

# Low emission vehicles & LowCVP activities in accelerating the market

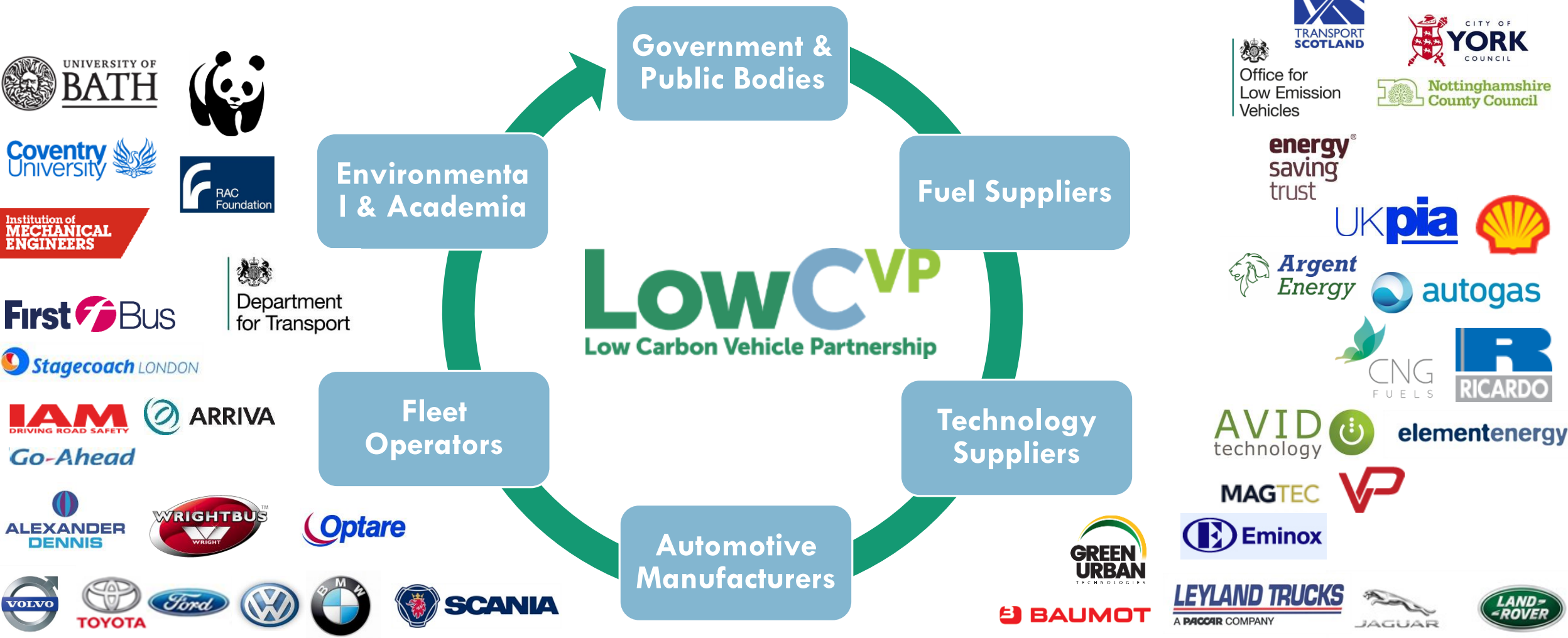
Tuesday 21<sup>nd</sup> November 2017

APSE Vehicle Maintenance & Transport Advisory Group Meeting

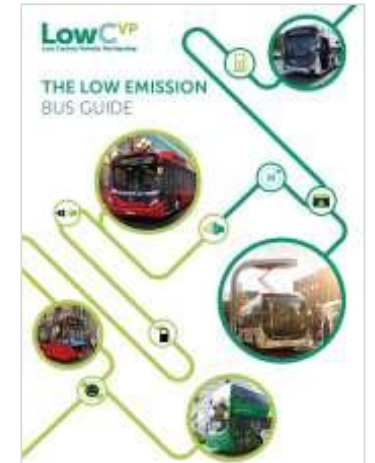
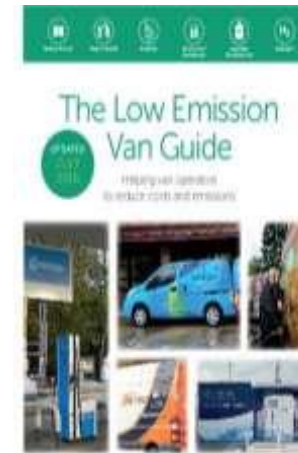
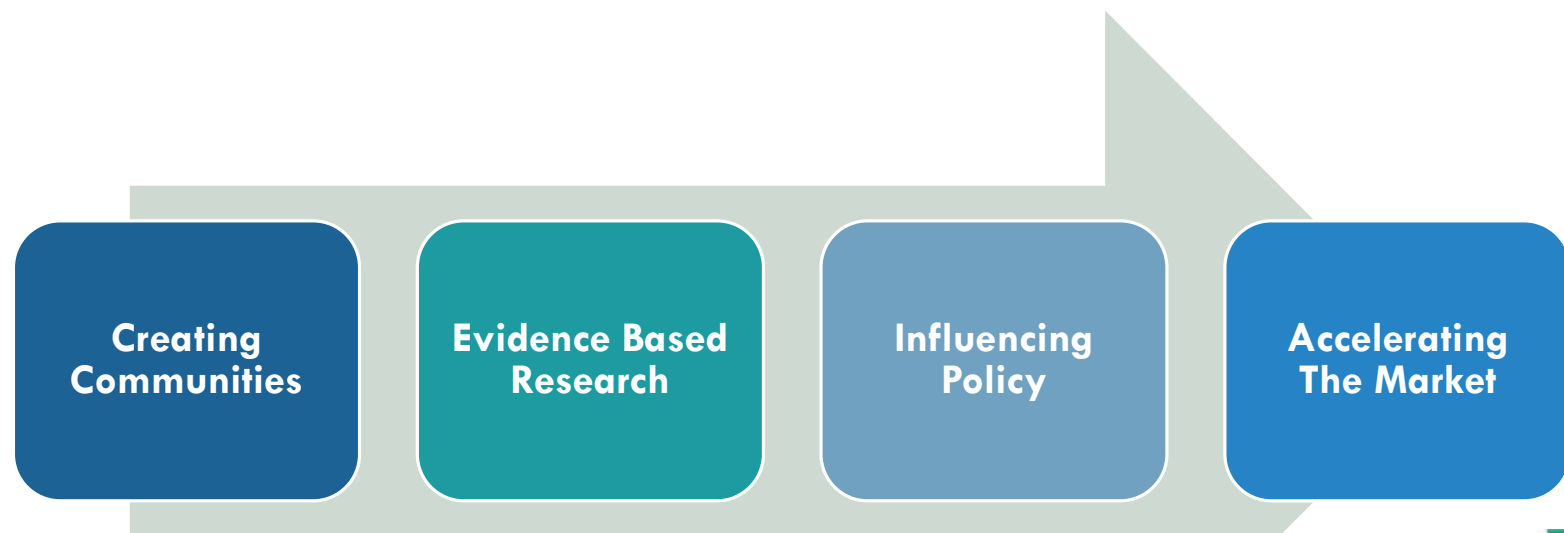


