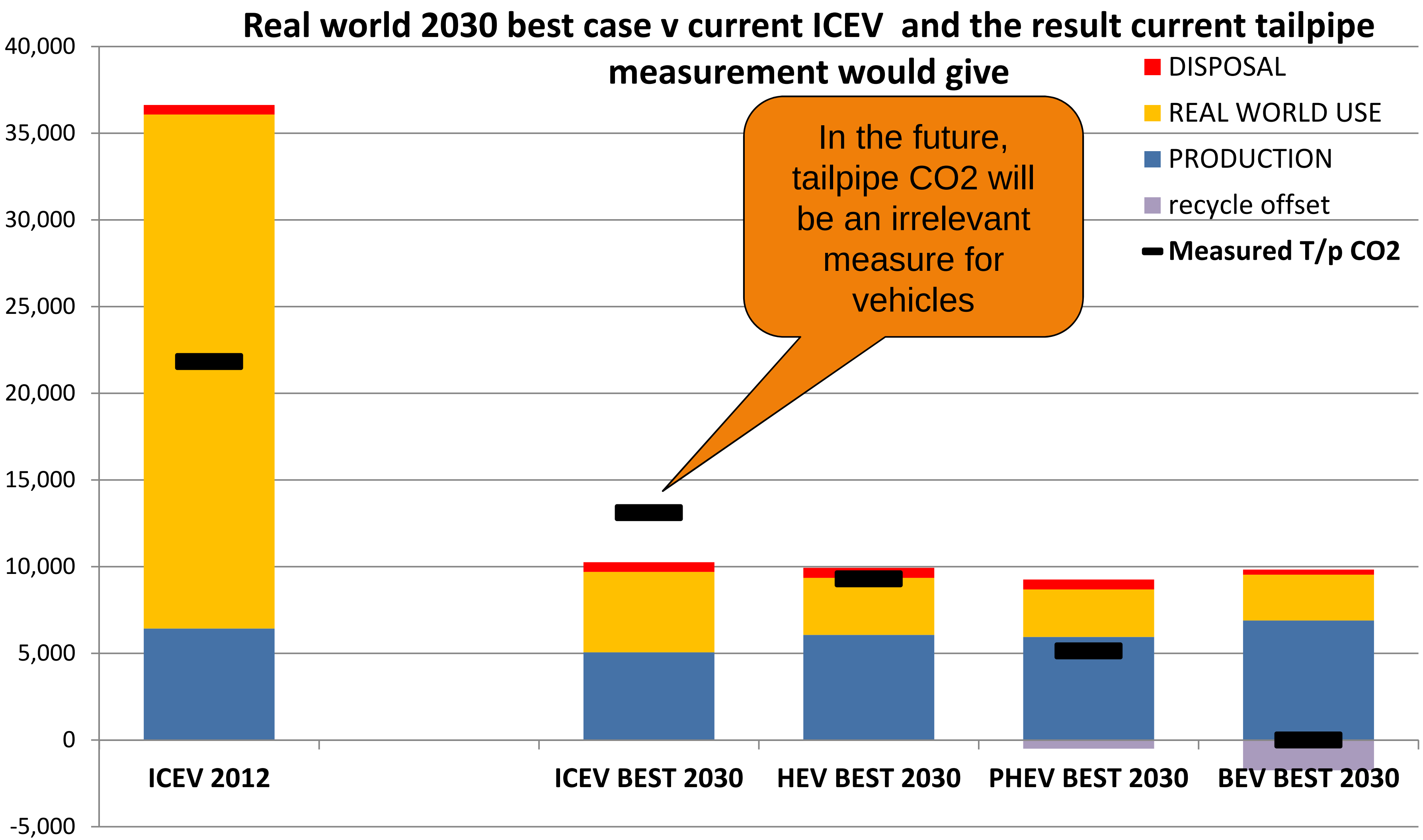
Tailpipe CO_2 is no longer representative



