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Low Emission Bus Technology and Funding

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Outline

- UK Government policy on low emission road vehicles
- Low emission buses – grant funds and policies in place
- How we interact with industry to assist in grant fund applications
- Our assessment criteria for Low Emission Bus Scheme
- Economic analysis of low emission bus technology
- Main implications of each technology

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UK Government policy on low emission road vehicles

- The UK is committed to air quality improvement and an 80% carbon emissions cut by 2050
- Our vision is that by 2050 almost every car and van in the UK will be an ultra low emission vehicle (ULEV)
- We also want to increase ULEV market penetration in buses and heavy goods vehicles
- Crucially, UK Government is technology neutral in deployment of ULEVs

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UK Government policy on low emission road vehicles

- We address barriers in the low emission bus market through:
  - Grant funds: funding additional upfront vehicle costs
  - Infrastructure funds: funding infrastructure cost, providing city charging solutions
  - Vehicle price subsidy (cars), tax incentives (road tax), research and monitoring
  - Collaboration with industry, academics, operators and consumers

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Low emission buses – grant funds and policies in place

- Several UK-based and European bus builders supply the UK market
- Most buses operated by private sector
- Upfront costs are a key concern
- Infrastructure requires space, building works, energy supply
- Technology is new, experience could be rare
- However, both local government and bus operators attracted to low emission buses
- UK has a strong record in low emission investment - 8% English buses low emission

Photo credit: LowCVP, 2016, Low Emission Bus Guide

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Low emission buses – grant funds and policies in place

- **Grant funds** focused on *new* low emission technology:
  - Green Bus Fund 1-4 (£90m): ran 2009-12, delivered 1,250 low emission buses
  - Low Emission Bus Scheme (LEBS) (£30m): ran in 2015 – will deliver 330 buses and infrastructure
- **New funding programmes**:
  - Last month, UK Treasury announced a further £150m in total, for cleaner buses and taxis over the next few years

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How we interact with industry to assist in grant fund applications

- Worked with industry to create a low emission bus standard and emissions test
- Hosted workshops with industry to teach about technology and infrastructure
- Created a downloadable running costs and benefits calculator for industry
- Hosted workshops with prospective bidders to explain application process
- Used help from the not-for-profit industry partner LowCVP throughout

A low emission bus achieves minimum 15% well to wheel carbon saving

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Our assessment criteria for Low Emission Bus Scheme

- We wanted to drive up ambition of projects and their environmental benefit
- We award up to 75% of additional costs for buses and infrastructure; 90% of additional costs for *zero emission capable* buses
- Technical detail of bids were reviewed by expert engineers
- Bids were awarded scores on 4 criteria
- Winners were picked according to their total score

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Our assessment criteria for Low Emission Bus Scheme

- **LEBS budget**: **£30m**
- **Total funds bid for: £123m**
- Number of bids: 35
- Types of bidders: Operators, local transport authorities (e.g. Transport for London) and a university
- Size: big and small

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Our assessment criteria for Low Emission Bus Scheme

Bidder	Type of technology	Number of buses	Total amount funded
Birmingham City Council and Transport for London	Hydrogen fuel cell	42	£3,814,000
Kingston University	Hybrid	7	£347,400
Arriva and Merseytravel	Biomethane, Electric, Hybrid	72	£4,982,349
Milton Keynes Borough Council	Electric	11	£1,757,621
Nottingham City Council	Electric		£921,154
Nottinghamshire County Council	Electric	2	£526,900
Nottingham City Transport	Biomethane	53	£4,433,401
Reading Buses	Biomethane	16	£1,721,655
Sheffield City Region Combined Authority	Hybrid	44	£1,320,000
Transdev Blazefield	Electric	8	£2,255,700
Transport for London	Electric	34	£5,000,000
West Midlands Travel Limited	Hybrid, Electric	29	£3,074,620
West Yorkshire Combined Authority	Hybrid	8	£234,000
TOTAL		**326**	**£30,388,800**

