The UK's Zero Emission Road Freight Trials

Dr Alistair Barnes

Innovation Lead – Zero Emission Vehicles

Innovate UK

HM Government

Agenda

- Introduction to Innovate UK
- Heavy goods vehicles:
  - The Problem
  - The Options
  - The Approach
- Zero Emission Road Freight Trials:
  - Current Work
  - Future of the programme
- Outlook

UKRI Innovate UK

HM Government

Innovate UK

- We are the UK’s innovation agency and at the heart of delivering UK R&D expenditure to businesses
- We invest in new ideas and technologies and connect businesses to the right people to drive economic growth and social benefits

UK Research and Innovation

- Wide sector cover: Health, Robotics, AI, Net Zero...

Innovate UK

Heavy Goods Vehicles: The Problem

- Lorries are essential
- Department for Transport statistics for 2020:
  - **>26 billion kilometres** on UK roads
  - Almost **20 million tonnes of greenhouse gasses**
  - Air quality implications
- The transport sector is the largest producer of greenhouse gasses in the UK (24%)
  - 16% of those come from heavy goods vehicles
- Unlike passenger cars: not yet a clear ‘winning’ technology to enable net zero
  - More difficult: long distances and heavier vehicles
  - Solution: renewably powered, zero tailpipe emissions

Heavy Goods Vehicles: The Options

Alternative fuels and combustion engines:

- Diesel engines improving – change the fuel as well?
- Natural gas
- Biofuels / Biomethane / HVO
- E fuels – synthesising fossil fuels
- Hydrogen combustion engines

UKRI Innovate UK

UK Transport Vision 2050

Innovate UK publication on the future of transport:

- Where we think transport will be in 2050
- The steps along the way – predictions by decade

Six areas of focus:

- travel and transport demand
- connectivity
- energy vectors
- autonomy
- business models
- infrastructure

Heavy Goods Vehicles: The Options

Battery Electric:

- Like electric cars, but bigger?
- Transition underway for LGVs and shorter distance HGVs
- Good round trip efficiency, smoother quieter drive
- Needs infrastructure
- Needs clean electricity grid

UKRI Innovate UK

Heavy Goods Vehicles: The Options

Hydrogen fuel cells:

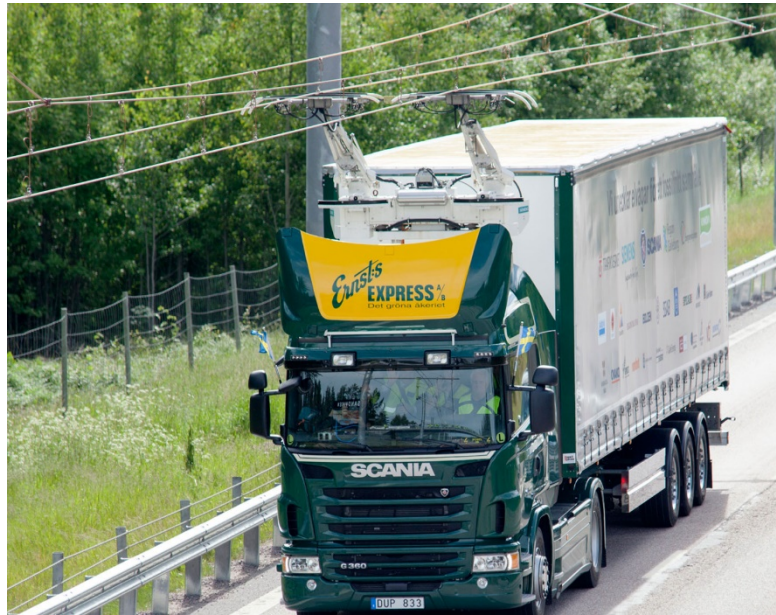
- Battery truck - recharged whilst driving by HFC
- Could enable longer ranges or heavier loads
- Still have materials challenges (embrittlement, platinum)
- Much less efficient than batteries only – higher OPEX
- Needs renewable hydrogen production and refuelling infrastructure – should not use fossil hydrogen

Heavy Goods Vehicles: The Options

Electric Road Systems (ERS):

- Catenary is the most well known
- Smaller batteries but much more infrastructure – cost? embedded carbon?
- Incomplete solution – needs other technology for rural and edge cases
- Difficult in UK: tall vehicles and low bridges
- Sufficient OEM support?