Gloria Esposito  
Head of Projects

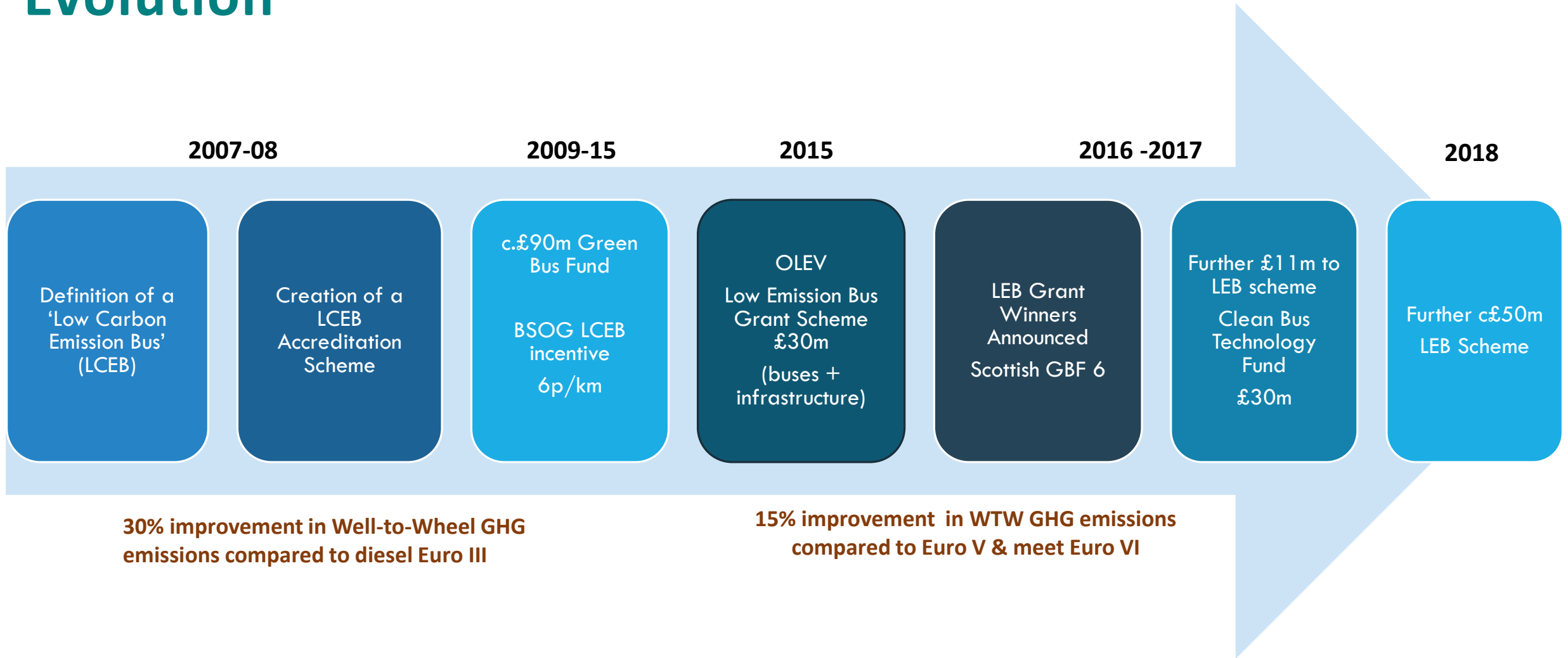
LowCVP is a public-private membership organisation, our mission is to “accelerate the sustainable shift to low carbon vehicles fuels & technologies ” in the UK.



