Project introduction and approach

Electric Freightway Report 1

GRIDSERVE ELECTRIC FREIGHTWAY

in partnership with

HITACHI
Inspire the Next

UKRI Innovate UK

Funded by UK Government

Project introduction and approach

Electric Freightway, part of the Zero Emission HGV and Infrastructure Demonstrator Programme, is funded by the Department for Transport and delivered in partnership with Innovate UK.

Foreword

The decarbonisation of the UK truck fleet is one of the greatest disruptors haulage and logistics have ever seen. It's also expected to have one of the greatest impacts on the environment, with HGVs accounting for around 20% of road transport emissions. Industry is already responding, but rather than simply ask how we can make new technologies fit existing businesses, shouldn't this be an opportunity to see how many other issues we can solve during the process of transformation?

This is what we're aiming to do with the GRIDSERVE Electric Freightway consortium. A group of leading organisations have come together with the intention of being first movers in zero carbon transport for the logistics and haulage industries. Learning by doing will bring hundreds of High Power charging stations to the UK's roads and depots, alongside one of the largest fleets of fully electric 40+ tonne HGVs. We'll push the vehicles to their limits to establish just what is possible, while highlighting where there is the need for process, technological or policy innovation to enable the transition to electric.

This first report from the GRIDSERVE Electric Freightway project introduces what we have planned, and how we're going to keep the industry informed. Throughout the project a series of further reports will document the project's progress, reporting key learnings for the industry and developing a business case enabling fleet operators to sustainably transition to eHGVs in the future.

Sam Clarke Chief Vehicle Officer, GRIDSERVE

Freight transport is a large contributor to global CO_2 emissions, so decarbonising the sector is vital to meet net zero targets.

By working closely together with GRIDSERVE and the wider Electric Freightway consortium we hope to show that, by implementing new technology and adapting business processes based on our experience elsewhere, a net zero future is possible for this industry.

This unique opportunity will test some of the most challenging electrification scenarios in the UK. Through this we will gain the data and practical experience needed to allow HGV operators to plan and prioritise their decarbonisation journey, highlighting where we need to continue to innovate to overcome remaining challenges in implementing zero emissions trucks.

Andrew Barr President, Hitachi Europe; Chairman, Hitachi ZeroCarbon

01 Executive Summary

Welcome to this first report from Electric Freightway, part of the UK Government's Zero Emission HGV and Infrastructure Demonstrator Programme. Electric Freightway is directed by GRIDSERVE, Hitachi and a consortium of industry stakeholders in order to inform the UK's transition to zero tailpipe emission freight. Funding for the demonstration was announced by the Department for Transport and Innovate UK on 19 October 2023. This report introduces the project's aims and the planned approach.

A pioneering demonstration

The first phase of the project, scheduled to conclude in July 2025, will involve the installation of a network of electric heavy goods vehicle (eHGV) charging stations across the UK. Approximately 220 High Power chargers are to be installed by GRIDSERVE at around 30 public and private sites.

In parallel, the project's HGV operator and truck manufacturer partners will put c.140 electric trucks on the road, and begin operating them in a range of scenarios, including demonstrations of more challenging longer routes. Hitachi will capture and analyse data from the vehicles and infrastructure, conduct stakeholder surveys and gather learnings, publishing the project's findings in a series of reports.

Partners will continue to operate the trucks and chargers, reporting data for a total period of five years. The project is part of the Zero Emission HGV and Infrastructure Demonstrator Programme, a Department for Transport funded programme supporting four innovative zero tailpipe emission HGV demonstrators, utilising battery electric and hydrogen fuel cell powered vehicles. More information about the programme can be found at:

https://iuk.ktn-uk.org/news/new-funding-helps-drive-hgv-decarbonisation-in-uk/

The need for Electric Freightway

HGVs contribute 20% of the UK's transport greenhouse gas emissions[ii], so decarbonisation of this sector is essential for the UK to meet its 2050 net zero targets.

