



TRANSPORT

**DELIVERING
INCREASED REAL
WORLD FUEL
EFFICIENCY**



WHY TRANSPORT?

WHAT WE ARE DOING?

- » UNDERTAKING A SYSTEMS INTEGRATION APPROACH TO THE FUTURE OF VEHICLE DESIGN AND VESSEL CONCEPTS
- » DEVELOPING AND THEN DEMONSTRATING COMPONENT TECHNOLOGIES
- » APPLYING TECHNOLOGIES TO DEMONSTRATION VEHICLES AND VESSELS THAT ARE AT LEAST 30% MORE EFFICIENT

Transport is one of the largest contributors to total CO₂ emissions in the UK, producing 139 million tonnes of CO₂ in 2011 (30% of total UK CO₂ emissions). The heavy duty vehicle sector contributes 32% of all transport emissions equating to 8% of total UK CO₂ emissions.

The automotive and energy industries are responding to this challenge by developing a range of low-carbon vehicle and fuel technologies. There is significant potential to increase the efficiency of conventional internal combustion engine vehicles for both Heavy Duty Vehicles and Light Duty Vehicles. Beyond that, new fuels, such as bio-fuels, electricity, hydrogen and natural gas, offer substantial opportunities to reduce carbon emissions.

HDVs when compared to other technologies are a cost effective carbon abatement opportunity. Our modelling work indicates that large CO₂ reductions are possible at reasonable costs. We believe large reductions in fuel consumption are possible, by using technologies that will not affect vehicle availability or resale values. We are seeking to minimise the technology risk, to allow Original Equipment Manufacturers to invest in this technology innovation.

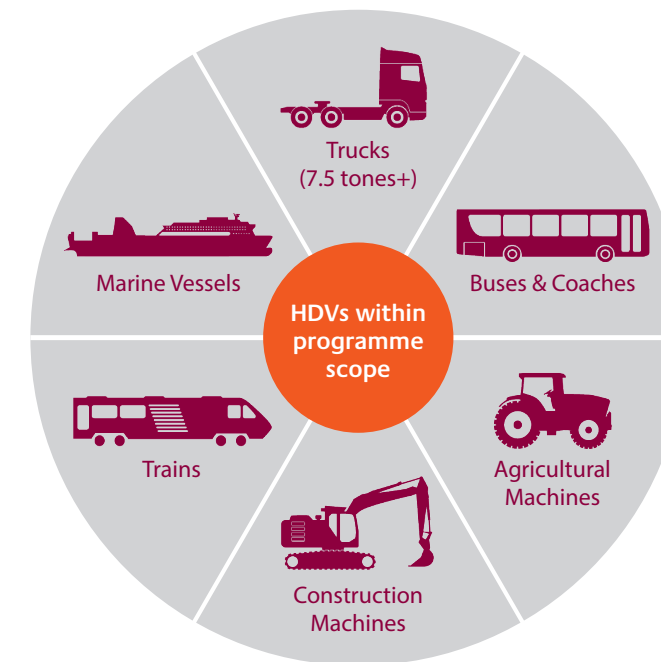
Our HDV efficiency programme was launched in 2012 by then Business Secretary Vince Cable. The programme has an aim to increase the efficiency of UK HDVs – in land vehicles and marine vessels by at least 30%.

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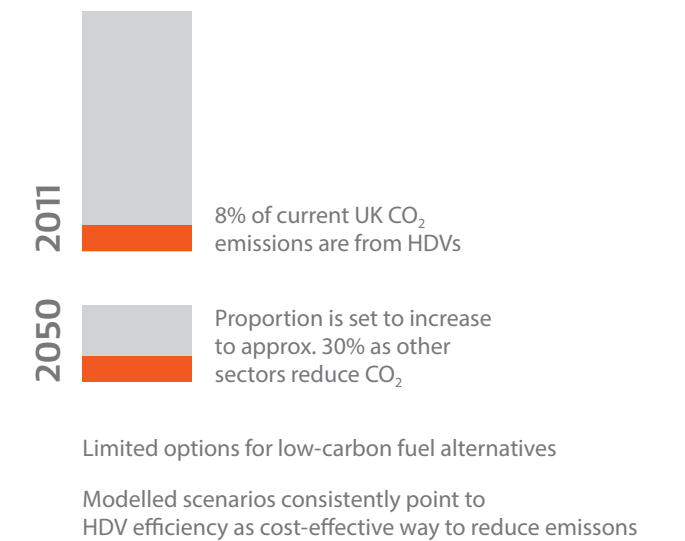
HDV EFFICIENCY PROGRAMME OVERVIEW