# What does our work focus on?



# National Low Emission Bus Policy Evolution



LowCVP has influenced Government policy over the last decade and continues to drive ambition

# Currently 5,674 low carbon emission buses running across the UK, largest electric and hybrid bus fleet in Europe!!

**Leading cities Nottingham, London, Reading, Manchester, Leeds**



LowCVP website

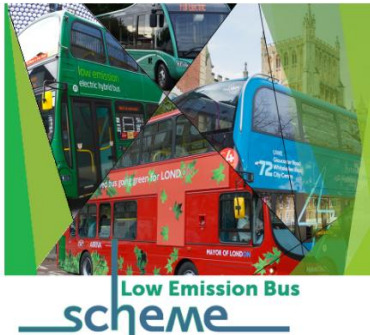
# LowCVP LEB Web-Portal – all you wanted to know about low emission buses and more

## Low Emission Bus Hub



A low emission bus (LEB) is one that operates using efficient technology or alternative fuels rather than just a traditional diesel engine. They are defined by the UK Government as producing 15% less Well-to-Wheel (WTW) emissions compared with an equivalent Euro V standard diesel bus.

Low emission buses can help lower the running cost and environmental impact of your fleet. [\[Click for More\]](#)



- Background [Click to view](#)
- Testing and Accreditation [Click to view](#)
- LEB Certificates [Click to view](#)

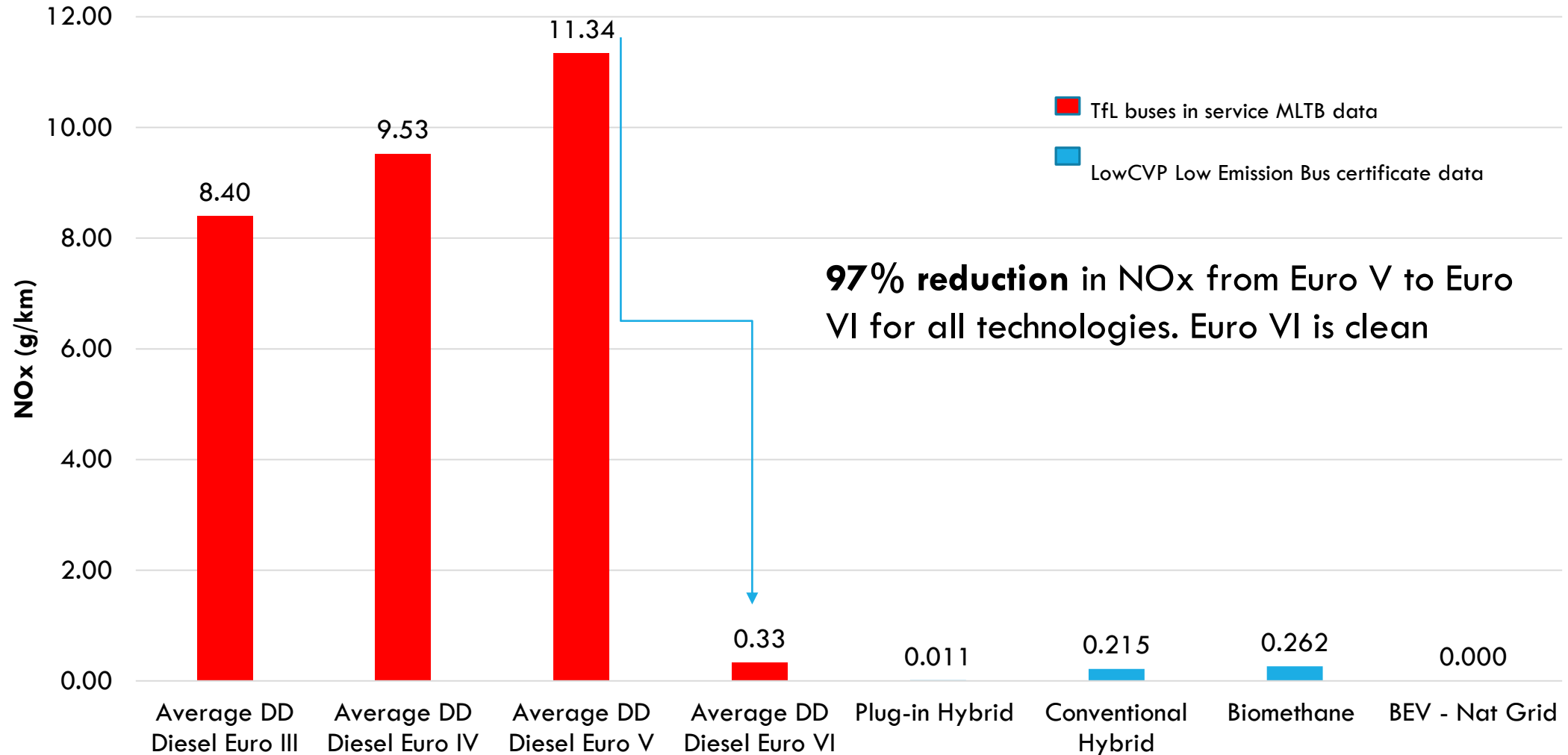


Low Emission Bus Accreditation Scheme – vehicles tested over LowCVP UK LUB cycle – certificates published on LowCVP website

<p>Optare Solo EV Pure Electric</p> 	<p>Fuel: UK Grid Electricity</p> <p>Well-To-Wheel GHG saving compared to Euro V diesel equivalent:</p> <p>69%</p> <p>Zero Emissions Range:</p> <p>&gt;30km</p> <p>WTW CO2e per passenger km:</p> <p>5.6 g CO2e / pass km</p>	 <p><a href="#">Click on the certificate to download</a></p>
<p>Scania / ADL 300 Biomethane</p> 	<p>Fuel: Biomethane – Gas Bus Alliance</p> <p>Well-To-Wheel GHG saving compared to Euro V diesel equivalent:</p> <p>82%</p> <p>Zero Emissions Range:</p> <p>N/A</p> <p>WTW CO2e per passenger km:</p> <p>3.0 g CO2e / pass km</p>	 <p><a href="#">Click on the certificate to download</a></p>

