LowCVP
A decade of driving low carbon

Andy Eastlake

Low Carbon Vehicle Partnership – UK

12Jun14

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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 former Chair of the LowCVP Board

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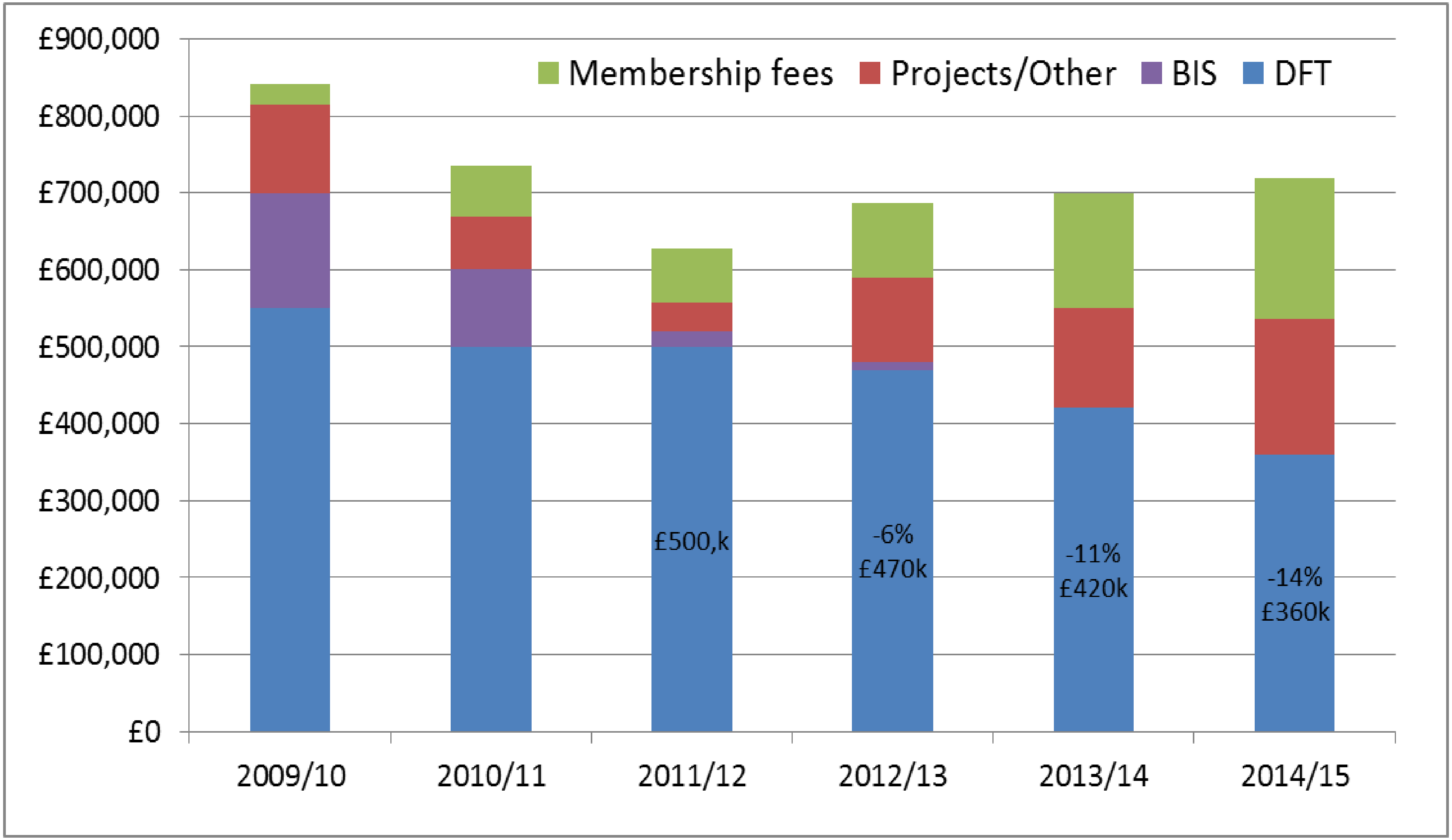
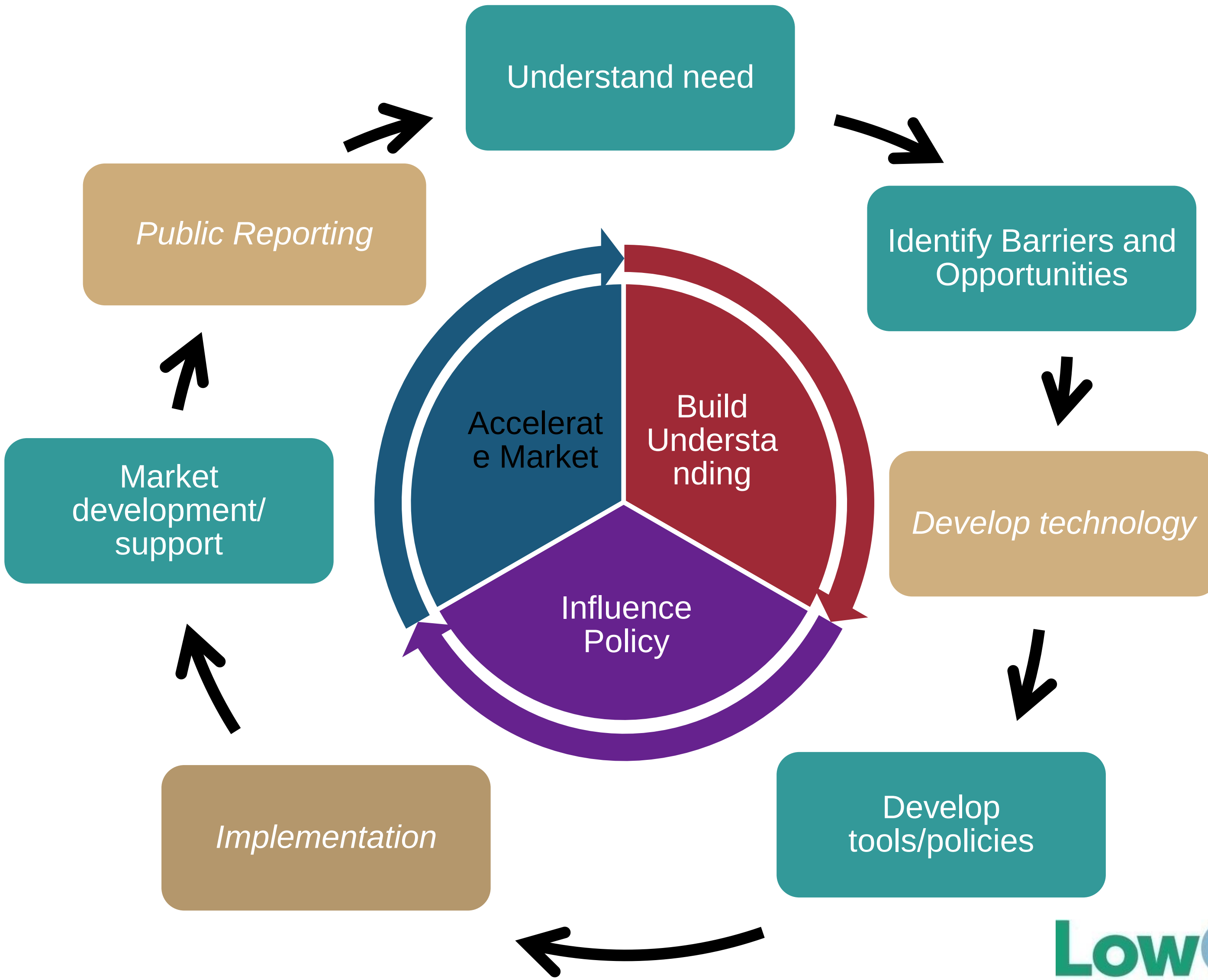
LowCVP Funding Evolution 2009 – 2015



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.