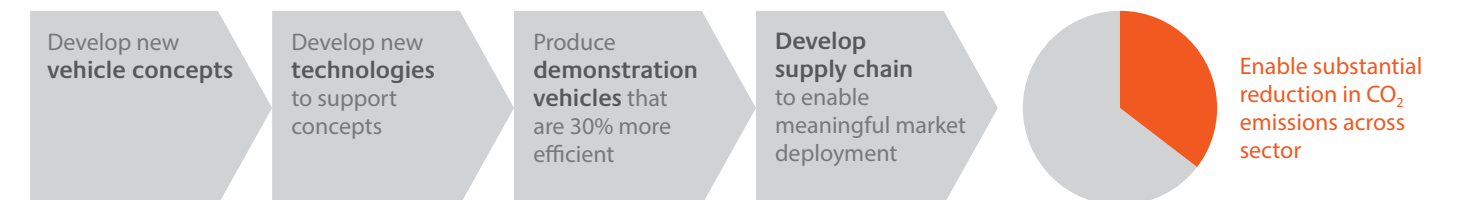
HDV PROGRAMME OVERVIEW



WHY IS HDV EFFICIENCY SO IMPORTANT?



OBJECTIVES



THE PROJECTS


EFFICIENCY FOCUS AREA PHASE ONE

- » Desk top study to investigate efficiency and reducing emissions of HDVs
- » Detailed analysis of the UK's HDV fleet
- » Identified potential efficiency improvements in determined drivecycles

This desk-top study evaluated HDV (including coaches, buses and mining vehicles), determined drive-cycles showing the types of UK usage patterns for each class of vehicle. It identified potential efficiency improvement technologies and evaluated the benefits case for each one.

The nine month long project launched in 2009 was led by Ricardo and included ETI members Caterpillar and Rolls-Royce.

The consortium carried out a detailed analysis of the UK's HDV fleet and identified ways in which technological solutions could increase its efficiency and contribute to a reduction in fuel consumption.



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THE PROJECTS



MARINE VESSEL SYSTEMS INTEGRATION PHASE ONE

- » **Developing a range of highly efficient concept marine vessels representative of the UK fleet**
- » **Building on the techno – economic shipping model developed under the Low Carbon Shipping Project led by UCL and part funded by EPSRC**
- » **Identifying technologies required to achieve a 30% fuel consumption reduction in Marine UK fleet**

This project has focused on developing a range of highly efficient concept vessels by combining data and modelling techniques from academia with commercial knowledge and technology development expertise from industry. The project is being delivered by Rolls-Royce with support from University College London (UCL). The work carried out by UCL is being undertaken by researchers from both the UCL Energy Institute and UCL Mechanical Engineering.

The project has completed the creation and integration of a full-scale shipping model that is focused on the activity of and the vessels involved in the UK's sea-based transportation needs. This has leveraged Rolls-Royce technology knowledge at a vessel level and combined it with UCL's capabilities to understand and model the shipping network. It has built upon the Low Carbon Shipping project led by UCL and funded in part by the Engineering and Physical Sciences Research Council (EPSRC).



£2m

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LAND VEHICLE SYSTEMS INTEGRATION PHASE ONE

- » **Focused on concept engineering of innovative and efficient land vehicles**
- » **Identifying technologies required to achieve at least 30% fuel consumption reduction in land based HDV fleet**
- » **Started in March 2012, an investment from the ETI of £3m, the prime contractor is Caterpillar**

This project focused on the concept engineering of a range of innovative and efficient land vehicles. Outputs from the project will help to determine which technologies are required to achieve at least 30% fuel consumption reduction in land based HDVs.