Scania truck on trial in Germany:



UKRI Innovate UK

Heavy Goods Vehicles: The Approach

The UK is committed to:

- Net Zero by 2050
- Ending the sale of new, non-zero emission HGVs by 2035/2040
- Conducting on road trials, as recommended by the Climate Change Committee

Timeline to get to 2050:

- 2022: Launch trials to understand relative importance and viability
- Mid 2020s: Trials need to start collecting data
- Mid 2020s: Decision making on various zero emission HGV technologies
- 2030: Roll out infrastructure at scale to enable zero emission HGVs
- 2040: end sale of polluting HGVs as many HGVs last 10+ years
- 2050: Net zero, no/few fossil fuel powered HGVs on the road

HM Government

Zero Emission Road Freight

FY 21/22: £20 million investment in Zero Emission Road Freight:

- Accelerating deployment of 16t-26t rigid battery electric HGVs
- Feasibility studies for on-road trials
- Supply chain technology

Innovate UK

News story

Road freight goes green with £20 million funding boost

Government encourages fleet operators to convert to battery-electric vehicles in the transition to zero emission road freight.

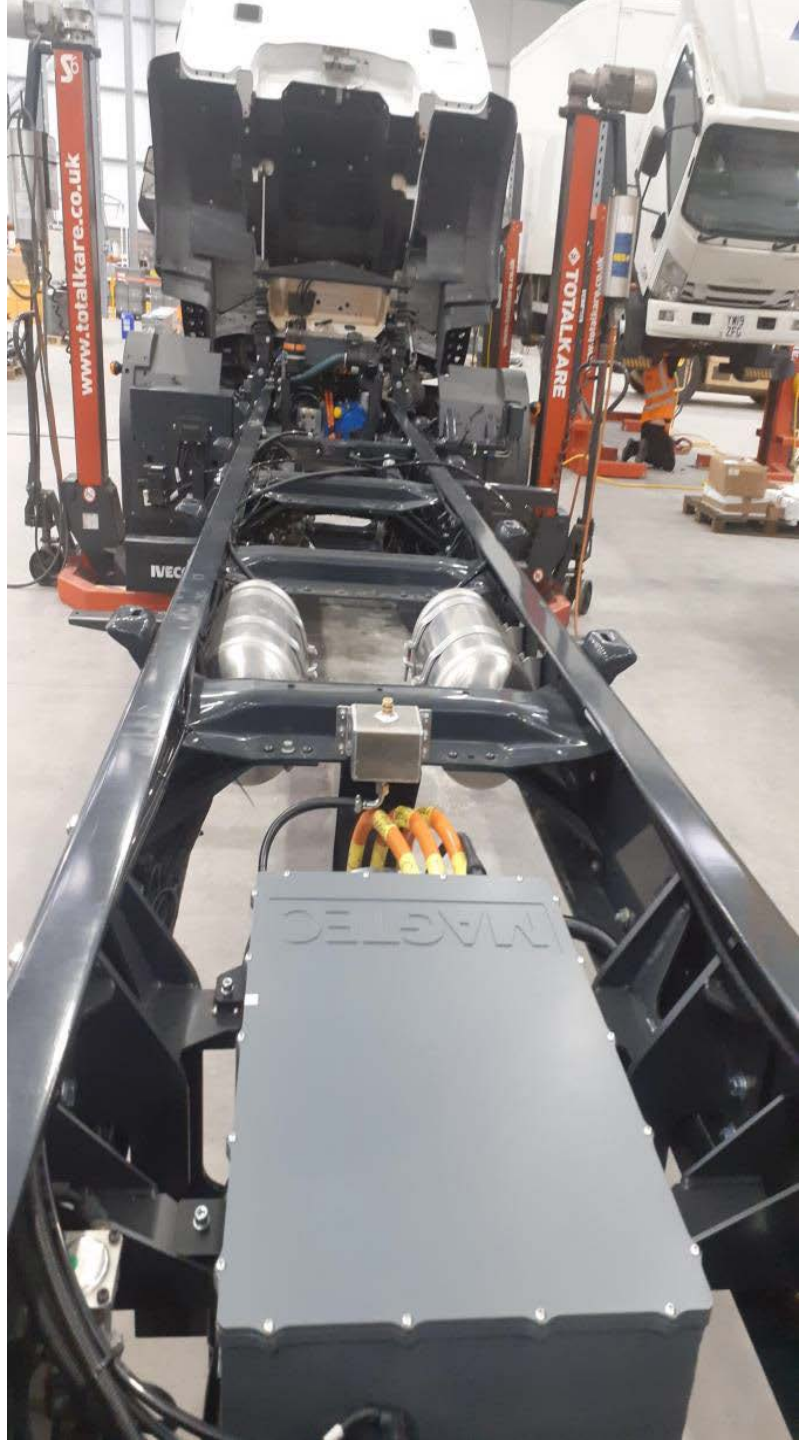
From: Department for Transport, The Rt Hon Grant Shapps MP, and Iain Stewart MP

