Efficient, intelligent, autonomous
Applying low emission vehicles

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Low Carbon Vehicle Partnership
LowCVP is a public-private partnership that exists to accelerate the shift to low carbon vehicles and fuels whilst protecting air quality.

Creating Communities
- Gathering multiple stakeholders to address common challenges/objectives

Building Understanding
- Researching market barriers, evidence to inform policy, measures to increase market take-up

Influencing Policy
- Defining measurement processes, designing incentive schemes, helping to create robust policy

Accelerating the Market
- Promotion of common policies, fleet operator guidance, outreach to delivery partners
Reducing road transport GHG emissions in the UK is challenging

- Almost 25% UK GHG emissions from road transport, cars and trucks highest emitters.
- Transport lagging behind other sectors in terms of reduction.
- UK Government has a commitment to reduce road transport GHG emissions by 80% in 2050 relative to 1990 levels.

Interwoven challenges in our cities – air quality, safety, congestion.

Source: Meeting the Carbon Targets, Progress Report, Climate Change Committee 2016
How do we minimise energy and emission impacts of transport?

Cleaner more efficient vehicles
- Improve power efficiency
- Use alternative technologies (electric, plug-in hybrid)

Use low carbon fuels
- Use of biofuels
- Renewable electricity/hydrogen

Reduce the amount of driving
- Better town planning
- Managing travel demand

Improve transport system efficiency
- Better traffic management
- ITS, Connected Vehicles, Autonomous Vehicles
Transforming the UK vehicle fleet to be cleaner, more efficient and lower carbon takes time – buses show the most progress

Stages in market development of ultra low emission vehicle for different sectors

- Research & innovation
- Trials and early adopters
- Mass market uptake
- Changing mass mobility

Cars 2016 – 1.5% (supported)
Trucks (-10yrs) – 0% (no support)
L Cat (-15yrs) – 0% (no market)
Bus (+10yrs) – 40% (supported)
Fuels (+5yrs) – 4.5% (supported)

Cars on road (000's)
LowCVP model for stimulating the demand and supply of low emission buses

18 models on the market

Devised a bus emission assessment procedure based on well-to-wheel GHG performance of different technologies.

Produced guidance for bus operators

Influenced UK bus fiscal policy >£250m to support LEB past 6 years. Created LEB definition.
What has been achieved to date?

Efficiency of diesel buses has improved by >30% - Intelligent energy management, hybridization, light weighting

4750 LEB across the UK
- Battery electric
- Plug-in hybrid
- Hybrid
- Hydrogen fuel cell
- CNG with biomethane
- Efficient diesel

WTW CO2e improved 25%-83% compared to conventional diesel bus

102,211 tonnes CO2e saved in 2016 (+ AQ benefits)
Low Carbon Vehicle Partnership

Moving towards ‘Connected’ Low Emission Buses

Intelligent Use of Telematics

• On-board sensors & software to communicate vehicle performance
• Reduces fuel / electricity consumption – cost savings
• Improves electric range of e-Buses, early indication of maintenance
• Demonstrates performance of emission reduction technologies

Automatic Charging & GPS for Zone Management

Wireless ‘inductive’ charging for electric and plug-in hybrid buses

Geo-fencing for plug-in hybrid buses – ‘low emission zones’
Autonomous buses – early stages of innovation

The Navya Arma is an electric and fully autonomous bus capable of driving on public roads.

Demonstrated at London Heathrow Airport on 24th January – to ferry customers from the car park to terminal buildings – 13 hours, 15 passengers.
Combination of connectivity, automation plus shared vehicle ownership/use has the potential to make car travel lower carbon, more efficient and cheaper.

However, benefits are no way guaranteed, impacts and policy implications require examination and careful consideration.

**Key questions explored in the study**

1. What are the potential travel, energy and carbon impacts?

2. Do we let market decide the development? Or do we need to plan ahead to reap the carbon benefits?

3. What are the key areas that require attention from policy makers?
Autonomous, automated, connected

Connectivity and co-ordination – vehicles and infrastructure

Types and levels of autonomy

V2X = V2V + V2I

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Analysing the carbon, energy, travel ripple
Snap shot of results - energy efficiency

<table>
<thead>
<tr>
<th>Mechanisms</th>
<th>Energy effect direction &amp; size</th>
<th>Automation level required</th>
<th>Connectivity level required</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Traffic flow improvement &amp; congestion mitigation</td>
<td>😐</td>
<td>1-5</td>
<td>V2X-2way</td>
<td>Step change at higher levels of automation &amp; connectivity</td>
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<tr>
<td>Dynamic eco-routing</td>
<td>😊</td>
<td>1-5</td>
<td>V2X-2way</td>
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<tr>
<td>Automated eco-driving</td>
<td>😐</td>
<td>2-5</td>
<td>V2X, 2way</td>
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</tr>
<tr>
<td>Higher motorway speed limits</td>
<td>😞</td>
<td>2-5</td>
<td>V2X-2way</td>
<td>Only with regulatory changes</td>
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<tr>
<td>Vehicle platooning in motorways</td>
<td>😐</td>
<td>3-5</td>
<td>V2V</td>
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<tr>
<td>Additional comfort &amp; convenience features</td>
<td>😞</td>
<td>3-5</td>
<td>I2V</td>
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<td>Do-emphasized performance</td>
<td>😊</td>
<td>4-5</td>
<td>I2V</td>
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<tr>
<td>Light-weighting in city cars</td>
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<td>4-5</td>
<td>V2X-2way</td>
<td>Only with very high uptake &amp; regulatory changes</td>
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<tr>
<td>Right-sizing</td>
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<td>5</td>
<td>V2I-2way</td>
<td>Only for MOD services</td>
</tr>
</tbody>
</table>

- Early benefits from connectivity and connectedness even without automation
- Potentially large benefits at high levels of automation and connectivity
- BUT these benefits are highly uncertain and depends on innovations in other areas
Study conclusions and recommendations

- Majority of energy efficiency benefits are likely to result from a high level of connectivity and co-ordination between vehicles and infrastructure, not automation per se.

- Full automation could help accelerate the transition to low carbon vehicles.

- Large scale benefit of fully automated vehicles only materialises when they are affordable and widespread – decades

- Automation does not automatically mean EVs, synergies between automation and low carbon fuels

- Planning & coordination of multi stakeholders - automotive industry, telecommunication industries, transport system operators, mobility service providers

- Strategic, synergistic and timely policy required

- More work required to encourage car sharing ownership – policies to support development of new mobility services

- Establish data safety & sharing protocols to ensure smart connectivity at early stages

- Demand management will be required to mitigate potential increase in travel from autonomous cars
Low emission, intelligent and autonomous vehicles
Offer carbon benefits BUT we must consider unintended consequences

Carbon footprint of an electric bus
38g CO₂e/passenger km

Carbon footprint of electric autonomous pod
20g CO₂e/passenger km
Thank you for listening

Further information or to learn about joining LowCVP:

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