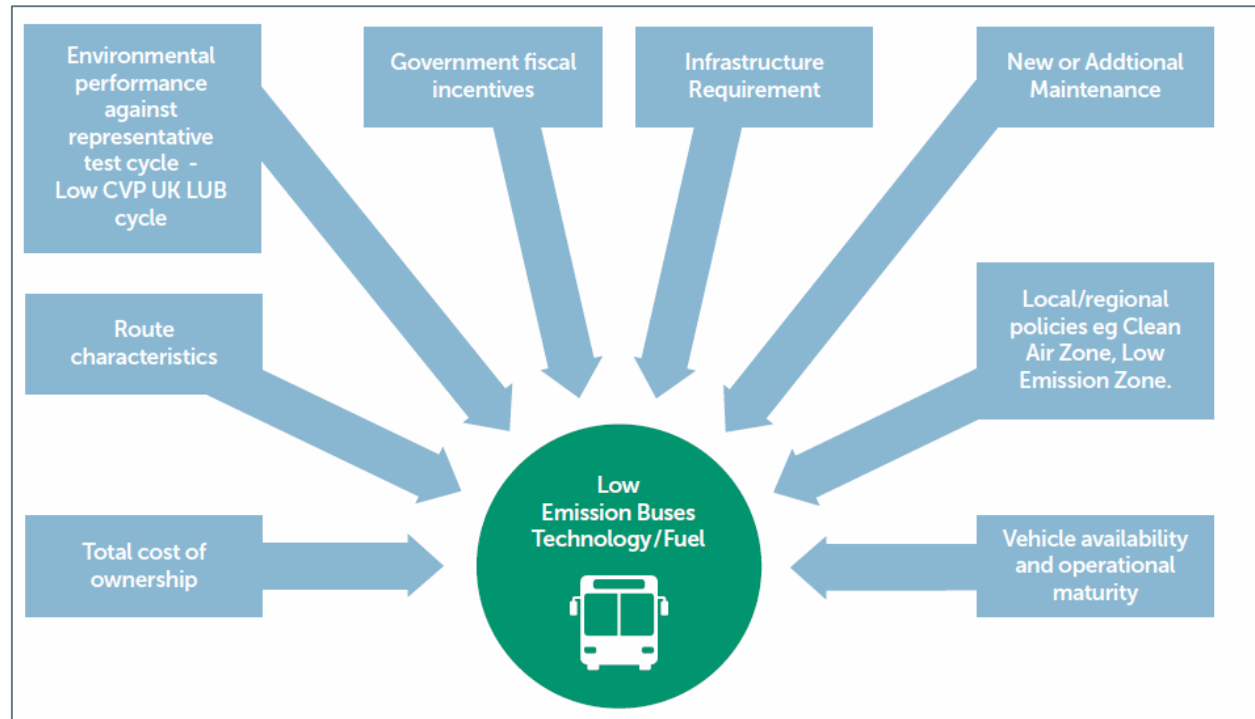
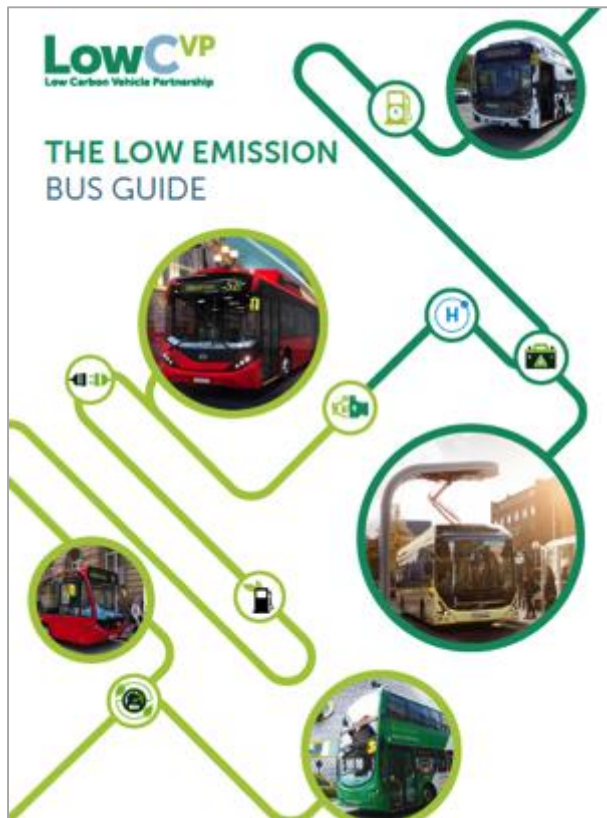
# Low Emission Bus Testing

### NOx emissions from Buses: Euro Standard emission comparison



# LowCVP Low Emission Bus Guide



Created to assist bus fleet operators and local authorities procure the latest clean and green buses and retrofit technology for diesel buses.



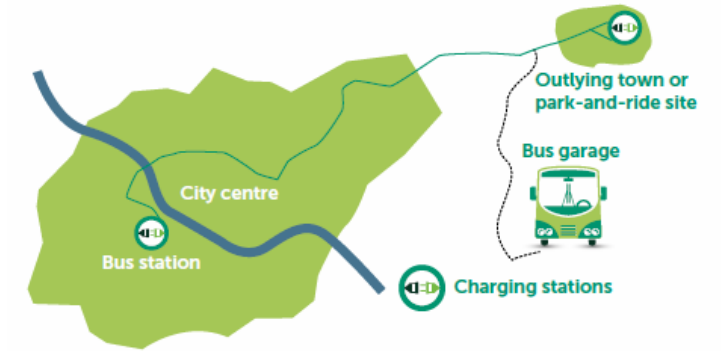
- Electric
- Plug-in Hybrid
- Hybrid
- Hydrogen FC
- Gas (CNG)
- Renewable fuels – biomethane, HVO, biodiesel
- Euro VI diesel with electric ancillaries
- Retrofit SCR

