Ultra Low Emission Trucks

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What is a Ultra Low Emission Truck?

- **Electric?** Certainly - But for whom?
- **Hybrid?** Probably - Depending on application
- **Gas?** Possibly - Depending on engine & fuel
- **Diesel?** Perhaps – Euro level

So what emissions are being reduced and are we measuring grams per tonne/kilometre?
Why do we need Ultra Low Emission Trucks?

Carbon emissions must be reduced by:

20% by 2020 and by 80% by 2050

In the UK transport is responsible for 26% of Carbon emissions

To reduce this we must reduce the carbon intensity of fuel.

And

Reduce grams of CO₂ per tonne/kilometre
Air quality must be improved because:

**Infraction proceedings by EU**

European Commission (Commission) has sent the UK a ‘Letter of formal notice’ for breaching nitrogen dioxide (NO$_2$) limit values in 16 of 43 zones.

London has the highest levels of NO$_2$ of any capital city in Europe. The UK has the highest proportion of zones breaching legal limits. Exhaust emissions from passenger cars (including private hire vehicles) of NO$_2$ and dangerous airborne particles (PM$_{2.5}$) are expected to rise from 39% and 49% of transport exhaust emissions respectively in 2010 to a staggering 47% and 54% respectively in 2015.
World Health Organisation says studies have found adverse health effects at concentrations that were at or below the current EU limit values. Leading scientists say there is evidence for a long-term effect of NO\textsubscript{2} on natural mortality as high as that of PM\textsubscript{2.5}.

The Mayor of London, Boris Johnson, estimates UK faces fines of £300m per annum for London alone if compliance is not achieved.

Cities affected outside London include Birmingham, Glasgow, Kingston upon Hull, Leeds, Manchester and Southampton and so-called ‘zones’ such as Eastern, East and West Midlands, North East, North West and Merseyside, South East, Teesside, The Potteries and Yorkshire.

Why do we need Ultra Low Emission Trucks?
Use of Diesel and engine efficiency

Source: Mercedes Benz-Trucks - Actros 1844 LS; 40 t EURO 5, G211-12KL/14.93-1.0, HL6 Axle i=2.846, Route: Stuttgart-Hamburg-Stuttgart 1.517 km, Average speed v=83.2 km/h
Why not purely electric for all vehicles?

Battery technology is not sufficiently advanced to drive long distance trucks under electric power alone!

<table>
<thead>
<tr>
<th>Range</th>
<th>Diesel</th>
<th>100% electric with Li-ion battery</th>
</tr>
</thead>
<tbody>
<tr>
<td>500 km 7.5-tonne distribution operations</td>
<td>![Image] 90 litres 76 kg</td>
<td>![Image] 2.3 m$^3$ 4.7 t</td>
</tr>
<tr>
<td>3000 km 44-tonne long distance operations</td>
<td>![Image] 990 litres 836 kg</td>
<td>![Image] 26 m$^3$ 52t</td>
</tr>
<tr>
<td>500 km 7.5-tonne distribution operations</td>
<td>![Image] Eco Hybrid with Li-ion battery</td>
<td>Diesel 72 litres / 61kg</td>
</tr>
</tbody>
</table>

Calculation: consumption: 20 l/100 km /33 l/100 km, efficiency: diesel engine = 40%, electric motor = 80%, energy content: diesel = 11.8 kWh/kg, Li-ion battery = 0.19 kWh/kg, weight: diesel = 0.845 kg/l, Li-ion battery = 2 kg/l
Greenhouse gas emissions weighted by global warming potential (million tonnes carbon dioxide equivalent)

- Energy supply: 39%
- Business: 15%
- Transport: 26%
- Public: 2%
- Residential: 15%
- Agriculture: 1%
- Industrial process: 2%
- Waste Management: 0.3%

Ranking of Truck Duty Cycles by CO$_2$ Emissions Share

- **Long Haul**: 45%
- **Regional delivery**: 15%
- **Construction**: 25%
- **Urban**: 11%
- **Municipal**: 4%
Sources of NOx in the UK

NOx emissions Thousand tonnes

- Energy Industries: 315 thousand tonnes
- Manufacturing & Construction: 125 thousand tonnes
- Road Transport: 350 thousand tonnes
- Non-road transport: 164 thousand tonnes
- Other: 91 thousand tonnes

Sources of $\text{PM}_{10}$ in the UK

PM$_{10}$ emissions Thousand tonnes

- Energy Industries: 67
- Manufacturing & Construction: 10
- Road Transport: 24
- Non-road transport: 8
- Other: 4

Sources of PM$_{2.5}$ in the UK

PM$_{2.5}$ emissions Thousand tonnes

- Energy Industries: 43
- Manufacturing & Construction: 17
- Road Transport: 9
- Non-road transport: 5
- Other: 3