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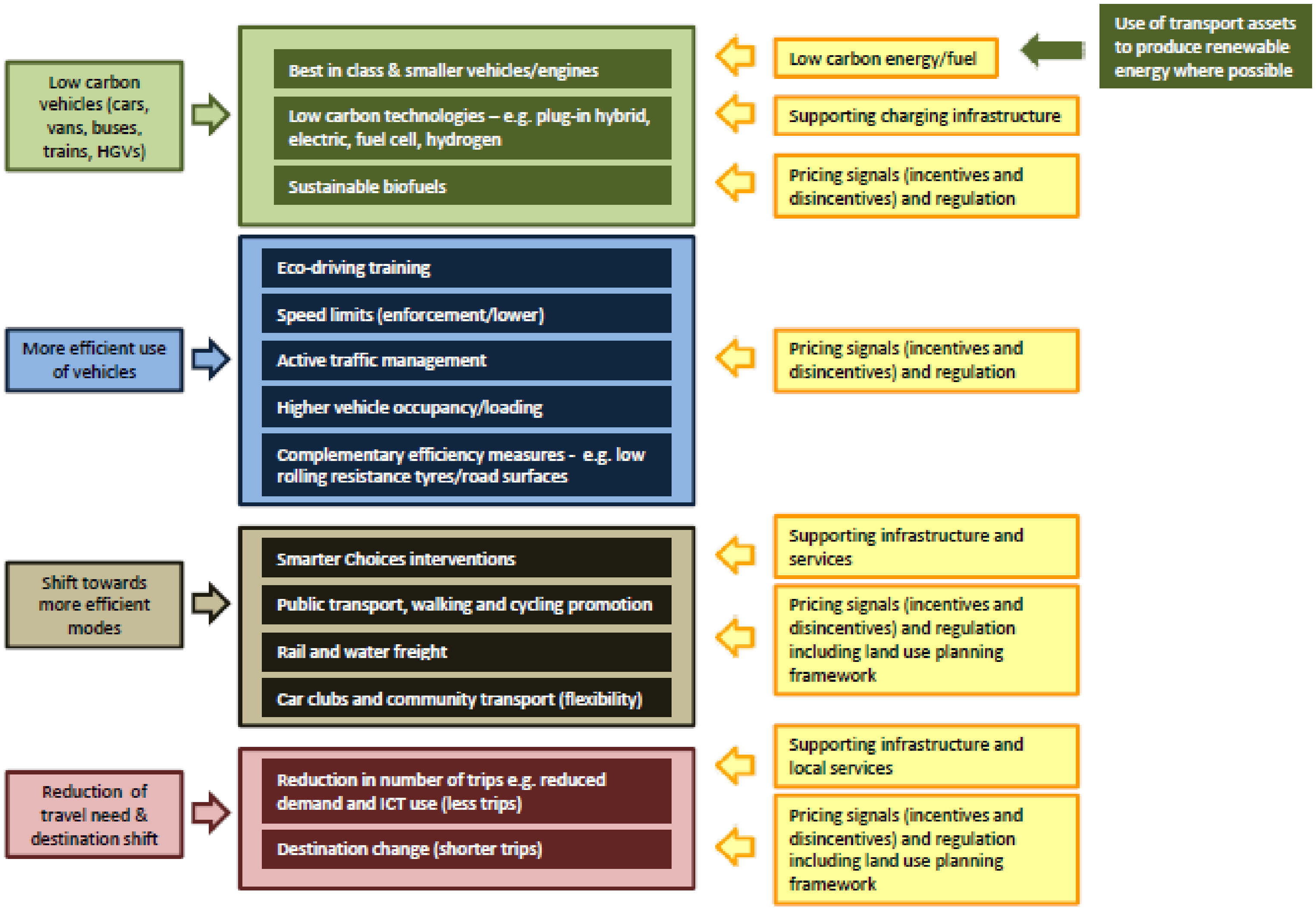
Low carbon transport framework requires an integrated approach