This project builds upon the HDV Efficiency Focus Area feasibility study completed in 2010.

£3m

Started in March 2012, an investment from the ETI of £3m



THE PROJECTS

CONTINUED »



HIGH EFFICIENCY SELECTIVE CATALYTIC REDUCTION PHASE TWO

- » Developing a more efficient exhaust emission clean up system with new urea injector design
- » Aims to deliver fuel efficiency and CO₂ benefits between 3-4%
- » Delivered by a consortium from academia and industry

This project is seeking to improve catalytic conversion efficiency in exhaust systems in HDVs.

Launched in November 2012, with an investment of £4.5m, the project is led by Johnson Matthey. The consortium includes Loughborough University and Caterpillar.

The 44-month long project aims to help HDV fuel efficiency by developing a more efficient exhaust emission clean up system (commonly known as a “catalytic converter”). Often diesel engine fuel efficiency is reduced by having to comply with exhaust emission standards. It is hoped that the new exhaust system developed by this project will be so efficient that it will effectively remove this constraint; allowing the HDV diesel engine to be more fuel efficient. The project aims to deliver fuel efficiency and CO₂ benefits of between 3-4%.



£4.5m

Launched in November 2012, with an investment of £4.5m, the project is led by Johnson Matthey. The consortium includes Loughborough University and Caterpillar

WASTE HEAT DRIVEN AIR CONDITIONING SYSTEM PHASE TWO

- » Builds upon project partner ClimateWell’s established sorption technology
- » Potential to reduce fuel consumption in HDVs by up to 3-4%

Swedish company ClimateWell have been appointed to develop a tailored thermal heat-pump component to be integrated into a heating, ventilation and air conditioning system for use in a range of HDVs in a drive to improve fuel efficiency. This project will seek to develop a system with the ability to use the hot exhaust gasses generated on vehicles to cool the vehicle cabin by using ClimateWell’s heat pump component design. ClimateWell’s established sorption technology is based on the principle of a chemical heat pump technology with integrated energy storage in a salt solution.

Modelling analysis shows that using such technology has the potential to reduce fuel consumption in HDVs by up to 3-4% depending on the vehicle and its operating conditions. If successful this will make an important contribution to the overall HDV programme objective to improve overall fuel efficiency in HDV fleet by at least 30%.

£500k

Project to develop a tailored thermal heat-pump component to be integrated in Heating, Ventilation & Air Conditioning Systems in HDVs

THE PROJECTS

CONTINUED »



LOWER DRIVETRAIN PARASITIC LOSSES REDUCTION PHASE TWO

- » Seeking to cut the amount of parasitic losses in HDV lower drivetrain systems by 50%
- » HDV drivetrains can account for more than 10% of overall vehicle energy losses
- » Project is focusing on gears, bearings, surface treatments, lubricant flow and lubricant composition

This project is looking to improve the efficiency of HDVs by cutting the amount of parasitic losses in the lower drivetrain system by 50%. Parasitic losses – that are caused by the churning of the lubricating oil and component friction – in HDVs and off-road vehicle drivetrains can account for more than 10% of overall vehicle energy losses.

Started in July 2012, with an investment of £2.1m from the ETI, the consortium includes Romax Technology, Castrol Ltd and ANSYS Inc.

The project will look to improve overall system design, with a synergistic focus on gears, bearings, surface treatments, lubricant flow and lubricant composition. Technologies advanced and developed in this project will ultimately be available to be utilised across a portfolio of HDVs including HGVs, coaches, buses, tractors, wheeled loaders and articulated quarry trucks.