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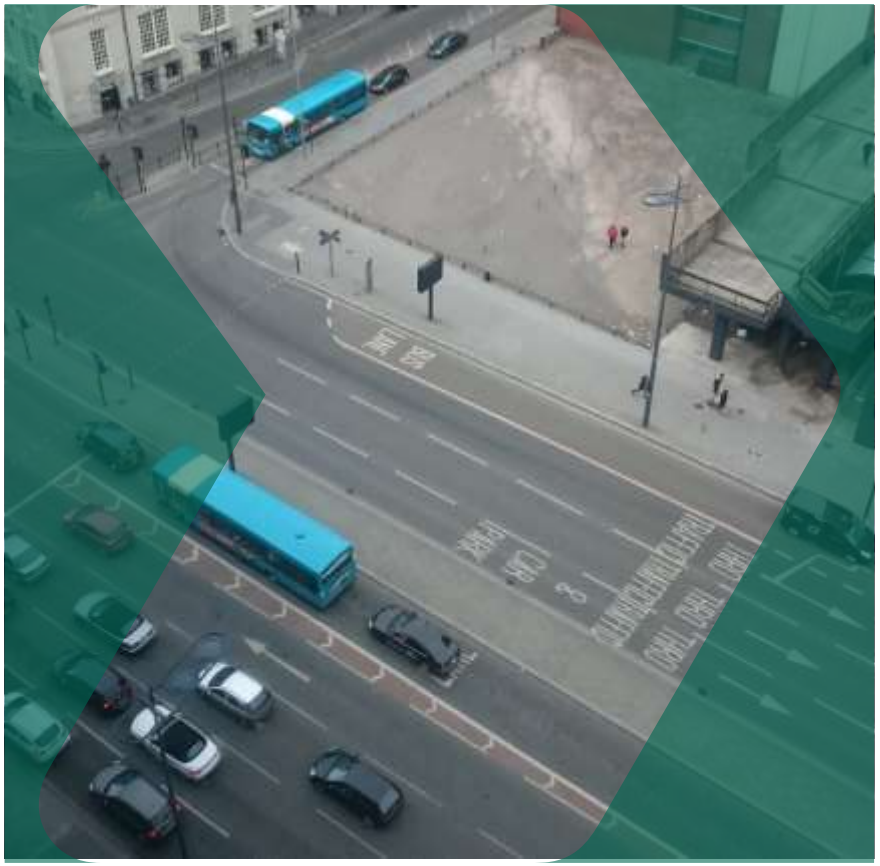
Economic analysis of low emission buses

- Key features of low emission bus economics:
  - Capital costs
  - Net fuel savings vs conventional diesel
  - Reliability and maintenance
  - Vehicle and infrastructure useful lifetime
  - Carbon savings
  - Air quality savings
- Data comes from variety of places:
  - Manufacturer price quotes
  - Low emission bus certificate
  - Operational experience
  - UK Government economic appraisal datasets



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Economic analysis of low emission buses

	Indicative low emission bus capital cost	Capital cost of diesel equivalent	Additional cost
Single decker hybrid	£215,000	£123,000	+£92,000
Double decker hybrid	£286,000	£190,000	+£96,000
Single decker plug-in hybrid	£300,000	£123,000	+£177,000
Single decker biomethane gas	£170,000	£123,000	+£47,000
Single-decker electric	£295,000	£123,000	+£172,000
Single decker hydrogen	£500,000?	£123,000	+£377,000

- Without grant funding, IRR could be less than 10%, or even worse when cost of raising capital is taken into account
- With capital costs so high at the moment, grant funding is required