Vehicle operators will no longer be able to buy new diesel HGVs after 2040 and yet transition to electric in the HGV sector is at a very early stage. Virtually no dedicated eHGV charging infrastructure exists in the UK at present, with existing car chargers not designed to meet the needs of HGV operators. Larger eHGVs are only just coming to market, and currently cost significantly more to purchase than diesel trucks.

Electric Freightway intends to help kick start the transition process by implementing a national eHGV charging infrastructure and providing HGV operators with the information they need to plan the successful adoption of fully electric vehicles. Government funded grants have been made available to those operators participating in the demonstrations, to subsidise much of the estimated difference in total cost of ownership between diesel trucks and eHGVs.

Collecting and analysing data

Data is at the core of the demonstration. Since eHGVs are new and very different from both the diesel vehicles that came before them and existing passenger electric vehicles (EVs), there are many unknowns about how they perform in use. By gathering data on a wide range of HGV journeys in various real-life scenarios and applying data science techniques, we will be able to identify the key factors that impact eHGV performance.

This information will allow HGV operators to make informed decisions about whether eHGVs can meet their route requirements, whether they need to re-plan their schedules to mitigate against possible limitations and how to take advantage of the benefits of eHGVs.

The business case for eHGVs

One of the key barriers to eHGV adoption, other than the limited availability of vehicles and charging, is the higher cost of new vehicles to purchase or lease. We will use the outcomes of our data science work to explore whether eHGVs have sufficiently low operating costs over their lifetime to offset the increased upfront costs so delivering a lower overall Total Cost of Ownership (TCO). The project will identify scenarios where eHGVs can make economic and practical sense now and will consider whether policy, subsidy or other changes will be required to stimulate adoption.

What happens next?

Over the last six months, we have been focused on working with our project partners to plan their vehicle and infrastructure requirements. Over the coming months we expect the demonstration to begin, the first eHGVs to be delivered and the groundworks to commence for the first eHGV charging infrastructure sites. In parallel with this, we will be conducting a survey of drivers and fleet managers to compare their perceptions of eHGVs before and after introducing them, while also collecting useful insights from their initial operational experience.

As the demonstration progresses, we will be regularly sharing updates on our website at https://www.gridserve.com/electric-freightway/.

Future reports will explore what we have learnt from planning and implementing our infrastructure and vehicle rollout, the outcomes from user surveys and initial results from the analysis of vehicle data. We will also share our emerging findings at industry events, and through GRIDSERVE and Hitachi ZeroCarbon social channels throughout the project.

02 Introduction

Electric Freightway is a collaborative demonstration of eHGVs and associated charging infrastructure across the UK. Throughout the project a series of reports such as this will document the project's progress, reporting key learnings for the industry and developing a business case for future fleet operators.

The problem we are addressing

The objectives set for HGVs by the UK's net zero strategy are some of the most ambitious in the world, with all new HGVs under 26 tonnes expected to be zero tailpipe emission from 2035 and all larger vehicles, such as those taking part in this demonstration, following by 2040.

There is a long way to go to meet these targets since at present very few dedicated eHGV charging stations exist in the UK and most existing charging infrastructure is not designed for charging large vehicles. Hauliers' depots may require significant modifications to allow for eHGV charging. The market for larger eHGVs is also in its infancy; freight operators require reassurance that eHGVs are capable of operating on their routes economically before they commit to investing in this new technology.

What will the project result in?

The aim of Electric Freightway is to help kick-start the deployment of fully electric long haul truck fleets with a multi-year demonstration involving 40-44 tonne capable eHGVs. Electric Freightway will deliver the detailed findings required to support the development of business cases for scalable eHGV deployment as well as the creation of a network of supporting charging infrastructure.

The consortium partners will trial eHGVs across some of the most demanding routes in the UK in order to prove the capability of these vehicles and identify any requirements for technical or policy innovations that will facilitate the transition to net zero road freight.

The project will result in the creation of a network of public charge points on major routes, designed specifically for eHGVs. Project partners will also commercialise the learnings from the project to further accelerate their eHGV transition as well as sharing these learnings with other businesses in the sector.

How is the project funded?