Source: ATKINS

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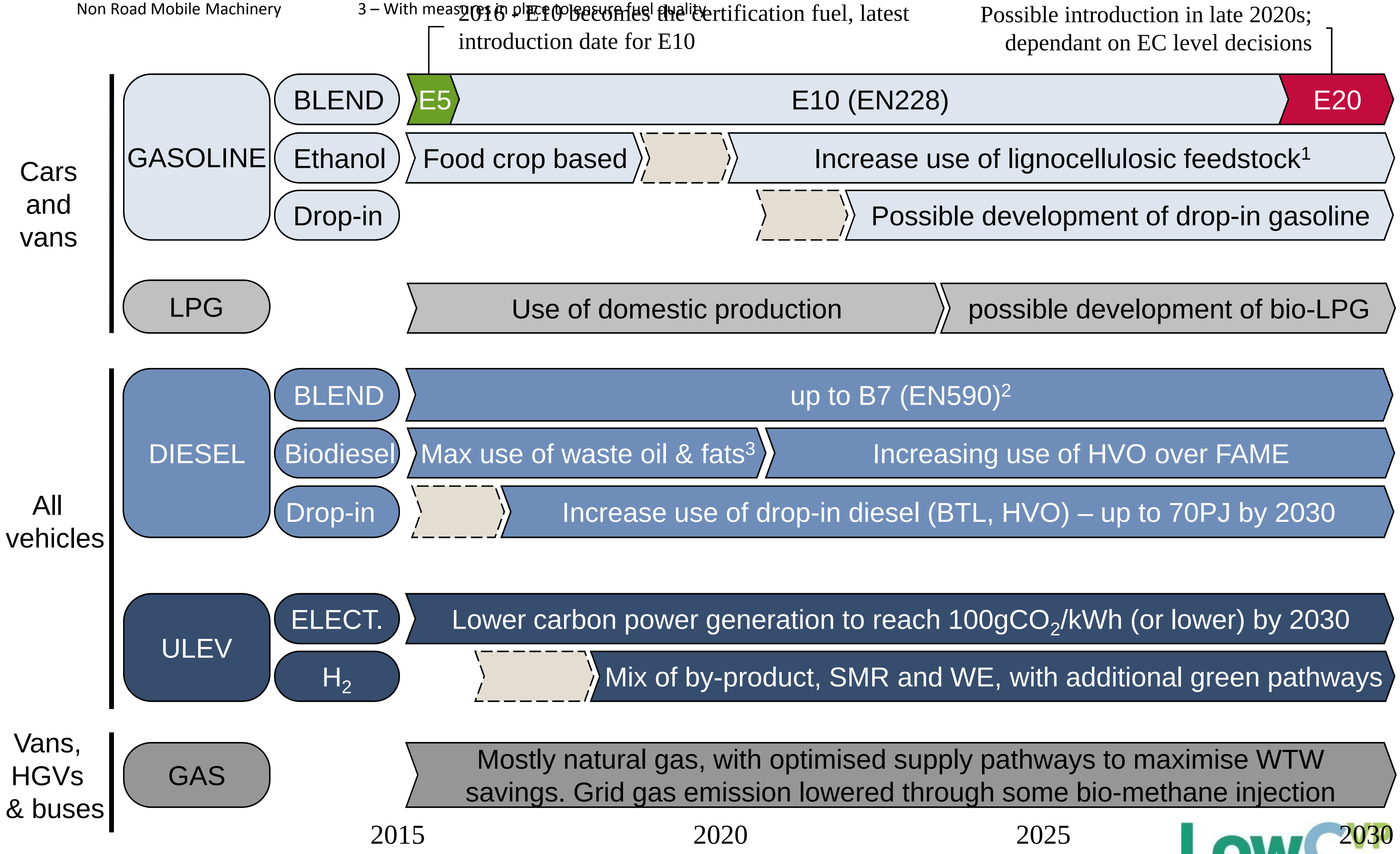
2015-2030 fuel roadmap: fuel types and blends

Uncertain ramp up start or rate, dependent on policy support or framework

SMR: Steam Methane Reforming; ULEV: Ultra Low Emission Vehicles; WE: Water Electrolysis; 1 – Possible development of butanol 2 – Effective blend likely to stay at B2 for Non Road Mobile Machinery 3 – With measures in place to ensure fuel quality



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BUT … Well-to-Wheel assessment is needed

No current options completely eradicate carbon from the fuel use chain, however all have significant opportunities to reduce carbon

- Liquid fuels (petrol/diesel) – higher biofuel blends and substitution
- Electricity - renewables and the low carbon grid
- Gas – Biomethane
- Hydrogen – production from water electrolysis.