LowCVP activity cycle



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LowCVP's work programme has been developed to align with DfT, BIS and OLEV strategies together with members objectives

Overarching Aims

- Reduce road transport CO2 emissions
- Improve air quality
- Stimulate UK economic growth

Alignment with OLEV strategy

- Focusing on inward investment and the supply chain
- Technology neutrality
- Working with the EU on ambitious but realistic regulation
- Addressing market failure
- Consistent communications

Key Activity Areas

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Work Programme 2014/15

	PRIORITY FOR FIRST SIX MONTHS (green)	IDEAS FOR FUTURE WORK (amber)	
27/Feb	Understanding the issues	Influencing the policies	Accelerating the market
CARS	(amber) Researching and influencing the information used in the car buying process	(green) National Complementary Policy Framework/toolkit for Low Carbon cars	
VANS			(green) Low Carbon Van Guide dissemination and on-line comparison tool
HGV	(amber) Gas Strategy/Task Force future priorites		(green) Accreditation of low carbon HGV technologies
BUS		(green) Low Emission Buses - Overcoming Barriers and next step market interventions	(amber) Low Carbon Bus Symposium
FUELS	(amber) Advanced fuels - Policy interventions for progress (green) Fuelling delivery Infrastructure roadmap	(green) Policy options and timing for fuels to meet RED targets	(amber) E10 fuel - market preparation
INNOVATION	(green) LEP best practice guide to Automotive SME innovation (green) Environmental benefits of 'L' Cat Vehicles		(amber) Low Carbon Automotive directory (amber) Technology collaboration Challenge
OVERARCHING	(amber) LowCVP GHG transport Model	(green) UK Auto success - The role of Low carbon policies	(amber) LCA of a range of vehicle categories

Development of an accreditation scheme for HGV technology

Original proposal based on feasibility study - LowCVP/TRL/Millbrook in 2010

Development of Pilot Scheme via physical testing of two technologies and facilities for correlation and documentation of accreditation process.

Review of proposal to be carried out by Steering group incl DfT

- Testing to be track based using PEMS (Portable emission Measurement systems)
- Track routes at test facilities to be modelled to replicated EU VECTO drive cycles.
- Measurements to include AQ emissions (NO_x, CO_2, THC, CO)

  Particulates possible but extra cost and limited value (differentiation less robust)

Aim to prove process and demonstrate results

To share with industry to garner further uptake

Aim to develop de-facto testing standard for

Future projects

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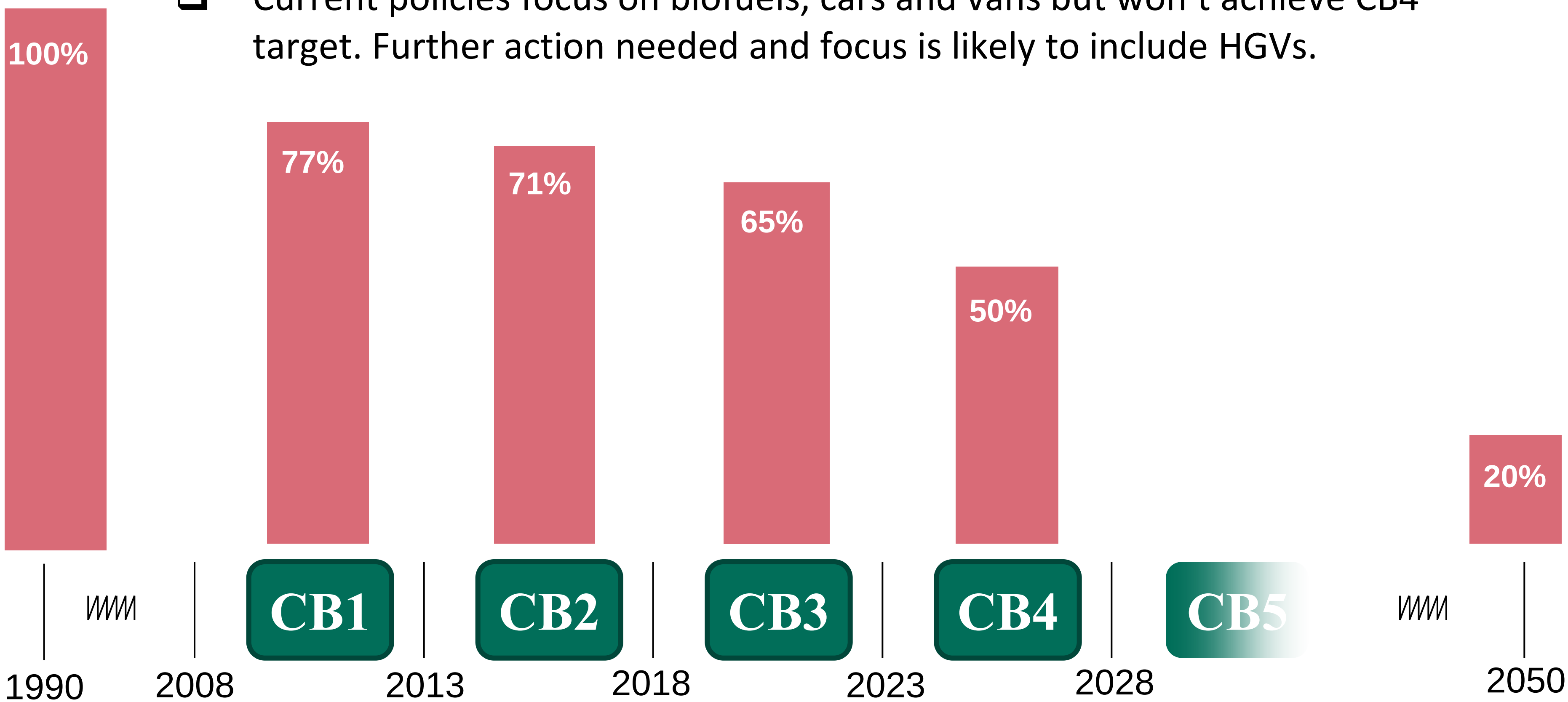
UK is committed to reducing GHG emissions by 80% by 2050 compared to 1990 through a series of "carbon budgets"