# Outlines LEBs and infrastructure currently available

## LEB Accredited Buses

Electric Bus Models	Energy Consumption and Electric Range	WTW GHG and Air Pollution Emissions
 <p><b>Volvo 7900 Electric</b> Single Decker Length: 12m Passenger capacity: 83 GVW: 18,000 kg</p>	<p>84.7 kWh/100km Up to 39.3 km</p>	<p>WTW GHG Emissions: 447.3 gCO<sub>2</sub>e /km 5.3 gCO<sub>2</sub>e/passenger km WTW GHG savings: 65% Zero emission</p>
 <p><b>Optare Solo EV</b> Single Decker Length: 9.2-9.9m Passenger capacity: 55 GVW: 11,300 kg</p>	<p>51.0 kWh/100 Up to 208km</p>	<p>WTW GHG Emissions: 307 gCO<sub>2</sub>e/km 5.6 gCO<sub>2</sub>e/passenger km WTW GHG savings: 69% Zero emission</p>
 <p><b>BYD eBus</b> Single Decker Length: 12m Passenger capacity: 70 GVW: 18,700 kg</p>	<p>83.1 kWh/100km Up to 452.7 km</p>	<p>WTW GHG Emissions: 429.6 gCO<sub>2</sub>e/km 6.1 gCO<sub>2</sub>e/passenger km WTW GHG savings: 62% Zero emission</p>
 <p><b>BYD-ADL Enviro200EV</b> Single Decker Length: 12m Passenger Capacity: 90 GVW: 18,600 kg</p>	<p>83.1 kWh/100km Up to 425.1 km</p>	<p>WTW GHG Emissions: 429.6 gCO<sub>2</sub>e/km 4.8 gCO<sub>2</sub> e/passenger km WTW GHG Savings: 68% Zero emission</p>

Overview of different charging strategies and what to consider regarding installation



Opportunity Charging

Plug-in Charging



# Sharing real world experiences of green buses – raising confidence in technology performance and demonstrating benefits



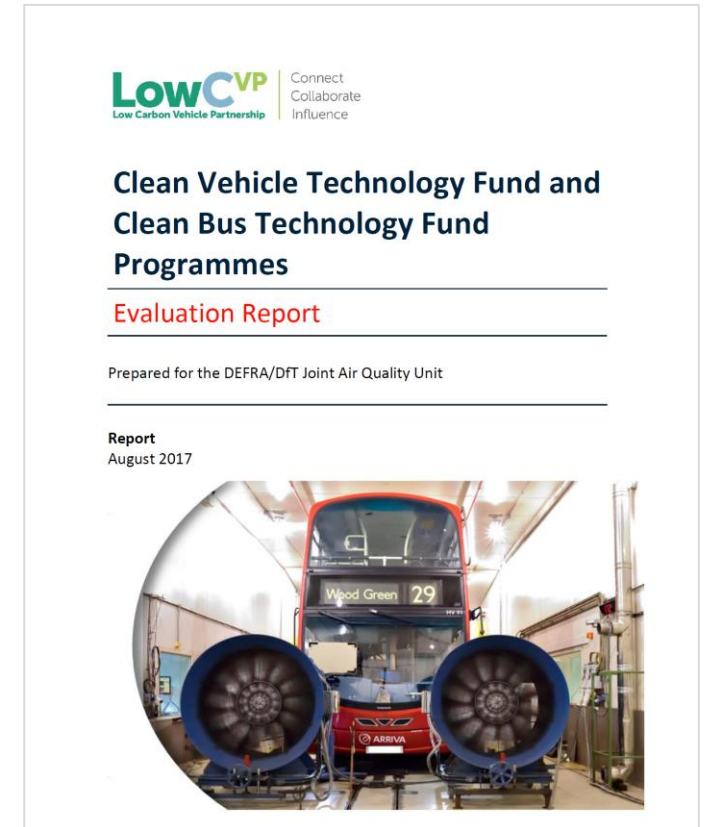
## LowCVP collaboration with Greener Journeys

- 20 bus fleet operator case studies covering -
  - Hybrid, PHEV, BEV, HFC, electrified ancillaries
  - Renewable fuels - biomethane and biodiesel
- Real world experience of operating LCEB
- Environmental and cost benefits
- Fleets covered - Arriva, Stagecoach, First Bus, Go Ahead, Reading Buses, Lothian Bus, Nottingham City Transport, Transport for London, Oxford Bus Company



# Evaluating Retrofit Technologies

- The Clean Bus Technology Fund (CBTF) 2013/2015 and Clean Vehicle Technology Fund (CVTF) 2014 programmes were introduced by the DfT to help reduce NOx emissions from diesel vehicles in cities experiencing poor air quality.
- £19 million was shared between 30 local and regional authorities.
- Focus on buses, other vehicle types covered under CVTF 2014
- The LowCVP was commissioned by Defra/DfT to undertake an evaluation of the CVTF and CBTF programmes – determine technology performance.
- Report available on LowCVP's website.
- Helped inform the introduction of the £30m Clean Bus Technology Fund 2017