Only by combining a WTW approach **together** with in-use vehicle energy efficiency will the lowest carbon pathway for the use phase become apparent.

There is no single solution so keeping our options open allows optimum combinations and applications of transport energy pathways

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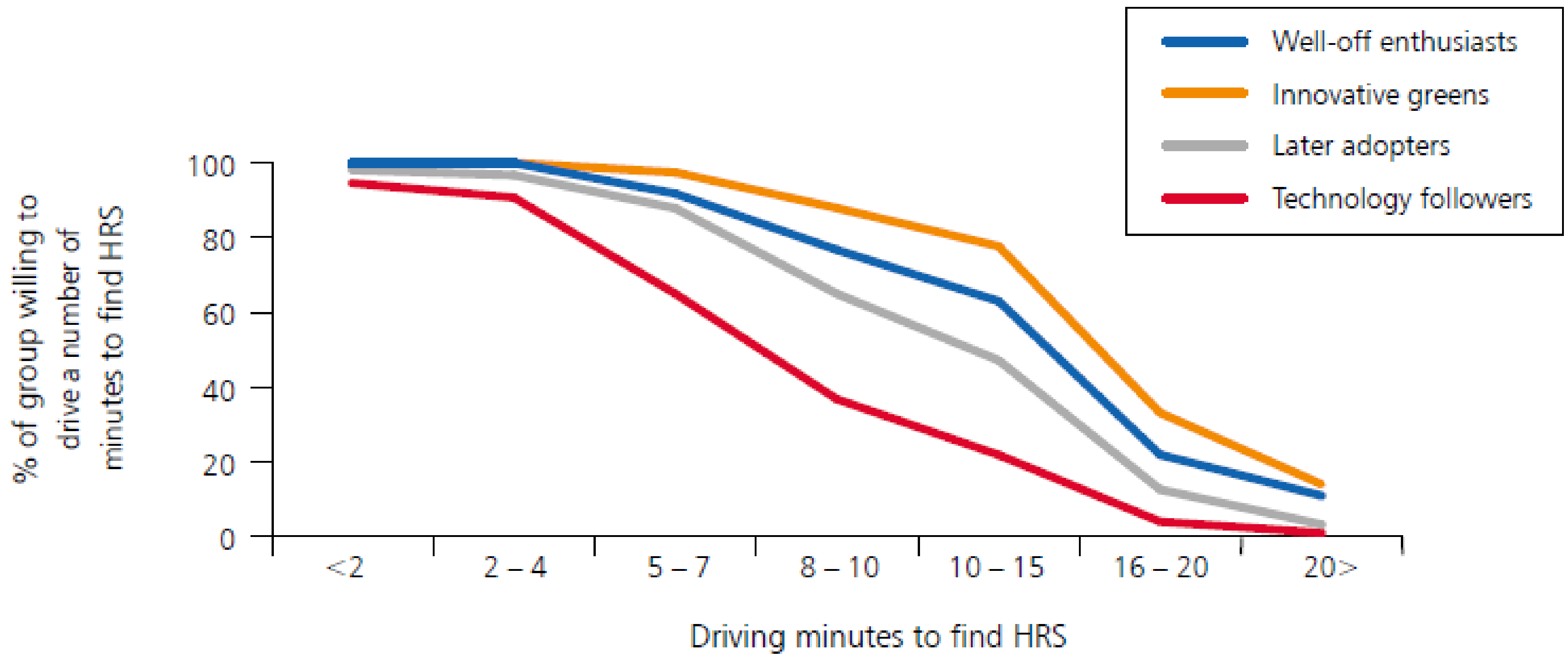
A new transport energy infrastructure