Published 27 July 2021

Supporting uptake of battery electric trucks

- Trucks available today which are suitable for a wide range of duty cycles, but lack uptake
  - E.g. 150 mile range, overnight and rapid charging
- Industry was challenged to: ‘develop an interactive solution to de-risk, aid and encourage fleet operators to convert to battery electric vehicles.’
  - Matching spec to use case
  - Deployment and infrastructure
  - Data collection
  - Repair and maintenance
  - Total cost of ownership (TCO)

UKRI Innovate UK



Hydrogen Truck Trial Feasibility Studies

Considering difficult questions:

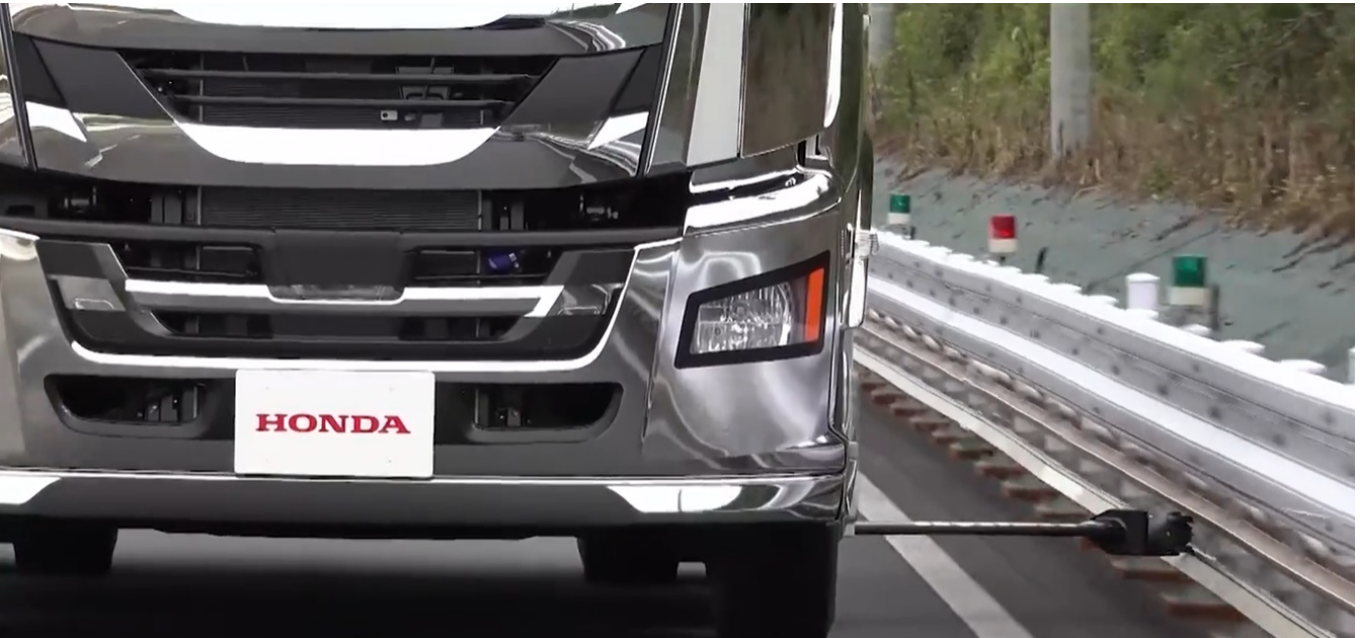
- Where would the hydrogen come from?
- Who can supply the trucks?
- Which operators?
- What duty cycles can the trucks perform?

Scottish Hydrogen Freight Trial (SHyFT)	Arcola Energy Limited, University of St Andrews, BOC Limited, ScottishPower Energy Retail Limited, Newcold Ltd	Develop a viable scale trial for Scotland with appropriate early adopters for Arcola Energy's FCEV powertrain in the 44t truck segment.
UK Aggregated Hydrogen Freight Consortium	Element Energy Limited, TRL Limited, Toyota (G.B.) PLC	A study into a nationwide deployment of hydrogen freight vehicles and associated hydrogen refuelling station networks.
H2GVMids	EDF Energy R&D UK Centre Limited, University of Nottingham, Adelan Limited, University of Birmingham,	A feasibility study into the use of hydrogen for 44t trucks considering the Midlands as a trial area.

Electric Road System Feasibility Studies

Covering technology-specific topics:

- Safety and catenary cable height
- Voltage and power requirements
- Utilisation and Billing



Project Title	Lead and partners	Summary
UK Electric Road System	Costain Limited, University of Cambridge, Heriot-Watt University, Ove Arup & Partners Limited, Milne Research Limited, Siemens Mobility Limited, Possible, SPL Powerlines UK Limited, Scania (Great Britain) Limited, Box Energi Limited, Clarke Infrastructure Planning Ltd	Identify the optimum technological, economic and environmental recommendations for an Electric Roads System Demonstrator.
ElectroRoad	Honda R & D Europe (U.K.) Limited, Galliford Try Infrastructure Limited, TRL Limited, Miralis Data Limited, Honda R&D Co. Ltd	Complete a comprehensive study of an innovative Electric Road System applied to 44t Heavy Goods Vehicles as a cost effective and feasible solution.
Catenary Cable System Demonstrator Feasibility Study	City Science Corporation Limited, Wood Group UK Limited, Oxfordshire County Council, Furrer + Frey GB Limited	Examine the feasibility for an Electric Road System demonstrator on appropriate sections of the A34.