# 2137 Vehicles Funded. 11 Technologies. 9 Vehicle Types

	Retrofit Technology	Vehicle Types	No. of vehicles funded	Euro Standard	Covered in evaluation study
Exhaust After Treatment	Selective Catalytic Reduction	Bus, coach, fire engine, mini-bus, car	1,594	Pre Euro, Euro II - V Euro 4/5	Yes
	Thermal Management Technology	Bus	83	Euro VI	Yes
Fuel Saving	Flywheel hybrid	Bus	104	Euro III/V	Yes
	Mild Hybrid	Bus	40	Euro III-V	Yes
	Hybrid Assist	Van	18	Euro 4	Yes
	Battery powered ancillaries	Ambulance	109	Euro III	No
Engine Conversion	Battery Electric	Bus	7	Euro II	Yes
	Range extender battery electric using compressed biomethane gas	Bus	1	Euro III	No
	Spark ignition engine powered by CBG	Bus	16	Euro III	No
	Duel Fuel Compressed Natural Gas	Black Taxi	113	Euro 2,3,4	Yes
	Spark Ignition Engine powered by LPG	Black Taxi	65	Euro 1,2,3	No

Retrofit Technology	Vehicle Category	Euro Standard	Average NOx emission reduction	Average tail-pipe NOx emissions	
Exhaust After-Treatment Technology	SCR	Bus	Euro III	88%	0.3 g/km
			Euro IV	90%	0.7 g/km
			Euro V	98%	0.8g/km
		Coach	Euro II	86%	1.4 g/km
			Euro III	99%	0.2 g/km
		Fire Engine	Euro III	70%	2.7 g/km
		Mini-bus	Euro 4	77%	0.3g/km
	Car	Euro 4	60%	0.2 g/km	
	Ammonia storage for SCR	Bus	Euro V	98%	0.5g/km
TMT	Bus	Euro IV	29%	11g/km	
Fuel Saving	Flywheel Hybrid	Bus	Euro III	26%	6.1 g/km
	Mild Hybrid	Bus	Euro V	5%	6.3 g/km
	Hybrid Assist	Van	Euro 4	6%	0.3 g/km
Engine Conversion	Dual Fuel CNG	Black Taxi	Euro 4	3%	1.1 g/km
	Battery Electric	Bus	Euro III	100%	

### Highest NOx emissions savings

- Selective Catalytic Reduction (esp buses)
- Conversion to Battery Electric

### Other Emissions

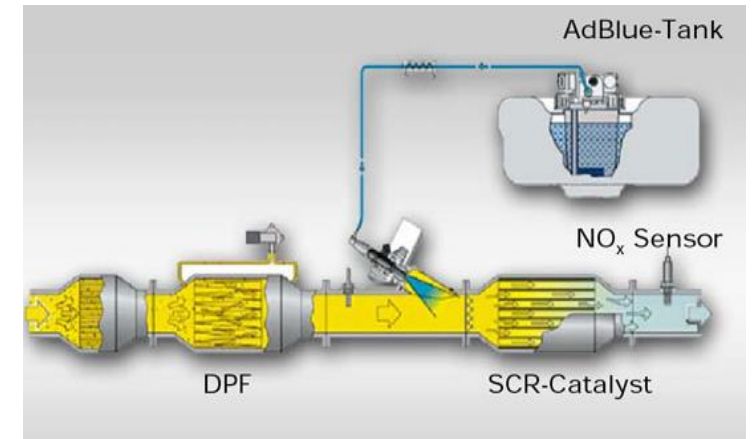
- SCR showed significant reduction in PM and NO<sub>2</sub> emissions, low ammonia.
- Significant increase in methane emissions CNG dual-fuel
- Slight increase in CO<sub>2</sub>e for SCR (nitrous oxide)

# Exhaust After-Treatment Technology: SCR

- Ammonia injected through a catalyst into the exhaust stream of a diesel engine.
- Chemical reaction occurs reducing NO<sub>x</sub> to nitrogen and water; secondary emissions produced



- Ammonia commonly supplied as aqueous urea (Ad-Blue)
- New ammonia storage – ammonia salt dosing trialled by TfL
- SCR commonly fitted with diesel particle filters that reduce PM emission.
- TfL largest retrofit bus programme in the UK > 6000 vehicles (Euro III/V)
- Focus has been on retrofit SCR buses, opportunities for taxis and vans



*Amminex ammonia salt*

# Engine Conversion: Battery Electric Buses

- The entire diesel engine drivetrain is completely removed and replaced with a battery-powered electric motor powertrain, resulting in zero tail-pipe emissions.
- York City Council won funding under the CBTF programme to convert six Euro II Dennis Trident double deck buses in Transdev's fleet.
- First double deck diesel bus conversion in the world carried out by Magtec
- Prototype bus been operation for two years, other five buses will be converted end of this year.
- Charged over night a Transdev depot.
- Good performance, 76 miles electric range, lower fuel cost.



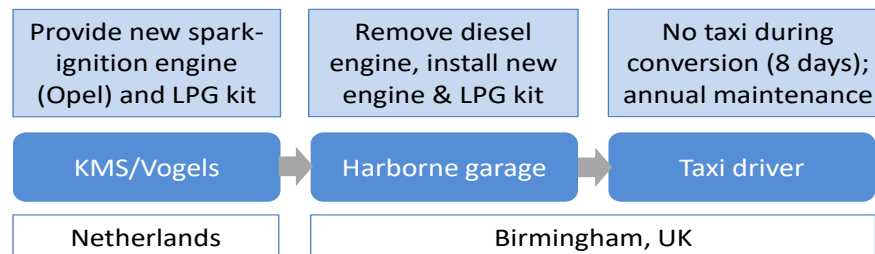
Transdev double deck fully electric sight seeing bus operating in York's CAZ.

# Birmingham City Council Retrofit LPG

- TX1, TX2 and TX4 taxis operate with diesel (compression-ignition) engines and typically belong to Euro 2 to 5 classes, i.e. they emit high levels of NOx and Particulate Matter.
- In September 2014, Birmingham City Council received £500,000 from the Department of Transport to convert c.80 taxis to the use of LPG, a much cleaner burning fuel than diesel.