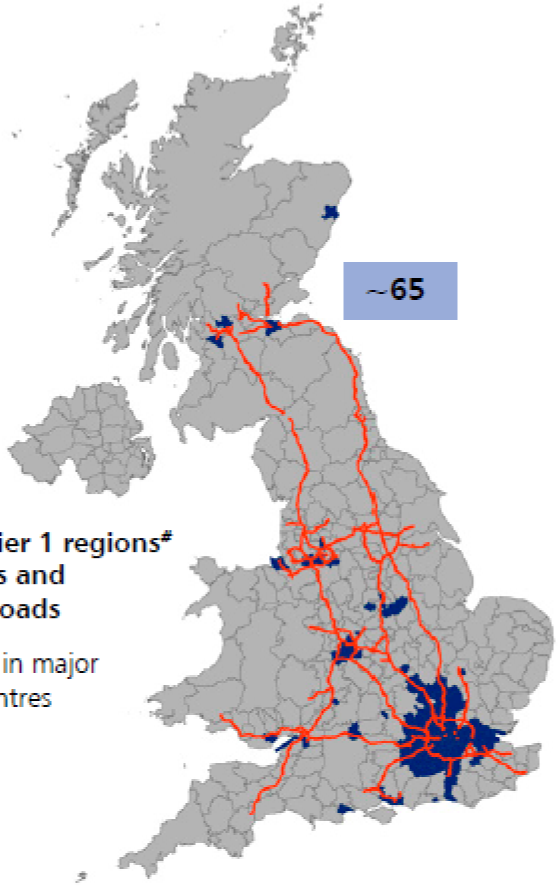
- There are significant challenges over the energy infrastructure for transport.
- Currently transport and residential energy are discrete supply and infrastructure.
- Combining users energy demands to a single source has substantial implications.
- The cost and climate impact of a “new” transport energy infrastructure must be incorporated in the long term plans (recent proposals from Europe appeared to ignore this!)

Finding fuel

H2 Mobility study mapped how much people will go out of their way to refuel



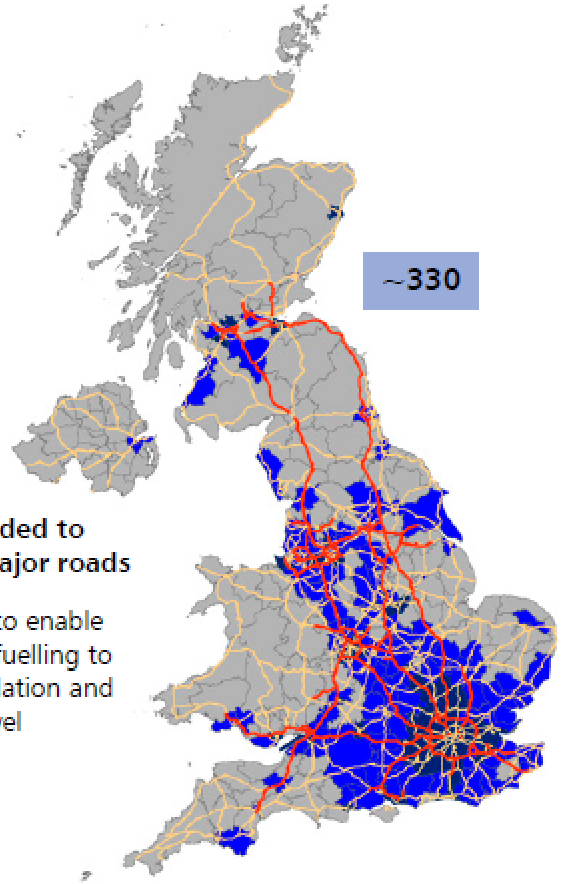
Mapping the development of infrastructure



2015-2020

Seeding of Tier 1 regions# – major cities and connecting roads

Initial seeding in major population centres



2020-2025

Coverage extended to Tier 2 and all major roads

Extend coverage to enable close-to-home refuelling to 50% of the population and long distance travel

Its not just Carbon Dioxide!