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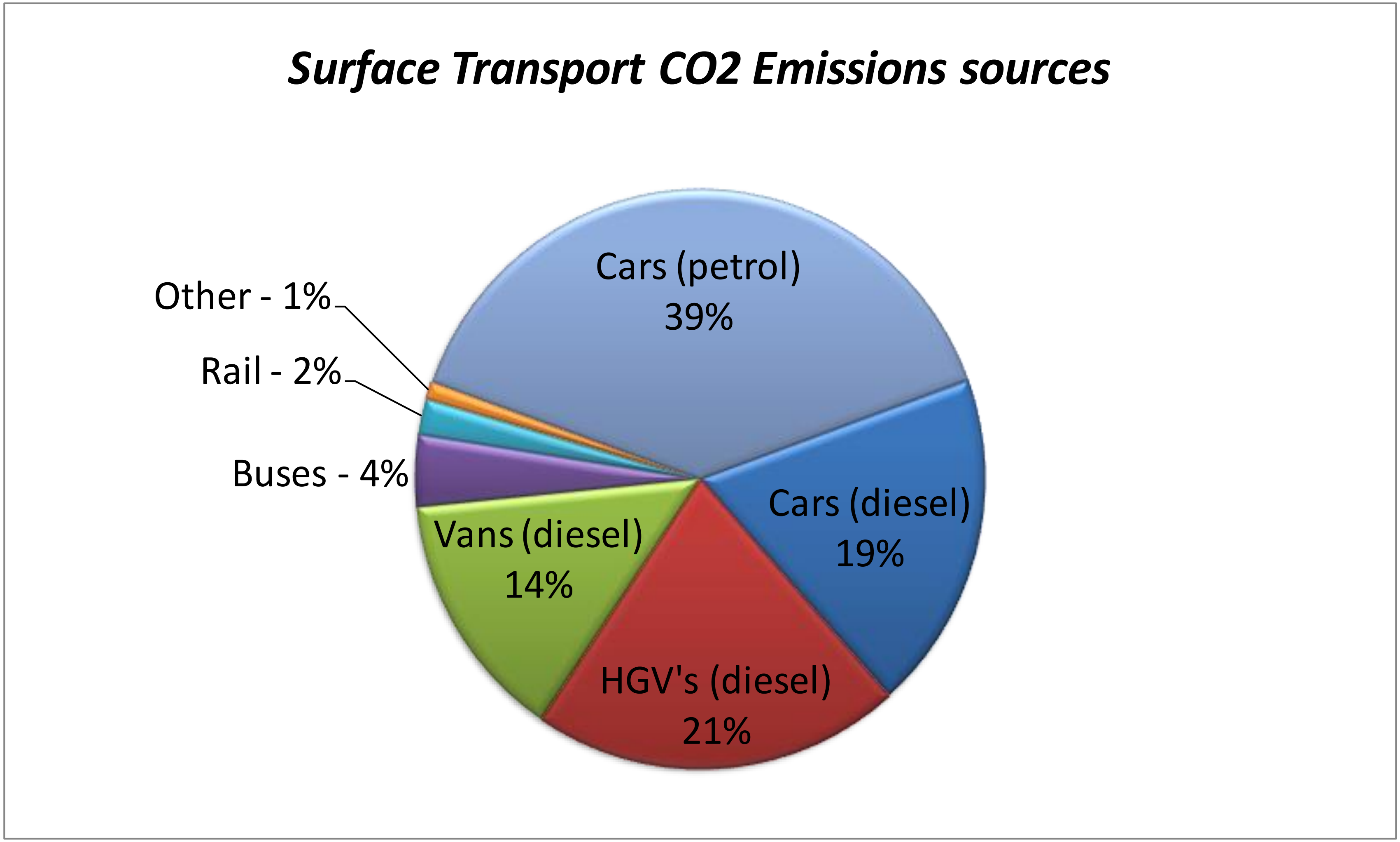
Petrol and diesel currently account for the vast majority of surface transport emissions (99.7%).



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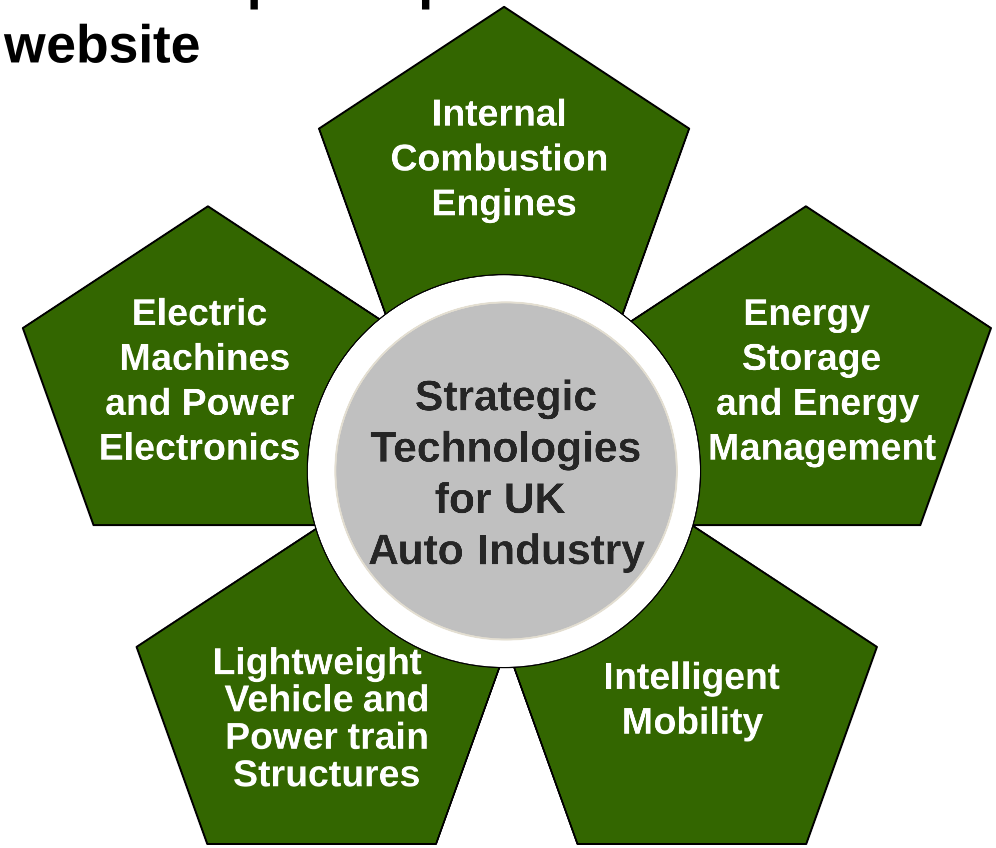
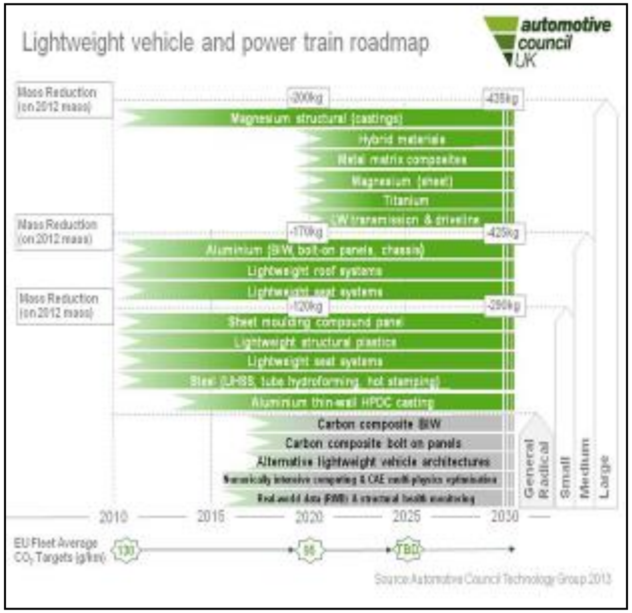
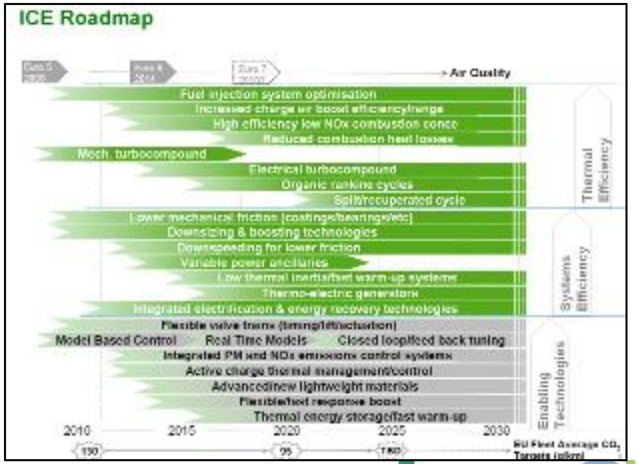
Technology Roadmaps