£2.1m

Started in July 2012, with an investment of £2.1m from the ETI, the consortium includes Romax Technology, Castrol Ltd and ANSYS Inc

GAS WELL TO MOTION PHASE TWO

- » Project to build knowledge of natural gas as a HDV fuel
- » Project will build a software tool to calculate the well-to-motion greenhouse gas emissions of natural gas powered vehicles
- » Findings will be used across the HDV efficiency programme

Natural gas is a potential long-term substitution for existing liquid fuel based technologies in heavy duty vehicles, but more research is required to assess the economic likelihood of this pathway. The software tool that Element Energy will develop will calculate the total greenhouse gas emissions (known in the industry as “well to motion”) and the subsequent associated costs for different gas production pathways. It will also consider how the influence of product development over time could influence the cost, performance, technology choices and the market take-up of liquefied natural gas and compressed natural gas.

Element Energy, the strategic energy consultancy specialising in the analysis of and technical insights into low carbon energy markets are the prime contractor delivering this year long £300,000 contract. They are joined with sub-contract support from University College London, one of the world’s leading universities, CNG Services Ltd, providers of consultancy and project management services in relation to the use of natural gas as a vehicle fuel and Strateco AB, a commercial advisory and research company with 30 years of experience in heavy and light duty natural gas vehicles.

£300k INVESTMENT

ETI project to build knowledge of natural gas as a HDV fuel

THE PROJECTS

CONTINUED »

ENGINE AIR SYSTEM PHASE TWO

The aim is to produce efficiency benefits which can be applied across the HDV land and marine fleets. The designs that Caterpillar will work upon will include turbo charging and supercharging. It is believed that with a high performance engine air system this will allow smaller and slower engines to be fitted into vehicles, machines and vessels which could reduce the fuel consumption of an average HDV by up to 2.5% without compromising on performance.

£2.5%

A high performance engine air system will reduce the fuel consumption of an average HDV by up to 2.5% without compromising on performance

CONTINUOUS VARIABLE TRANSMISSION PHASE TWO

» **Caterpillar to develop two new component technologies – a new gearbox design and engine air charging systems for HDVs**

The Continuously Variable Transmission project is seeking to design a new gearbox for use in HDV vehicles. ETI's research has highlighted that it is possible to install smaller and slower revving engines which can maintain the same acceleration rates as currently available vehicles enjoy. It is estimated that with these smaller designs it is possible to achieve up to a 5% fuel economy gain that could be applied across the entire HDV fleet.



LAND BASED HDV DEMONSTRATION VEHICLE PHASE THREE

» **Caterpillar to build a new 25 tonne off-road quarry truck in Peterlee to test new technologies developed in the ETI's HDV efficiency programme**

Caterpillar have also been contracted to build a land based HDV demonstration vehicle to test the components developed throughout the second phase of the ETI programme. They will build a Caterpillar AT 725 – a 25 tonne off-road quarry truck at their dedicated Articulated Quarry Truck facility at Peterlee in the North East of England. This represents the third phase of the programme which will seek to verify the fuel economy benefits identified in earlier work in real world conditions. The truck is yet to be built but testing of the technologies is due to take place throughout 2017.

ON HIGHWAY MARKET ANALYSIS

The aim of this project is to provide an improved understanding of the current activities and trends occurring in the On-Highway Heavy Duty Vehicle arena. Future technologies and legislation are being assessed to further enhance our knowledge of the existing market and anticipated future market state.

We will use the outputs from this project to ensure that the programme investment is generating innovative technologies. We will also be able to assess the potential impact of the outcome of their programme, based on this project's deliverables.

The project is being delivered by a consortium led by Ricardo UK with partners Automotive World and Ricardo-AEA.

ABOUT THE ETI

The Energy Technologies Institute is a partnership between global energy and engineering companies and the UK Government.

Its role is to act as a conduit between academia, industry and government to accelerate the development of low carbon technologies.

It brings together engineering projects that develop affordable, secure and sustainable technologies to help the UK address its long-term emissions reduction targets as well as delivering nearer term benefits.

It makes targeted investments in a portfolio of nine technology programmes across heat, power, transport and the infrastructure that links them.

ETI Members



CATERPILLAR



Rolls-Royce



Department for
Business, Energy
& Industrial Strategy

EPSRC
Pioneering research
and skills

Innovate UK

ETI Programme Associate

HITACHI
Inspire the Next

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