Source: Climate Change 1995, The Science of Climate Change: Summary for Policymakers and Technical Summary of the Working Group I Report, page 22.

Species	Chemical formula	Lifetime (years)	Global Warming Potential (Time Horizon)		
			20 years	100 years	500 years
CO_2	CO_2	variable §	1	1	1
Methane *	CH_4	12±3	56	21	6.5
Nitrous oxide	N_2O	120	280	310	170
HFC-23	CHF3	264	9100	11700	9800
HFC-32	CH2F2	5.6	2100	650	200
HFC-41	CH3F	3.7	490	150	45
HFC-43-10mee	C5H2F10	17.1	3000	1300	400
HFC-125	C2HF5	32.6	4600	2800	920
HFC-134	C2H2F4	10.6	2900	1000	310
HFC-134a	CH2FCF3	14.6	3400	1300	420
HFC-152a	C2H4F2	1.5	460	140	42
HFC-143	C2H3F3	3.8	1000	300	94
HFC-143a	C2H3F3	48.3	5000	3800	1400

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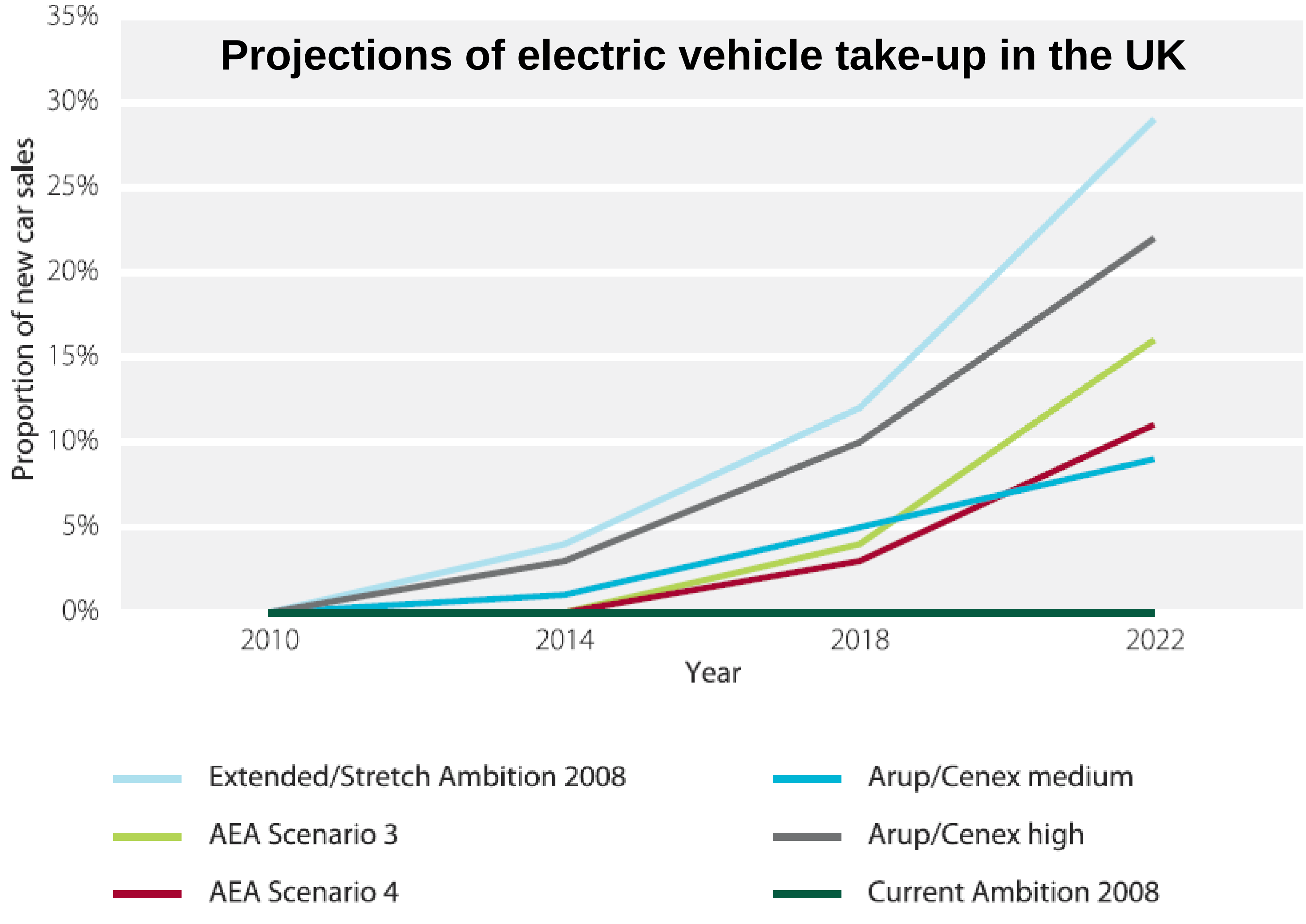
Market uptake is highly uncertain – depending upon public acceptability, battery costs / subsidies