Electric Freightway, part of the Zero Emission HGV and Infrastructure Demonstrator programme, is part funded by the Department for Transport and delivered in partnership with Innovate UK.

The project partners are committed to making their own significant investments in vehicles, infrastructure and resources to support the project, amounting to c£38m of the c£100m total project budget.

Project objectives

The goal of the Electric Freightway project, as part of the Zero Emission HGV and Infrastructure Demonstrator Programme is that it:

"will stimulate multi modal transport and examine different use cases that will create invaluable insights to allow the wider market to follow."

To do this, Electric Freightway will deliver:

"a demonstration which has a viable route to expanding nationally and internationally, as part of a long-term strategy to decarbonise this sector."

In doing so, the project and GRIDSERVE will create a viable eHGV network:

- **At the lowest possible cost**
- **In the fastest possible timeframe**
- **Delivering maximum customer service**
- **At the forefront of HGV electrification**
- **With net zero as the priority.**

And prove or disprove our key hypothesis that:

Electric 40-44t HGVs are ready to replace diesel HGVs and can deliver the same function when the right infrastructure is in place.

The scale of the project

The project is planned to deliver:

c.140 eHGV trucks

c.220 High Power chargers

c.30 public and private sites

This will be achieved through collaboration between a network of Electric Freightway partners representing the relevant business sectors including independent and in-house hauliers, eHGV manufacturers, charge point operators, logistics companies, landowners, financiers and solution providers. We will also be working closely with other stakeholders such as the Department for Transport, National Grid, National Highways, Connected Places Catapult and Innovate UK.

All of these organisations need to come together in order to facilitate the transition to zero tailpipe emission freight and ensure that the required charging infrastructure is in place.

Lead partner

GRIDSERVE SUSTAINABLE ENERGY

GRIDSERVE will develop, deliver and operate the network of charging hubs at the motorway service areas as well as the commercial depot charging solutions, and underlying technology platform needed to provide a seamless charging experience. GRIDSERVE will also source and report data for the project.

Principal partner

HITACHI Inspire the Next

Hitachi ZeroCarbon will collate, analyse and report on data gathered throughout the project, leveraging their experience of similar EV demonstration projects such as the Ofgem Network Innovation Competition Project, Optimise Prime. The reports and outputs are expected to inform stakeholders, the wider market and government policy to drive the further decarbonisation of commercial fleets.

Project consortium

OEM partners

The project is open to work with whichever vehicle OEMs the consortium hauliers choose. At present, the following companies are working closely with us as part of the consortium:

DAF

RENAULT TRUCKS

VOLVO

Haulier partners

We are working with a range of companies across different parts of the logistics chain, including dedicated third party logistics companies as well as organisations operating their own vehicles in support of their wider business. For simplicity, we will collectively refer to these companies as 'hauliers' throughout this report.

- a.f. blakemore & son ltd
- amazon
- Fergusons Transport
- KUEHNE+NAGEL
- MARITIME
- Royal Mail
- United Utilities – Water for the North West

Leasing partners

Hauliers can choose to buy vehicles outright from OEM partners or through lease/contract hire arrangements with our leasing partners:

- Novuna
- PACCAR FINANCIAL
- VOLVO Financial Services

Charging location partners

GRIDSERVE will work with landowners throughout the UK to secure locations for public and private charging infrastructure, including but not limited to:

- British Land
- DCC
- moto
- NISSAN

Project members and supporters

In addition to the core consortium, there are several other contributors to the project who will provide data from their vehicle operations, conduct demonstrations, host charging infrastructure or otherwise support Electric Freightway, including:

- ASDA
- boughey
- RIVERFORD ORGANIC FARMERS
- Samworth Brothers QUALITY FOODS
- Wincanton
- XPO Logistics
- Yusen Logistics

Introducing our partners: United Utilities

Electric HGV under test at United Utilities

"This is a really exciting development and an important step towards our 100% green fleet and net zero carbon targets.

A lot of people don't realise that at the end of the wastewater treatment process we are left with a sludge which is used to generate renewable energy.