Supply Chain Technology

Powertrain projects:

- Ricardo and University of Bath: High Voltage E-powertrain for Heavy Duty Road Freight
- Contract Innovation Ltd and University of Nottingham: Zero Emissions Electric Axle Suitable for 12-44t road freight applications
- Involution Technologies Ltd, Bramble Energy Ltd and University of Salford: INVO-EDU - A Zero Emissions 44ton HGV electric drive train
- Tetra Design Services Ltd: Electric Module for Low Flat Floor Semi Trailers

Also funding:

- Hydrogen refuelling, semi-trailers & refrigeration, battery packaging, and Advanced Driver Assistance Systems to enhance range

Looking forwards: Zero Emission Road Freight Trials

UK Net Zero Strategy, Autumn 2021:

> Building on the success of our £20 million zero emission road freight trials, we will expand these to trial three zero emission HGV technologies at scale on UK roads to determine their operational benefits, as well as their infrastructure needs.

Focusing in on Battery Electric HGVs (as an example):

- Trial of heavy, long-range battery electric HGVs
- City-to-city and national freight operations
- Recharge at state of the art high power chargers (>1MW DC)

UKRI Innovate UK

HM Government

Charging cars and HGVs: Speed and power

Current generation of electric cars:

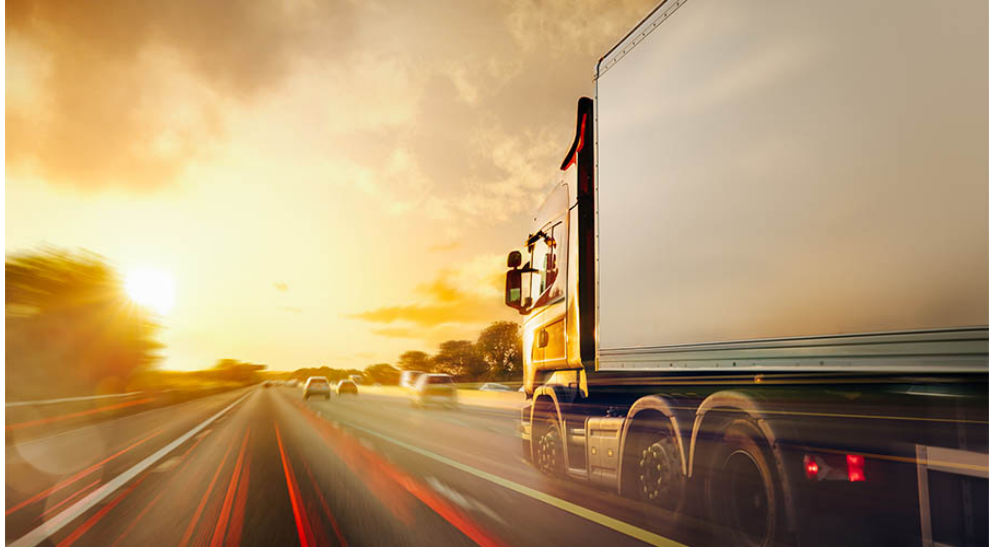
- 20-80% charge in 20-30 minutes with a peak charging power of around 200kW




Scale this up to a truck (~6-8x larger):

- Battery is 6-8x larger and can charge at 6-8x higher power and still achieve a 20-80% charge in 20-30 minutes (charge rate unchanged)
- However, the peak charging power needed is 1000-2000kW (1-2MW)
  - This is the power demand of around 2000 houses to charge a single vehicle!

Further challenges:



- Batteries are expensive, bulky and heavy
- High power demand for MW charging may offset the relative cheapness of electricity vs. diesel (or hydrogen)?
- Heating and cooling to allow rapid charging of a physically large battery will be difficult
- Frequent rapid charging is generally detrimental to battery health & lifetime

Outlook:

- Expectation of significant funding programme to trial multiple zero emission HGV technologies simultaneously
- Huge opportunity for UK engineers to lead the world towards net zero
- HGV decarbonisation is a significant challenge with a long way to go
- But.. for certain journeys/vehicles, there is technology available now and the focus should be commercialisation and business models

Look out for funding announcements!

- If you are interested in networking, Innovate UK KTN can support you (https://ktn-uk.org/)

UKRI Innovate UK

HM Government