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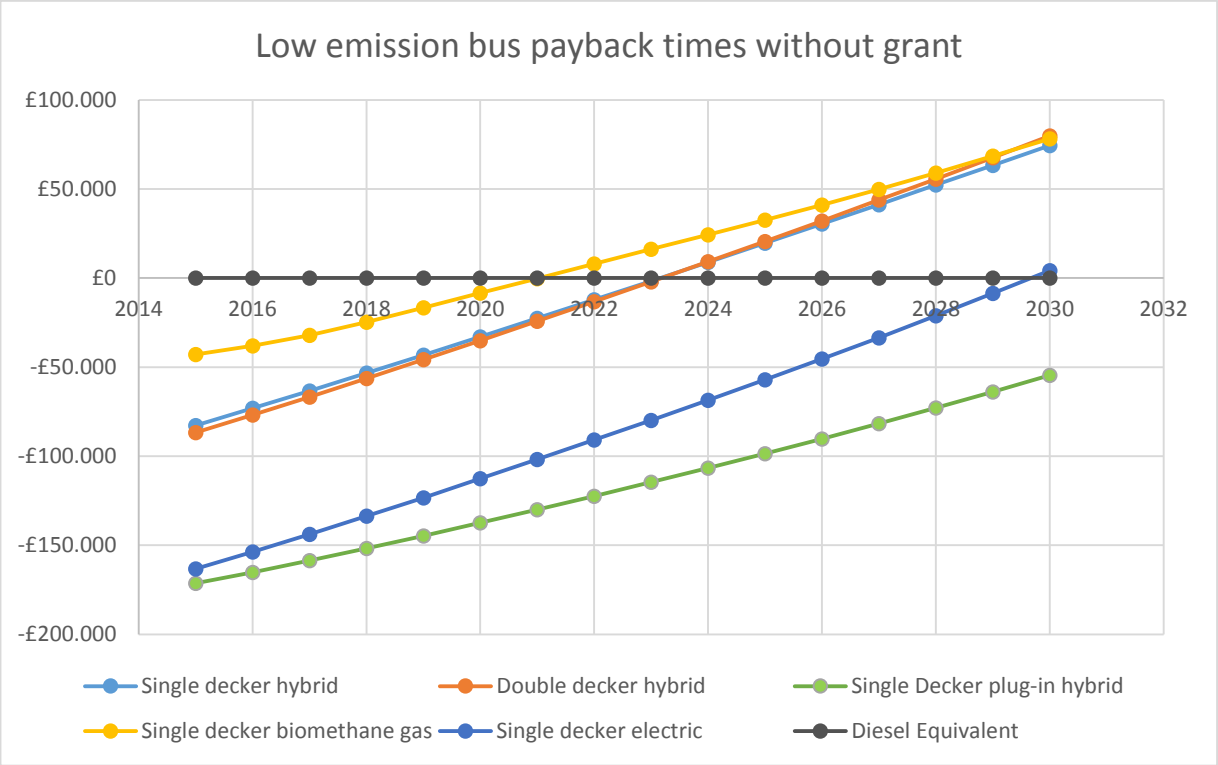
Economic analysis of low emission buses



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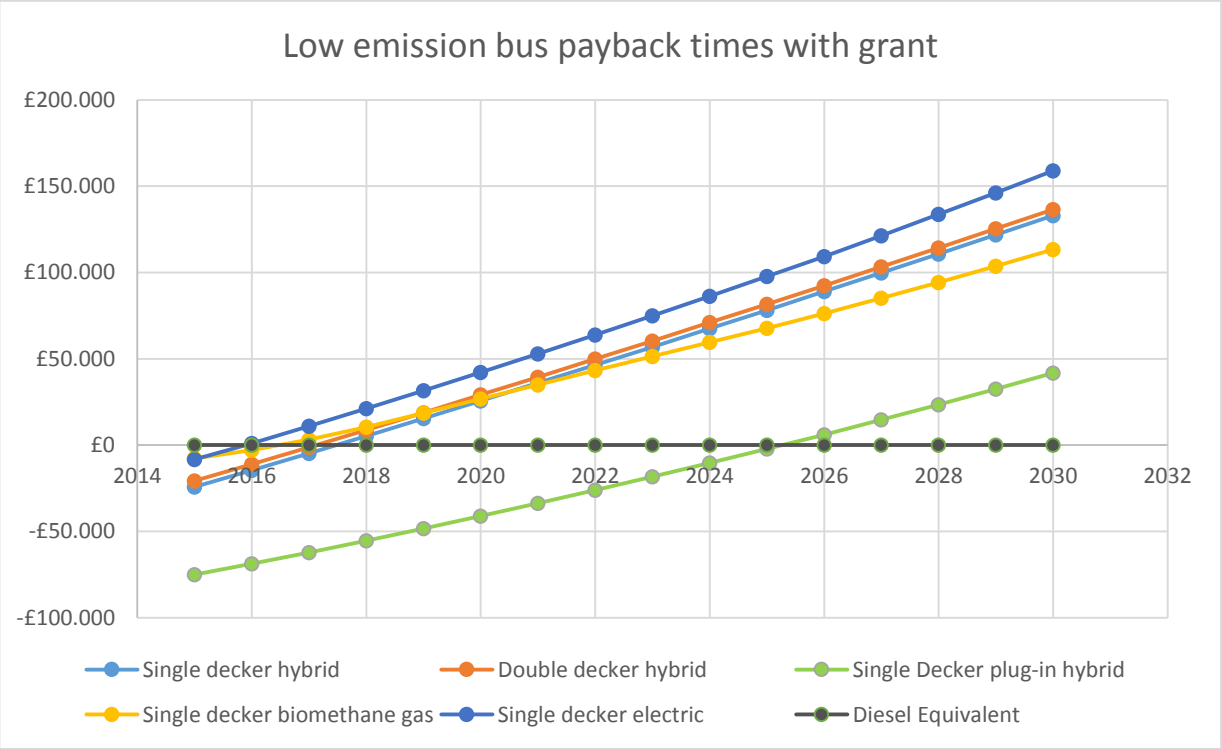
Economic analysis of low emission buses