- 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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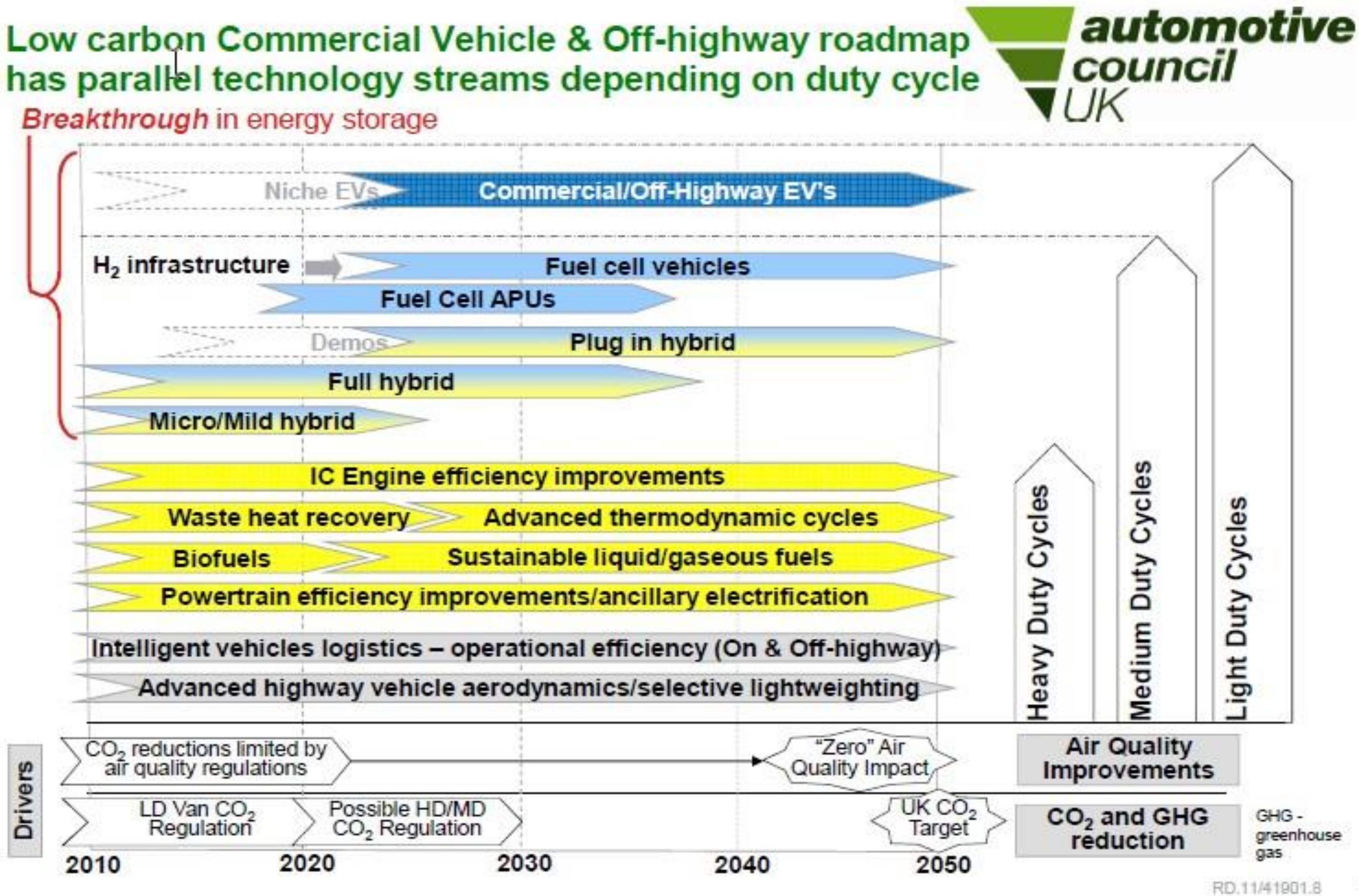
Road Freight road map



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Penetration of technology is slow

SMMT Motor industry facts 2013

New technology is a key carbon reduction strategy (eg new car CO2 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 fuels must remain compatible

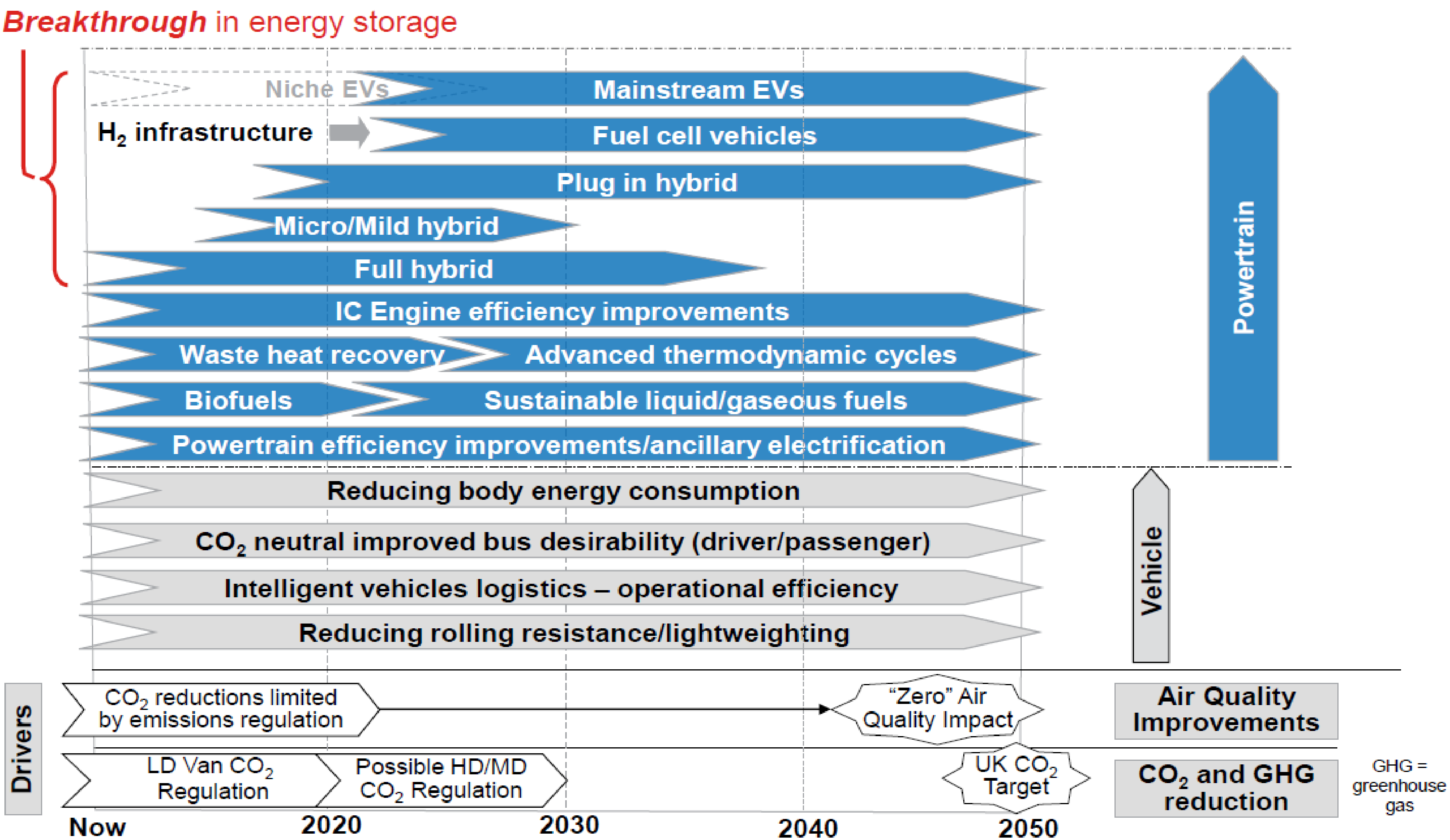
Example:

Sales of plug-in cars doubled in 2012 and 2013 but were just 2254 in a new car market of over 2M (and total fleet of 31.5M)

By March 2014, 8700 PICG claims had been made

Funding recently confirmed to continue until 2017 or 50,000 vehicles

The development of advanced technologies for buses is needed, in parallel with improvements to ICEs, to meet long term CO_2 targets



Air Quality Emissions Impacts of Low CO_2 Technology for Buses

Report for LowCVP

Date	10 October 2013	
Report	RD.13/125301.6	
Client Project Ref.	Q003889	
Confidential	Low Carbon Vehicle Partnership	
Report by	Richard Cornwell	Signe Hulbert
	Jon Andersson	Matthew Keenan

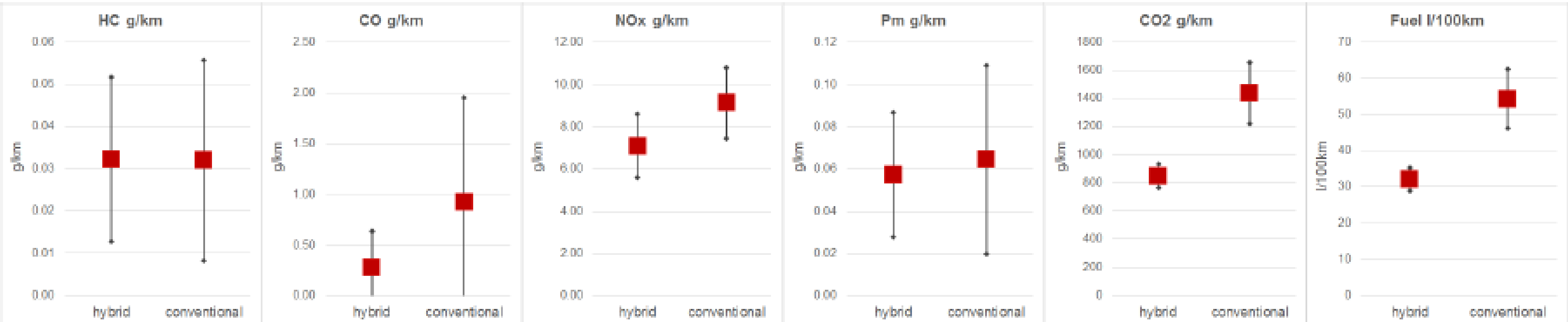
Approved

David Greenwood

Product Group Head – Hybrid & Electric Vehicles

DELIVERING VALUE THROUGH INNOVATION & TECHNOLOGY

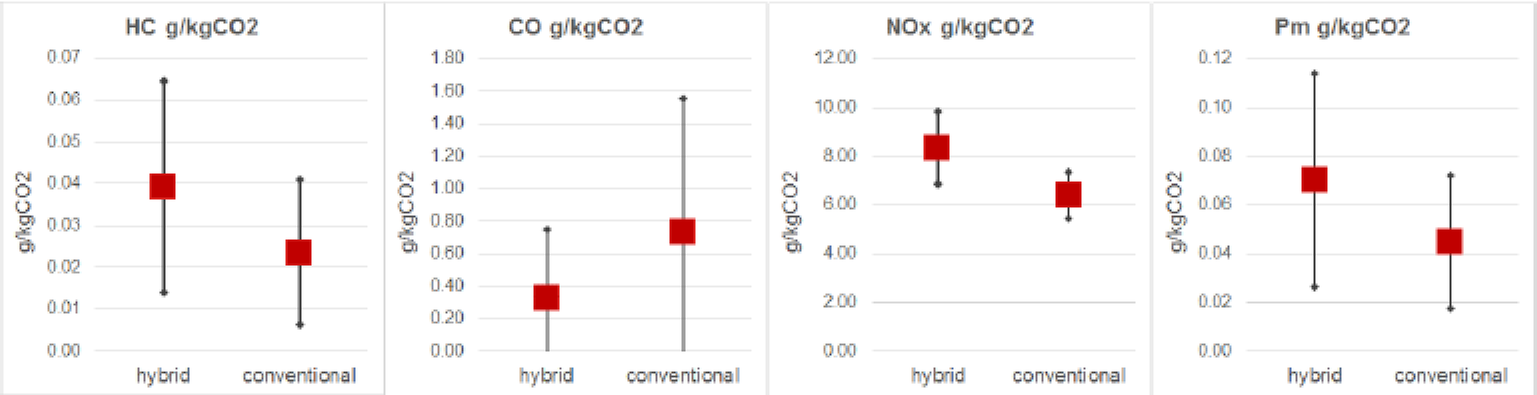
Measured emissions per km travelled over operating vehicle test cycle – hybrid vs conventional buses



Note: chart markers are average, error bars are +/- standard deviation

- Clearly the hybrid buses are making a significant impact on fuel consumption/CO2 emissions per km travelled. The error band (consistency across different models of bus) is much tighter also compared to the conventional buses.
- The chart shows that in all cases except for HC, the hybrid buses are performing significantly better than conventional buses in terms of absolute air quality emissions in grams per kilometre travelled.
- However, with the exception of CO, the proportional reduction of AQ emissions is somewhat less than the significant reduction in CO_2/fuel burned

Estimated relative emissions intensity per kg CO_2 emitted – hybrid vs conventional buses



Note: chart markers are average, error bars are +/- standard deviation

- In order to compare the hybrid and non hybrid technologies in terms of their emissions intensity (emissions produced per unit of fuel burned) the given data has been converted into g/kgCO_2. This method is the same used by the recent TNO report on real-world truck emissions
- These plots show that, excepting CO, the emissions intensity (gram per kgCO_2 emitted) is higher for the hybrid buses than conventional. In simple terms, the hybrid buses are doing well at reducing air quality emissions, but not as well as they could. This suggests a significant opportunity for hybrid buses to further improve their absolute emissions performance by reducing emissions intensity via improved powertrain / aftertreatment integration
- This increase in emissions intensity may be due to a greater dominance within the engine duty cycle of speed/load conditions away from the conditions seen on the ETC/ESC for which the engines will have been optimised. Put simply, the real world engine operating cycle in a hybrid bus may less closely match the legislative cycles the engines must meet, compared to a conventional bus. This is perhaps unsurprising, as the ETC cycle was originally derived from heavy duty conventional vehicle driving patterns (trucks & buses), not hybrids
- This discrepancy between real world and legislative cycles should reduce at Euro VI, since this legislation mandates a wide Not to Exceed (NTE) operating zone within which emissions must be within 150% of legal values

Reference: TNO report | MON-RPT-033-DTS-2009-03840, TfL Hybrid & Conventional bus data

Bus accreditation

LCEB test process records Emissions but currently no requirement to report.