Using the vehicles to collect the sludge and then using the clean energy it generates to charge their batteries is a great way of maximising the potential of that resource. We've recently trialled one electric HGV so we know it is a good solution for us."

Tom Lissett, Bioresources and Green Energy Director, United Utilities

The project will also work with a range of stakeholders to ensure that the findings from the project benefit the whole industry, including:

Project timeline

Electric Freightway is being carried out in two phases. The project was officially announced in October 2023 and the main activities of the demonstrator will run until July 2025. During this period, GRIDSERVE will build the project's charging infrastructure while haulier and OEM partners will introduce eHGVs into active service.

Hitachi will develop a series of reports sharing project insights based on the experiences of project partners and detailed analysis of data captured from the demonstration. These findings will be shared through a programme of knowledge exchange activities across the industry.

Following this initial phase, the project's partners and members will continue to operate their eHGV fleets and charging infrastructure. Ricardo, together with partners Costain and the Centre for Sustainable Road Freight, have been appointed by Innovate UK to act as an independent evaluator for all of the Zero Emission HGV and Infrastructure Demonstrator Programme projects. They will work with Hitachi to collect, analyse and share insights from the longer-term analysis of vehicle and charging data for a period of five years.

The purpose of this report

Throughout the Electric Freightway project we will publish findings from the demonstrations to help hauliers and charge point operators transition to eHGVs as smoothly as possible. We plan to share analysis of the practical considerations of implementing eHGVs, the economic impact of the transition and specific lessons learnt by our consortium partners.

This first report from Electric Freightway is aimed at providing context to the project. Section 03 gives some background to the problems that need to be solved and the questions we are trying to answer. Section 04 explains how data will be collected and analysed in order to bring benefits to the industry.

The report also outlines how Electric Freightway will evaluate the cost and performance of eHGVs against a 'baseline' case from diesel in Section 05 and outlines the assumptions that the project will need to make where data is not available in Section 06.

Based on initial analysis, a set of hypotheses around eHGVs has been created to be tested as the project progresses, as described in Section 07. Section 08 of this report will give an update on the progress of the demonstrator and outline our plan for future reports. Section 09 of this report includes a glossary, acknowledgements and references.

Contacting Electric Freightway

If you have any questions about the programme or this report, or have any suggestions for how our future publications and analysis could be improved, please contact the Electric Freightway team at: electricfreightway@gridserve.com

You can find out more about the project at our website https://www.gridserve.com/electric-freightway/ which will be updated as the demonstration progresses.

03 Background

Transition of freight to zero tailpipe emission technology is essential if the UK is to meet its net zero targets. This transition is currently at a very early stage and the infrastructure to support widespread electrification is not yet in place. Hauliers lack the evidence needed to determine whether eHGVs are capable of operating their routes and the data to support investment decisions.

Electric Freightway aims to address these issues through the implementation of a nationwide eHGV charging network and by analysing data from operating eHGVs in a range of challenging real-world scenarios.

The problem being addressed

To meet the UK's climate change ambitions of a net zero economy by 2050[i] it is vital that the transportation sector decarbonises through the rapid adoption of zero tailpipe emission vehicles.

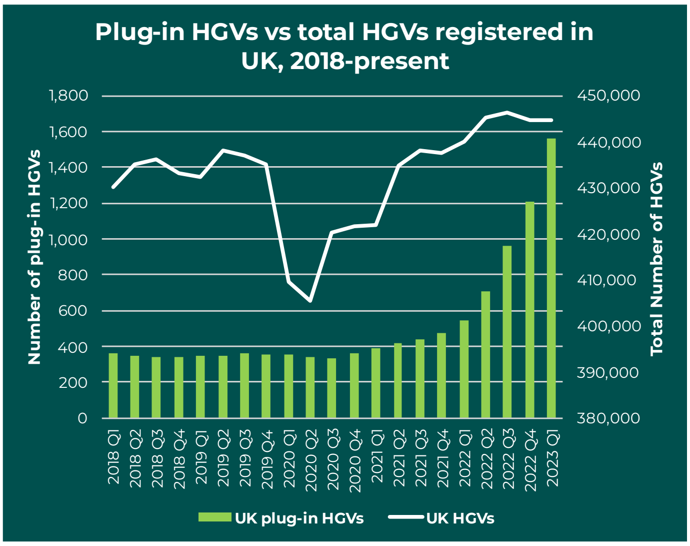
Transport accounts for 26% of the UK's domestic greenhouse gas emissions and, while HGVs account for only 6% of vehicle mileage on UK roads, they contribute 19% of transport emissions[ii]. Over 98% of UK HGVs are currently powered by diesel, and despite diesel HGV efficiency improving significantly over recent years, increased vehicle mileage and load has resulted in total emissions only reducing only 1% between 1990 and 2021. Diesel HGVs are also significant emitters of nitrogen oxide and particulate matter, impacting air quality in the areas where they operate.