## Current supply chain, established in 2015 for the Birmingham project

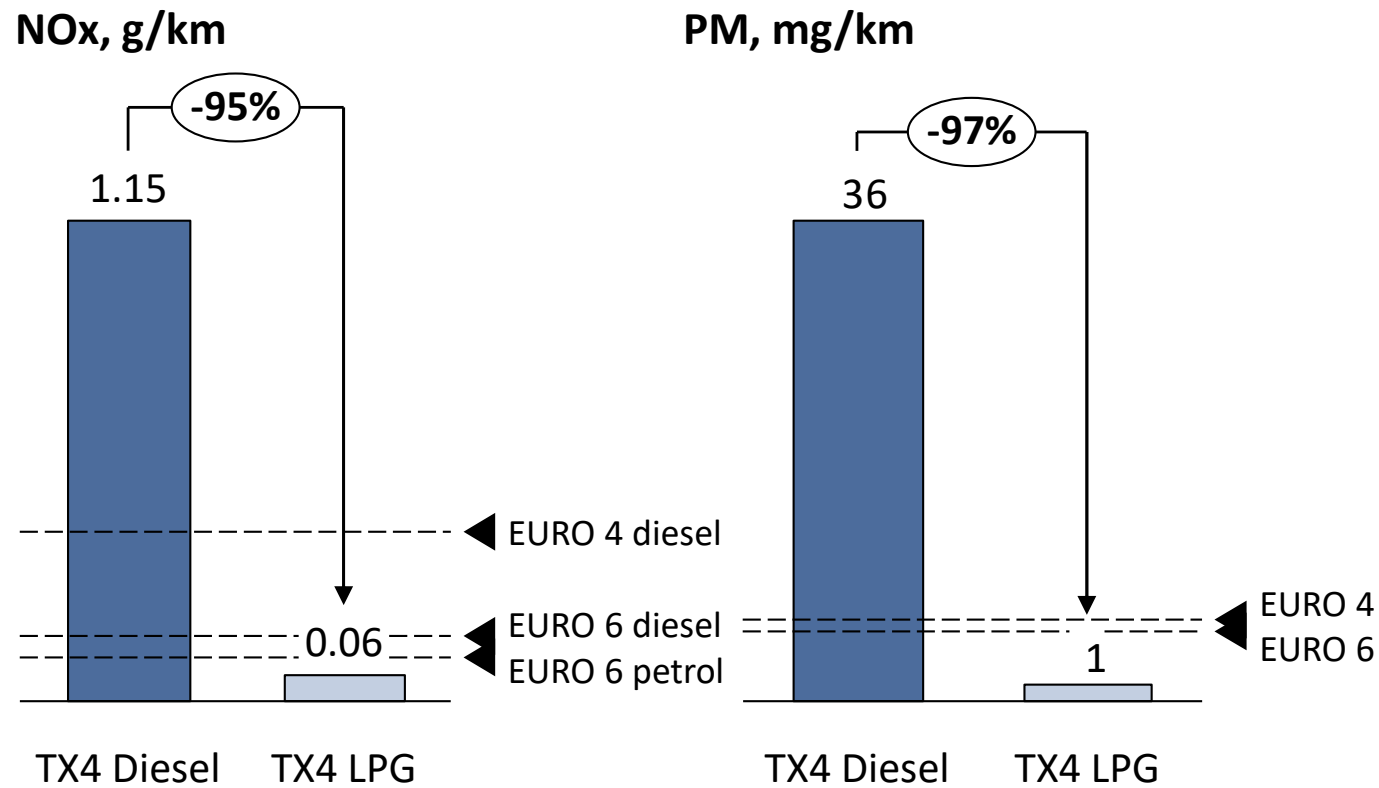


- KMS are providing the new Opel engines and the engineering of bespoke parts that are required to convert these engines to LPG into the taxi (TX1 & TX2 models – first tried on TX4).
- Vogels are providing KMS with all the standard LPG parts. Vogels' UK agent is National Autogas.
- Harborne garage removes the engines from the taxis, installs the new engine & LPG system. They calibrate the LPG system and can carry out the yearly maintenance.

## Key points/lessons learnt

- Early and continued engagement with users underpinned the success of the project – taxi drivers are the ones adopting the change so should be given the opportunity to input in and question the project
- Cost and time should be communicated clearly, differentiating *estimates* from *final values*; VAT accounting rules should also be clearly communicated from the start

# Vehicle emission testing results for BCC retrofit LPG black taxi – compliance with Euro 6




*Courtesy of BCC & Element Energy (Sept 2017)*

# Clean Vehicle Retrofit Accreditation Scheme

energy saving trust | Renewable Energy | Home Insulation | Home Energy Efficiency | Tr

## What is the Clean Vehicle Retrofit Accreditation Scheme (CVRAS)?

The CVRAS is a robust certification scheme for manufacturers of retrofit emissions reduction technology that will enable Clean Air Zone (CAZ) compliance of legacy fleet vehicles. This certification scheme supports the operation of Clean Air Zones and addresses the air pollution emissions from buses, coaches, heavy goods vehicles, mini-buses and vans.