Evidence of aftertreatment success has been delivered through this process, but no similar approved systems in place for other vehicles yet.

MILLBROOK

Low Carbon Emission Bus Approval Summary

Customer:	Volvo Truck & Bus Ltd.			
Customer Address:	Product Planning, Wedgnock Lane, Warwick, CV3 5YA			
Test Purpose:	Volvo B5LH MLTB Tests			
Vehicle No:	HOPE	Site No. 2	Dynamometer Settings	
Vehicle Type:	Wrightbus / Volvo B5LH		Inertia	13,768 kg
Engine:	Volvo Stop - Start Euro VI		F_0	488.12 N
Transmission:	Auto		F_1	-7.975 N/kmh
Fuel Type:	Pump Diesel		F_2	0.41920 N/kmh ^{2}
Passenger Capacity	94		F_3	-0.001952 N/kmh ^{3}
Millbrook Project No:	PT0124-008-02		Desired Test Inertia	13,141 kg

Emissions Results

Test Number	CO (g/km)	HC (g/km)	NOx (g/km)	PM (g/km)	CO_2 (g/km)	CH_4 (g/km)*	N_2O (g/km)*
ML02013351	0.07	0.00	0.14	0.01	873.68	0.00	0.241
ML02013355	0.07	0.00	0.13	0.01	872.54	0.00	0.162
ML02013356	0.05	0.00	0.04	0.00	865.13	0.00	0.178
Average	*0.06*	*0.00*	*0.11*	*0.01*	*870.45*	*0.00*	*0.194*

Total Tank-to-Wheel GHG CO_2 Equivalent

Test Number	CO_2 (g/km)	CH_4 (g/km x 21)*	N_2O (g/km x 310)*	CO_2 Correction for Test Mass (0.0637 x Δkg)	Calculated TTW GHG (g/km)
ML02013351	873.68	0.00	74.75	-39.94	908.48
ML02013355	872.54	0.00	50.34	-39.94	882.94
ML02013356	865.13	0.00	55.25	-39.94	880.44
Average	*870.45*	*0.00*	*60.11*	*-39.94*	*890.62*

Well-to-Wheel GHG CO_2 Equivalent

Test Number	Fuel Used Over Cycle (litres)	Net Heating Energy (MJ/Litre)	Total Fuel Energy (MJ)	WTT Diesel GHG Equivalence Factor (CO_2 Equivalent g/MJ)	Calculated WTT GHG Emissions (CO_2 Equivalent g/km)	Calculated WTW GHG Emissions (CO_2 Equivalent g/km)
ML02013351	3.01	35.67	107.26	14.20	167.09	1075.57
ML02013355	3.00	35.67	107.08	14.20	166.87	1049.81
ML02013356	2.96	35.67	105.46	14.20	165.45	1045.89
Average	*2.99*	*35.67*	*106.60*	*14.20*	*166.47*	*1057.09*

Test Validity Check

Test Number	Total WTW GHG Emissions (CO_2 Equivalent g/km)	Variation from Average (%)
ML02013351	1075.57	1.75%
ML02013355	1049.81	-0.69%
ML02013356	1045.89	-1.06%

Well-to-Wheel Summary

Total Tank-to-Wheel GHG (g/km)	*890.6*
Energy Consumption (MJ)	*106.6*
Fuel Type	*Pump Diesel*
Fuel Well-to-Tank Pathway Value (g/MJ)	*14.20*
Fuel Well-to-Tank GHG Total Over Test (g)	*1513.7*
Fuel Well-to-Tank GHG (g/km)	*166.5*
Total Well-to-Wheel GHG (g/km)	*1057.1*
Target WTW for number of passengers (g/km)	*1092.3*
Approved as Low Carbon Emission Bus?	*YES*

NEC variance in all tests shown was less than 1% and therefore no correction of exhaust emission values was necessary

** compound measured via Fourier Transfer Infra-Red (FTIR)*

Data Generated by:Loic Roussi 09-May-14 | *Data Approved by: Liam Kennedy* 15-May-14

Millbrook Project No: PT0124-008-02

Desired Test Inertia

Emissions Results

Test Number	CO (g/km)	HC (g/km)	NOx (g/km)	PM (g/km)	CO_2 (g/km)	CH_4 (g/km)*	
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ML02013355	872.54	0.00	50.34	-39.94	882.94
ML02013356	865.13	0.00	55.25	-39.94	880.44
Average	*870.45*	*0.00*	*60.11*	*-39.94*	*890.62*

Post 2020, CO2 regulations likely to change

TNO innovation for life

Requirements for post-2020 regulation

- Post-2020 regulation needs to:
  - cater for the future
  - reduce uncertainty or risks for manufacturers
  - provide incentives to the market to improve conventional technology AND develop and implement technologies needed to meet longer term targets
  - provide the right incentives to OEMs to develop and market CO_2 reduction options that are most cost-effective from a societal point of view
  - ensure that GHG emission reductions are in line with those foreseen

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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

RICARDO

"Fuel"

Generate
- Fossil fuel production
- Electricity generation
- Hydrogen production
- …

Distribute
Distribution network efficiency
- Power lines
- Pipelines
- Tankers
- …

Production
Assessment of environmental impact of producing the vehicle from raw materials to complete product

"In-Use"
- Tailpipe CO_2 from driving
- Impact from maintenance and servicing

Disposal
Assessment of environmental impact of "end of life" scenario, including re-use of components, recycle of materials and landfill

Source: Ricardo

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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

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BUT … real world fuel use higher than test