The UK eHGV transition

At present, eHGVs are a very small part of the UK haulage fleet – at the end of March 2023, 1,564 of the 444,600 HGVs on UK roads (0.35%) were plug in electric vehicles[iii]. In the sector of the market where this project focuses, 40-44t HGVs, electric vehicles are only just beginning to come to market.

Despite these numbers being low, growth in eHGV take-up has accelerated in the last three years with the total number on the road trebling, as shown in Figure 1, while the total number of HGVs has remained relatively flat. This growth is expected to accelerate in coming years as more eHGV models come to market, more hauliers realise the benefits of zero tailpipe emissions, and the deadline for the end of diesel truck sales (2035 for vehicles less than 26t, 2040 for vehicles above 26t) draws closer.

Figure 1 - Growth in plug-in HGVs registered in the UK



To enable the transition to eHGVs, charging infrastructure is needed at the depots where the vehicles are to be based as well as at key public charging locations on major routes.

Existing eHGV charging infrastructure

Heavy goods vehicles require substantially different infrastructure for charging than light vehicles. Not only do the chargers need to be higher power to charge larger batteries in a reasonable amount of time, but the size of the vehicles and requirements of heavy transportation operations result in a number of additional challenges:

- Existing charging bays are not of a suitable size to accommodate heavy goods vehicles (see Figure 2)
- Large vehicles may block multiple chargers
- Height restrictions can prevent eHGVs getting to chargers
- Inadequate space to manoeuvre eHGVs safely or in line with procedures
- eHGVs should ideally not reverse out of charging bays without a banksman, especially when pulling trailers
- Charging cables cannot always reach sockets on eHGVs (see Figure 3)
- Availability of chargers is not sufficiently widespread to plan journeys.

Figure 2 - HGV Tractor attempting to use a charging station designed for passenger cars

At the time of writing, very little infrastructure for eHGV charging exists in the UK. Some GRIDSERVE Electric Forecourts® have bays which can accommodate eHGVs, although not specifically designed for this purpose (see Figure 4), while the first dedicated eHGV charging points are only just starting to be deployed at some motorway service stations.

Figure 3 – Evaluating practicality of right-side charging eHGV using charger on left of bay: 7m of cable is needed

This limited public infrastructure provision will likely be a barrier to most operators considering the adoption of eHGVs on longer routes in the near term.

The infrastructure delivered through Electric Freightway will provide a network of charging stations that will allow hauliers to plan charging stops into their schedules. The management of charge point availability will need careful consideration to ensure it is sufficiently reliable and predictable so as to avoid disruption to vehicle schedules.

Figure 4 - eHGV tractors at GRIDSERVE Electric Forecourt®, Braintree

Challenges in designing eHGV charging infrastructure

Several barriers exist to the provision of eHGV infrastructure commercially and at scale. On the economic side, the lack of eHGVs on the road at present could result in low charger utilisation in the short term, while a number of practical hurdles need to be addressed to create a smooth charging experience for drivers.