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Economic analysis of low emission buses

	Conventional SD	*Conventional DD*	Hybrid SD	Biomethane SD	Electric SD	Hybrid DD
Annual distance, km	*74,000*	*74,000*	74,000	74,000	57,000	74,000
Fuel type	*Diesel*	*Diesel*	Diesel	Biomethane	Electricity	Diesel
Fuel unit	*litres*	*litres*	litres	kilograms	kWh	litres
unit/100km	*40L*	*50L*	30L	40-50kg	50-80kWh	40L
WTW carbon saving, gCO2e/km	*0*	*0*	300	900	550	400

- Key: SD= single decker, DD= double decker
- Above is an example of assumptions for modelling low emission bus impacts
- More detailed data is available from LowCVP's *Low Emission Bus Guide*, available online
- The guide is designed to help operators, and includes performance data from low emission bus certificates

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Economic analysis of low emission buses

Annual figures	**Distance- km**	**CO2e savings per vehicle - tonnes**	**Net fuel savings – to operator**	**CO2e saving per vehicle**	**Air quality saving**
Hybrid SD	72,000	22	£ 6,600	£ 1,400	?
Biomethane SD	72,000	65	£ 11,500	£ 4,300	?
Electric SD	56,000	31	£ 19,000	£ 2,000	£ 1,500 to £5,500?
Hybrid DD	72,000	29	£ 13,200	£ 1,900	?

- Key: SD= single decker, DD= double decker
- This is an example of **experimental** calculations of costs and benefits
- Bus performance is modelled based on low emission bus certificate data
- Air quality benefits depend on local area concentration of air quality pollution; figure given is for urban average vs London

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Economic analysis of low emission buses

Low Carbon Bus Investment Calculator

Step 1 - Calculate costs / savings of Biomethane Gas Bus

Step 2 - Input Assumptions

Average Annual Distance Travelled 43,000 miles

	Diesel Equiv.		Biomethane Gas	
Capital Cost	123,000	£	170,000	£
Avg Annual Fuel Consumption	27,926	litres	28,105	kg
Fuel Efficiency	7.00	mpg	1.53	miles/kg

Payback by **2022**

This is the first year where cumulative cost of LCEB is lower than diesel equivalent cumulative cost

Savings from an LCEB **£78,110** **(after 15-year period)**

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Hybrid buses

Bus Manufacturer

Performance

WTW CO2 saving
Air quality saving
Energy consumption
Electric range, if any

Infrastructure Provider

Infrastructure

Diesel fuel station
Electric charging, if plug in hybrid

Energy Provider

Diesel fuel/Electricity

Renewable diesel/electricity supply?

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Electric buses

Bus Manufacturer

Performance

WTW CO2 saving
Air quality saving
Energy consumption
Electric range

Infrastructure Provider

Infrastructure

Charging points required

Energy Provider

Grid Electricity

Carbon intensity of electric supply
Renewable electricity?

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Methane gas buses

Bus Manufacturer

Performance

WTW CO2 saving
Air quality saving
Energy consumption

Infrastructure Provider

Infrastructure

Gas refuelling stations

Energy Provider

Biomethane

Carbon factor of biomethane

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Key links

- LEBS homepage https://www.gov.uk/government/publications/low-emission-bus-scheme
- DfT Low carbon bus calculator https://www.gov.uk/government/publications/low-carbon-bus-calculator
- Office for Low Emission Vehicles homepage https://www.gov.uk/government/organisations/office-for-low-emission-vehicles
- LowCVP homepage – buses http://www.lowcvp.org.uk/initiatives/leb/Home.htm
- LowCVP Low Emission Bus Guide http://www.lowcvp.org.uk/assets/reports/LowCVP%20LEB%20Guide%202016%20interactive%20V3.pdf

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Questions