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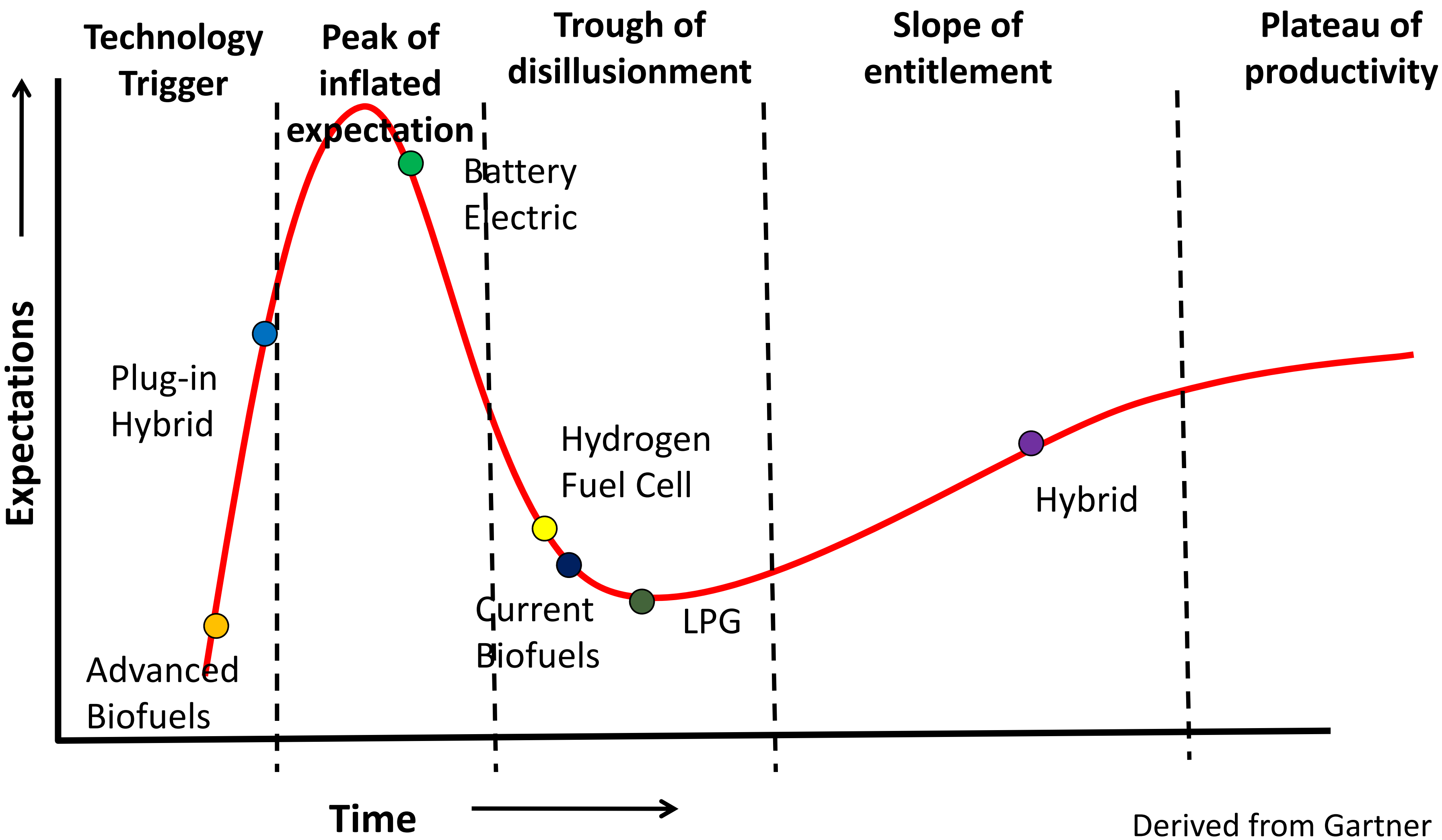
The adoption of new technologies is likely to be incremental and does not follow the hype cycle