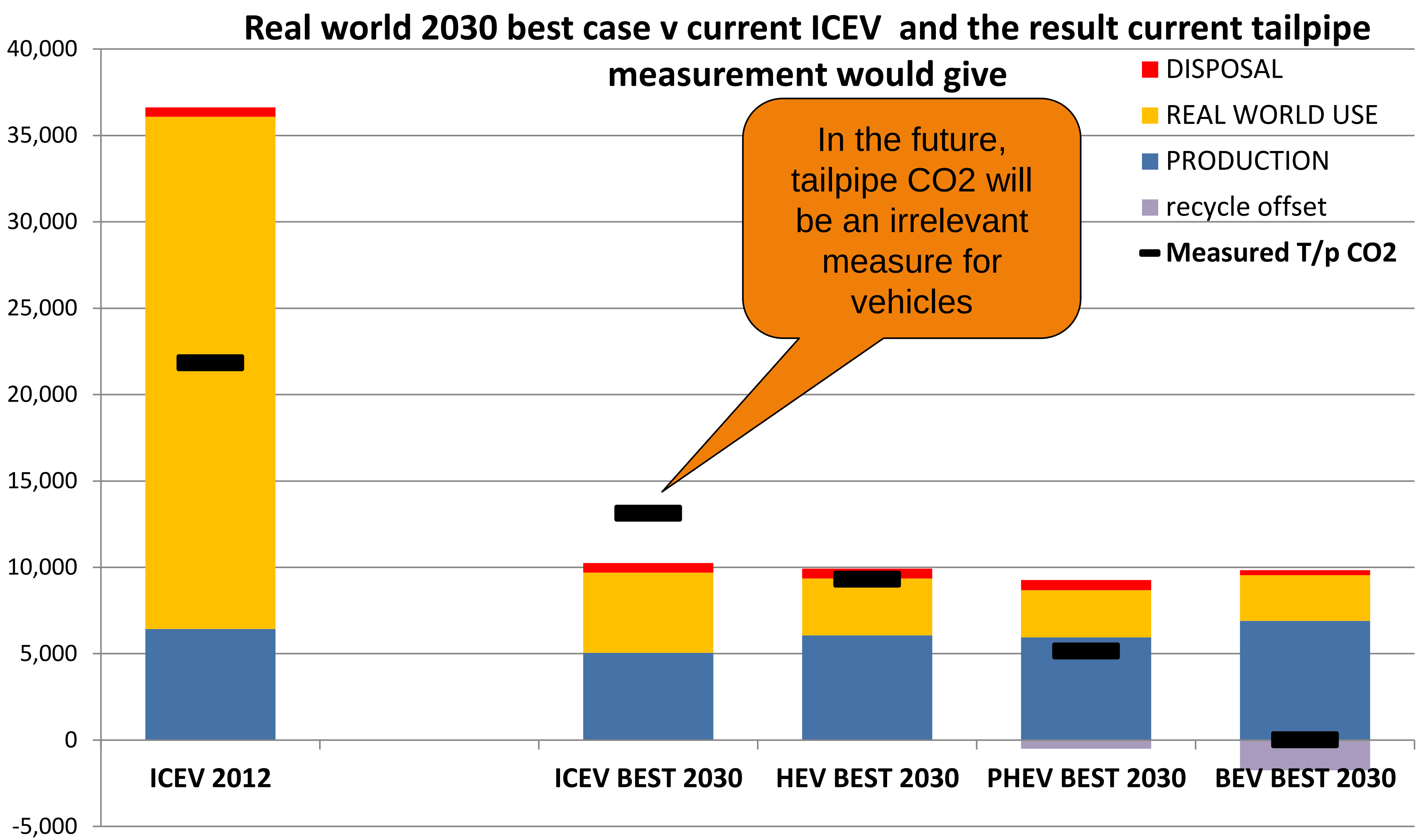
Recent reports have noted that consumers fuel consumption typically exceeds test cycle results by an average of 25%

- 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)


WHITE PAPER
MAY 2013
FROM LABORATORY TO ROAD
A COMPARISON OF OFFICIAL AND 'REAL-WORLD' FUEL CONSUMPTION AND CO_2 VALUES FOR CARS IN EUROPE AND THE UNITED STATES
AUTHORS:
Peter Mock, John German, Anup Bandivadekar (ICCT)
Iddo Riemersma (Sidekick Project Support)
Norbert Ligterink (TNO)
Udo Lambrecht (IFEU)

Tailpipe CO_2 is no longer representative



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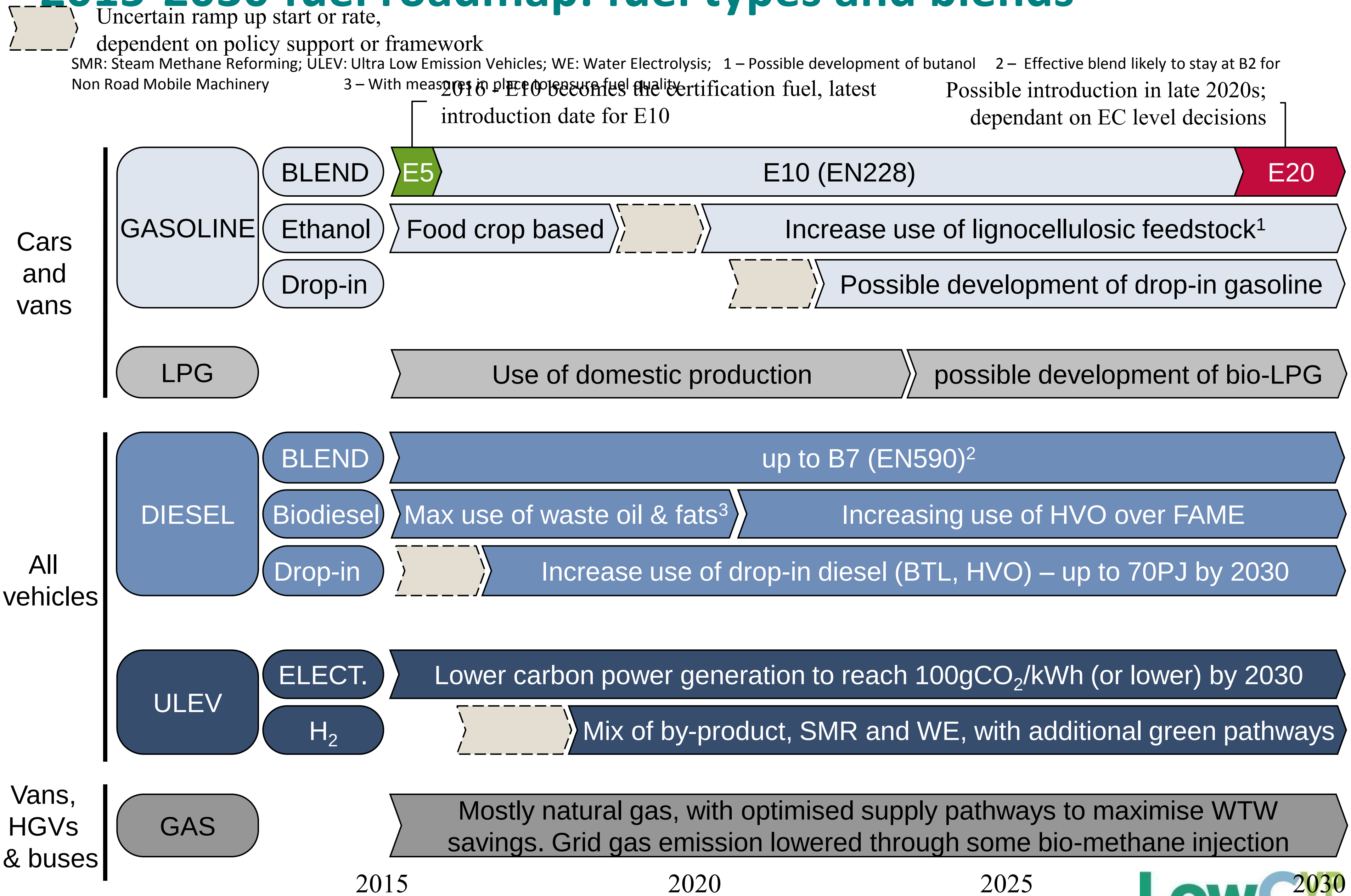
2015-2030 fuel roadmap: fuel types and blends



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Air Quality and LowCVP

Gloria Esposito

MC-P-14-06
LowCVP Members Council Meeting – 5 March 2014

Synergies and Conflicts – Air Quality and Climate Change

Low carbon vehicles can often be 'low emission vehicles' – Win-Win

- Methane/biomethane - low PM, low NOx at tailpipe
- Electric - zero CO_2 and zero pollutants at the tailpipe
- LPG - CO_2, PM and NOx at tailpipe