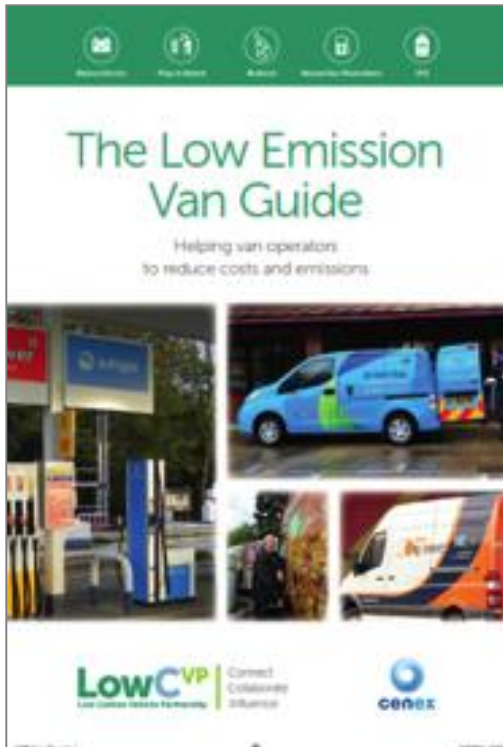
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Further information and helpful documentation

- Approved manufacturers and devices
- Getting certified

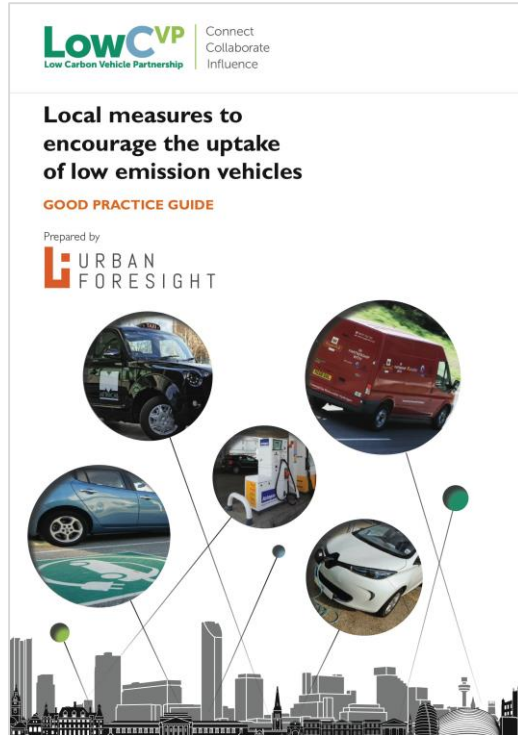
- The CVRAS is an independent certification scheme for manufacturers of retrofit emissions reduction technology to enable Clean Air Zone compliance of legacy diesel vehicles.
- The certification scheme addresses the air pollution emissions from buses, coaches, heavy goods vehicles, mini-buses, black taxis and vans.
  - Emission limits for air pollutant and greenhouse gas emissions
  - Vehicle emission testing procedures
  - Requirements for in service durability
- Designed by LowCVP, on behalf of JAQU, and delivered in partnership with Energy Savings Trust.
- Buses are the first vehicle type to feature in the scheme, other vehicles will be ready soon.

[www.EnergySavingTrust.org.uk/CVRAS](http://www.EnergySavingTrust.org.uk/CVRAS)

# Other activities which could help local authorities



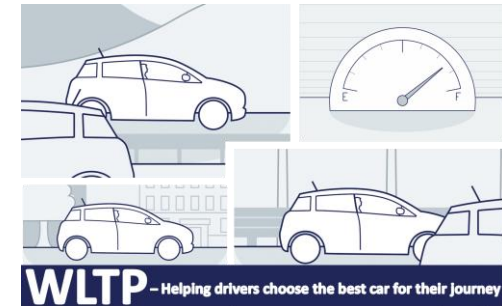
Workshops with local authorities to promote our guides



Fuel Economy		VED band and CO <sub>2</sub>
CO <sub>2</sub> emission figure (g/km)		
0	A	
1-40	B	
41-75	C	
76-90	D	
91-120	E	
121-150	F	
151-180	G	
181-170	H	
171-160	I	
161-150	J	
151-140	K	
141-130	L	
131-120	M	
121-110	N	
111-100	O	
101-90	P	
91-80	Q	
81-70	R	
71-60	S	
61-50	T	
51-40	U	
41-30	V	
31-20	W	
21-10	X	
11-0	Y	
0-10	Z	
		g/km
Fuel cost (estimated) for 12,000 miles		
A fuel cost figure indicates to the consumer a guide price for consumption purposes. This figure is calculated by using the combined drive cycle (own needs and highway) and average fuel price. The calculated annuality, the cost per litre as at Mar 2017 is as follows - petrol 132p, diesel 132p, LPG 10p.		
VED for 12 months		
Vehicle excise duty (VED) or road tax varies according to the CO <sub>2</sub> emissions and fuel type of the vehicle.		
1 <sup>st</sup> Year rate*	Standard rate*	
Environmental Information		
A guide on fuel economy and CO <sub>2</sub> emissions which contains data for all new passenger car models is available at any point of sale free of charge. In addition to the fuel efficiency of a car, driving behaviour as well as other non-technical factors play a role in determining a car's fuel consumption and CO <sub>2</sub> emissions. CO <sub>2</sub> is the main greenhouse gas responsible for global warming.		
Make/Model:	Engine Capacity (cc):	
Fuel Type:	Transmission:	
Fuel Consumption:		
Drive cycle	Litres/100km	Mpg
Urban		
Extra-urban		
Combined		
Carbon dioxide emissions (g/km):		
Important note: Some specifications of this make/model may have lower CO <sub>2</sub> emissions than this. Check with your dealer.		
Department for Transport	To compare fuel costs and CO <sub>2</sub> emissions of new cars, visit: <a href="https://www.gov.uk/co2-and-vehicle-tax-tools">https://www.gov.uk/co2-and-vehicle-tax-tools</a>	Vehicle Certification Agency

Creating new car labels taking into account new fuel economy data and CAZ compliance

New 'official' fuel economy and emission test for cars – preparing Government policy and car buyer information



Producing a Low Emission Taxi Guide – Launch May 2018

# Thank you for listening



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## Interested in joining the Partnership?