Derived from Gartner

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

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Getting the buyers to change uses a range of tools

Consumer purchasing behaviours vary widely

A portfolio of taxation gives the greatest shift

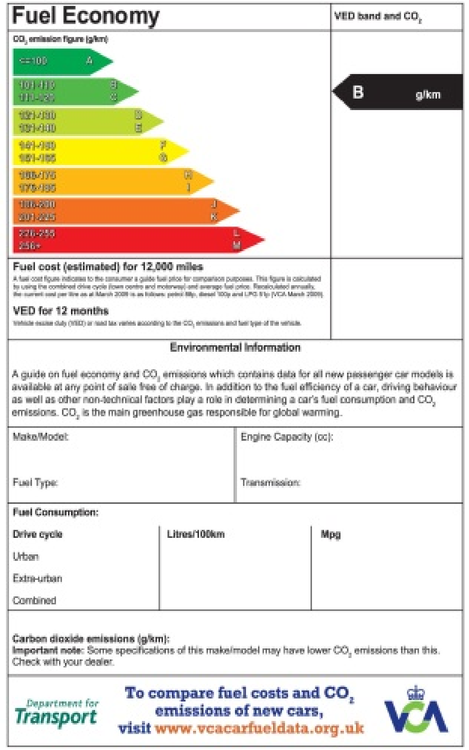
- Registration Tax based on CO2
- Ownership Tax Based on CO2
- Fuel Duty
- Progressive CO2 taxation of Company Cars has been very powerful in UK

These currently also significantly support Ultra low emissions vehicle (eg EV and PHEV) uptake.

Grants in place for cleanest vehicles

Low Emission Zones

CO2 based Congestion charges



LowCVP
Low Carbon Vehicle Partnership

Future mobility technology challenge

- What will our future vehicles look like, how will they be owned
- What will fuel them
- How will they be integrated into the system

- LowCVP among others. regularly challenge the industry to think about these questions and encourage innovation in every area

Low Carbon Vehicle Partnership

Technology challenge

Technology development for Cars, Vans, Public Transport Commercial vehicles is part of a very complex mobility and Energy system

It must comply with a range of needs/wants:

- Be compatible with the current and future energy pathways
- Meet the worldwide regulation /incentive/taxation frameworks
- Be saleable for high volume applications
- Deliver lower carbon on the tests and in the real world
- Ultimately be efficient on a life cycle basis
- Be compatible with the energy and infrastructure network
- Not rely on long term government support
- Support the changing face of mobility

- Be what the customer wants to buy and use!!

The Low Carbon Vehicle Partnership

Connect |Collaborate| Influence – www.lowcvp.org.uk

- **Connect**: With privileged access to information, you'll gain insight into low carbon vehicle policy development and be introduced to key stakeholders.

- **Collaborate**: You'll benefit from many opportunities to work – and network - with key UK and EU government, industry, NGO and other stakeholders

- **Influence**: You'll be able to initiate proposals and help to shape future low carbon vehicle policy, programmes and regulations

LowCVP is a partnership organisation with over 170 members with a stake in the low carbon road transport agenda.