# Key Technologies to reduce Emissions

<table>
<thead>
<tr>
<th>Technology</th>
<th>Urban Delivery</th>
<th>Regional Delivery</th>
<th>Long Haul</th>
<th>Municipal</th>
<th>Construction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dual Fuel</td>
<td>✅</td>
<td>✅</td>
<td>✅</td>
<td>✅</td>
<td>✅</td>
</tr>
<tr>
<td>Dedicated gas</td>
<td>✅ ✅</td>
<td>✅</td>
<td>✅</td>
<td>✅</td>
<td>✅</td>
</tr>
<tr>
<td>Hybrid &amp; Batt. Electric</td>
<td>✅</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stop/Start</td>
<td>✅</td>
<td>(✅)</td>
<td>(✅)</td>
<td>✅</td>
<td>✅</td>
</tr>
<tr>
<td>Aerodynamics</td>
<td>✅</td>
<td>✅</td>
<td>✅</td>
<td></td>
<td></td>
</tr>
<tr>
<td>LRR Tyres</td>
<td>✅</td>
<td>✅</td>
<td>✅</td>
<td>✅</td>
<td>✅</td>
</tr>
<tr>
<td>BioMethane</td>
<td>✅</td>
<td>✅</td>
<td>✅</td>
<td>✅</td>
<td></td>
</tr>
</tbody>
</table>

Opportunities to overcome barriers for uptake of low emission technologies appropriate to each commercial vehicle duty cycle - AEA
Why Natural Gas?

Lower emissions than petrol or diesel –
  The lowest Hydrocarbon fuel available
Available now
Plentiful supplies
At least 9 manufacturers are producing CNG Cars & Vans
Over 17 million vehicles worldwide
By using BioMethane ~ 60% carbon savings?
No ethical discussion
Why not Natural Gas?

Limited Refuelling Infrastructure

Additional cost of vehicles

Loss of Payload
Why Electric?

Zero tail pipe emissions

Available now

Quiet operation – Night time deliveries
Why not Electric?

- Difficulty with recharging quickly and large numbers
- Additional Cost
- Additional Weight
- Limited Availability
- Limited Range especially in adverse weather
Why Hybrid?

Up to 20% fuel saving

Cost effective

Minimal Weight Penalty

Availability

No Range issues if vehicle needs to be used for a different route
Why Not Hybrid?

You tell me!

Limited Range of Vehicles Available
## Estimated duty cycle CO2 saving - Long Haul

<table>
<thead>
<tr>
<th>Technology / fuel</th>
<th>Estimated duty cycle WTW CO\textsubscript{2}e saving*</th>
<th>Payback range***</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dual fuel</td>
<td>16 % (CNG)</td>
<td>2-4 years</td>
</tr>
<tr>
<td></td>
<td>9-12 % (LNG)**</td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>42 % (BioMethane)</strong></td>
<td></td>
</tr>
<tr>
<td>Dedicated natural gas</td>
<td>5-16 % (CNG)</td>
<td>1-3 years</td>
</tr>
<tr>
<td></td>
<td>11 % worse to 8 % better (LNG)**</td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>61-65 % (BioMethane)</strong></td>
<td></td>
</tr>
<tr>
<td>Aerodynamic improvements</td>
<td>6-9 %</td>
<td>3-12 months</td>
</tr>
<tr>
<td>Predictive cruise control</td>
<td>1-2 %</td>
<td>1-2 months</td>
</tr>
<tr>
<td>Reduced ancillary loads</td>
<td>1-2 %</td>
<td>1-3 months</td>
</tr>
<tr>
<td>Stop / Start and idle shut-off</td>
<td>1%</td>
<td>2-3 years</td>
</tr>
</tbody>
</table>

*CO2 savings figures based on emissions associated with the relevant fuel sources Defra/DECC GHG Conversion Factors, except tailpipe BioMethane.

**LNG figures presented as a range. Lower saving is based on standard Defra/DECC figures. Upper saving based on CNG liquefied to LNG in the UK.

***Based on current technology marginal capital costs. Fuel cost savings and low-high mileage sensitivities.
### Estimated duty cycle CO2 saving - Urban Delivery

<table>
<thead>
<tr>
<th>Technology / fuel</th>
<th>Estimated duty cycle WTW CO$_2$e saving*</th>
<th>Payback range***</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hybrid</td>
<td>20%</td>
<td>&lt; 5 years</td>
</tr>
<tr>
<td>Dual fuel</td>
<td>13% (CNG)</td>
<td>5-10 years</td>
</tr>
<tr>
<td></td>
<td>35% (BioMethane)</td>
<td></td>
</tr>
<tr>
<td>Dedicated natural gas</td>
<td>5-16% (CNG)</td>
<td>3-6 years</td>
</tr>
<tr>
<td></td>
<td>61-65% (BioMethane)</td>
<td></td>
</tr>
<tr>
<td>Stop / Start and idle shut-off</td>
<td>3%</td>
<td>1-2 years</td>
</tr>
<tr>
<td>Electric</td>
<td>Up to 40% but depends on Grid mix</td>
<td>20 years</td>
</tr>
</tbody>
</table>

*CO2 savings figures based on emissions associated with the relevant fuel sources Defra/DECC GHG Conversion Factors, except tailpipe BioMethane.

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Opportunities

Determine ULEV and ULEZ Criteria

Euro VI, Hybrid and/or Electric?

Encourage early adopters with reduction in Congestion Charge

Reduction for Diesel Euro VI Removal for Hybrid & Electric

This could be easily controlled via ANPR as used in Congestion Charge already

Thank you.................. Questions?