However there are risks associated with the low carbon vehicles

- Diesel engines have lower CO_2 but typically higher NOx/PM compared to petrol
- Risk of Increased NOx emissions from biodiesel & aldehyde emission bioethanol
- Gasoline direct injection engines may increase ultra fine particle emissions
- Risk of methane slip from gas powered vehicles (dedicated or dual fuel)
- Air pollution emissions from electricity generation are rarely attributed to EV's
- Hybrid systems may impact on aftertreatment effectiveness

More Joined Up Thinking is Starting

- *OLEV: 'The move to ultra low emission vehicles is inevitable. There are hugely significant benefits for the UK from this transition in terms of **energy security**, **air quality** and **carbon reduction**.' (ULEV Strategy 2014)*

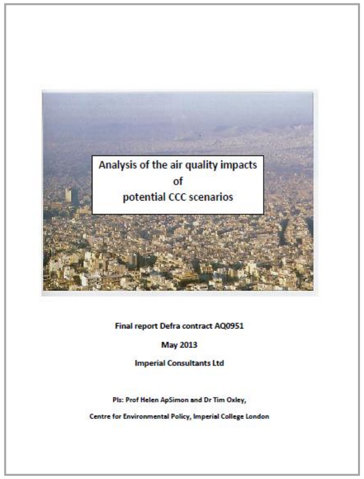
- *Defra: 'Now is the right time to consider how we can achieve these additional benefits, particularly from improving public health, through a **closer integration of air quality and climate change policies**.' (Air Pollution: Action in Changing Climate 2010)*

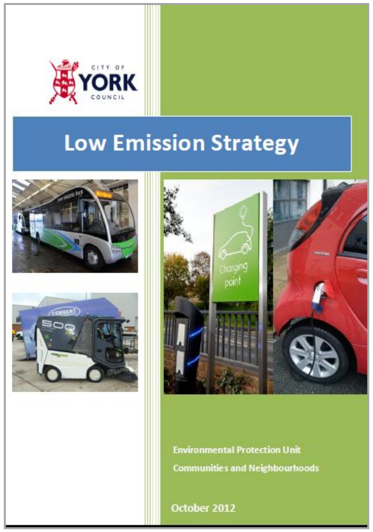
- Climate Change Committee – Analysis of the air quality impacts of potential CCC Scenarios (*Imperial College 2014*).

- TfL – Ultra Low Emission Zone – addressing NOx/PM and CO2
  Low Emission Vehicle Strategy – LCA study air pollution + GHG

- Local authorities starting to create Low Emission Strategies.

- Clean Bus Technology Fund – aim at reducing NOx in diesel buses, links with GBF and low carbon bus technologies.





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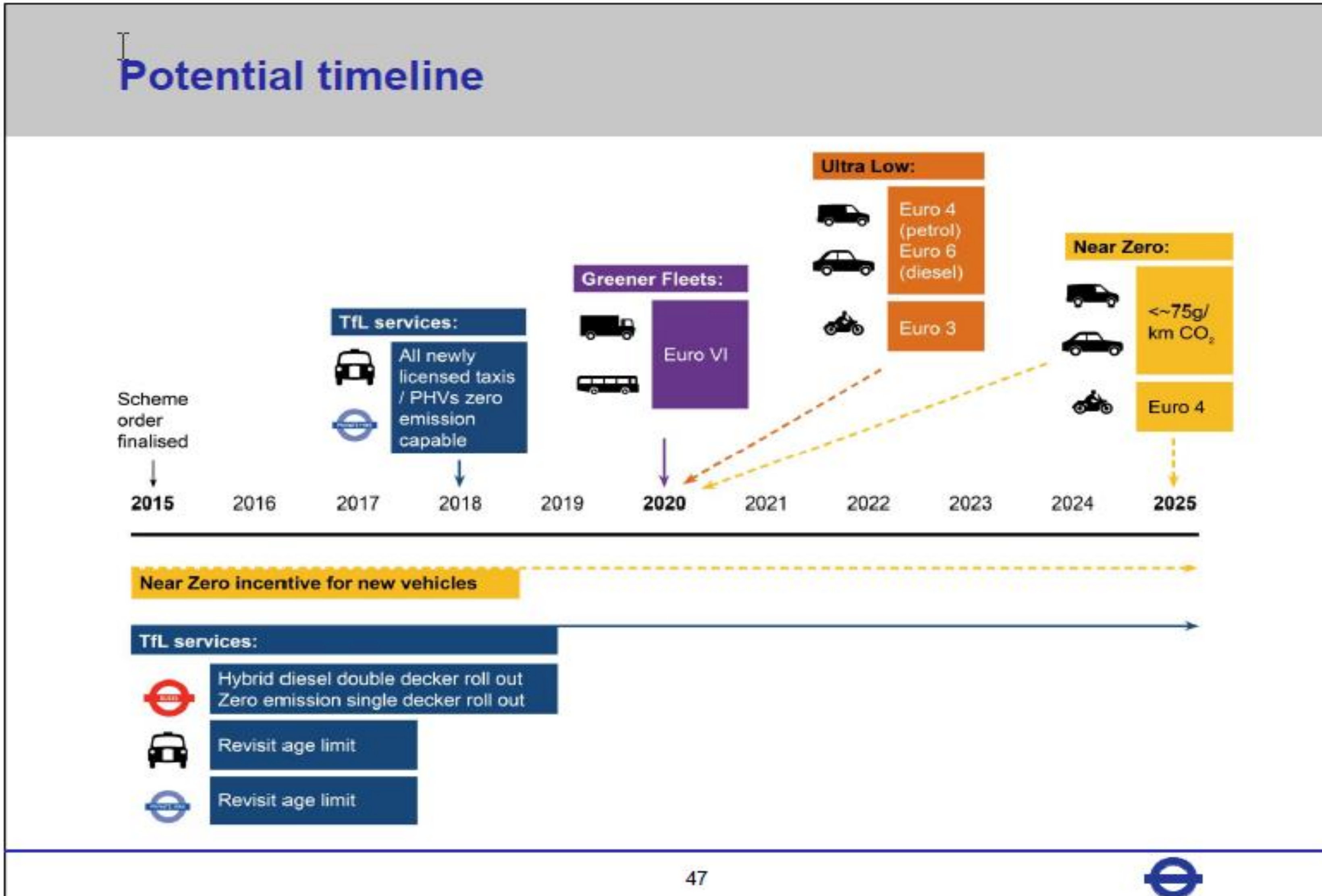
ULEZ proposal and consultation, Linkage to congestion charge - LowCVP supporting TfL



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LowCVP current view on AQ and Opportunities

Current Situation

LowCVP Focus on CO2 emissions from road transport, air quality considered briefly.

Members interest in air quality – BWG *'Air Quality Impacts of Low Carbon Bus Technologies'.*

LowCVP structure is unique, expertise in air quality agenda

AQ opportunity to accelerate uptake of Low carbon vehicles.

Going Forward

AQ and carbon inextricably linked and mutually beneficial

LowCVP potential role in integration on climate change and air quality policies for vehicles

- **Provide robust independent evidence regarding LEVs to inform policy.**
- **Improve the provision of information and policy advice for local authorities**
- **Support DfT's air quality policy team**
- **Improve stakeholder engagement between air quality and transport specialists, automotive and fuel industry, local/national Government, academia and NGOs.**

Emphasis on air quality could increase membership and funding opportunities.

The Low Carbon Vehicle Partnership

Connect |Collaborate| Influence

- **Connect**: With privileged access to information, you'll gain insight into low carbon vehicle policy development and into the policy process.
- **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 180 members with a stake in the low carbon road transport agenda.

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