In the initial months of the programme, GRIDSERVE has been working closely with fleet operators and landowners to design the project's public and private charging sites. This has identified several challenges, including:

- Electricity supply to sites is often not adequate for multiple High Power chargers and require supply upgrades. In extreme cases, the expected date of connection can be in the 2030s due to constraints on the electricity networks

- The ground works for chargers can be expensive, particularly if long cable runs are required from substations to feeder pillars
- Work can be disruptive, requiring excavation of roads, yards and car parks
- Depots and service areas are often constrained for space, limiting the number of chargers that can be installed and their layout
- Poorly designed charge stations are likely to result in damage to infrastructure from trucks and other safety concerns
- There is no standard for the location of CCS (combined charging system) connectors on trucks so this varies between brand, and may require long cables or different layouts
- Enhanced welfare facilities may need to be provided if drivers need to stop for longer periods of time to charge their vehicles.

Hauliers are also likely to have different service expectations than private customers. Failure to charge resulting in goods not being delivered could result in significant financial and reputational consequences for hauliers, so there is a greater expectation for infrastructure to be resilient and reliably available during planned charging times.

The project's second report will focus on the lessons learnt from charging infrastructure installation in more detail. Alongside this we will work closely with BSI so that our findings can contribute to developing future standards and codes of practice for eHGV charging, connectivity and safety.

Barriers to eHGV adoption

There are a number of barriers to the electrification of HGV fleets including ensuring that eHGVs are able to cover the distance and carry the payload (the weight of goods being transported) currently covered by diesel vehicles and upgrading depots to support eHGVs.

Relatively little practical research has been completed into the performance of larger eHGVs, making it difficult for fleets to accurately plan their transition. While there have been a number of attempts to quantify the total cost of operating eHGVs this has often been based on assumed or expected performance rather than the results of real-world trials.

Existing insights

Electric Freightway is part of the second round of eHGV projects being delivered by Innovate UK and the Department for Transport.

In the first round the Battery Electric Truck Trial (BETT)[iv] focused on smaller HGVs performing local routes that always returned to their depots. This project successfully demonstrated the capability of eHGVs for these routes, with 20 vehicles traveling over 280,000km for NHS and local government clients. One of the notable responses from the trial's surveys was "we would like to go further, if only there was somewhere to charge on-route".

Electric Freightway builds on this demonstrator by testing the capabilities of larger vehicles as they become available in the market and implementing on-route charging across the UK road network to allow longer zero tailpipe emission routes to operate. Some project partners are also already operating and supplying large eHGVs, in the UK and elsewhere, and the accumulated learning will be utilised as part of this demonstration.

Other Zero Emission HGV and Infrastructure Demonstrators

Alongside Electric Freightway, Project ZEN (Zero Emission Northern Freight) and eFreight 2030 will also be putting in place eHGV charging infrastructure as part of the Demonstration Programme. Electric Freightway will collaborate with these other projects wherever possible to ensure that the charging infrastructure installed meets the needs of all eHGV operators in the UK.

Beyond the UK

While the UK's targets for the ending of diesel HGV sales are among the most challenging in the world, the UK is not alone in needing to transition freight to electric. While sales of eHGVs worldwide have increased in recent years they are still minimal, with just 2,800 eHGVs sold in Europe in 2022 – equivalent to 0.5% of the vehicles sold[v].

To address this, several international projects, policies and initiatives have been put in place that we can learn from as we develop charging infrastructure in the UK. Relevant examples include:

- The Fraunhofer ISI led **HoLa**[vi] trial in Germany is installing HGV charging at three motorway locations and to logistics hubs on the A2 between Dortmund and Berlin, studying what infrastructure is needed for nationwide adoption of eHGVs.
- **ZEFES**[vii] is an EU funded project trialling a range of different electric and fuel cell truck configurations on long distance routes throughout Europe provided with charging infrastructure.
- **Volvo Lights**[viii] was a three-year project in Southern California trialling 30 pilot eHGVs in real-world scenarios ahead of commercialisation of the vehicles. Routes were relatively short, at 80-150 miles per day and key findings included the need to think holistically about the routes and truck specifications to improve efficiency.
- The **EU Alternative Fuels Infrastructure Regulation**[ix] (AFIR) has a requirement that charging stations of at least 350kW must be provided every 60-100km on core routes by a deadline of 2030.
- **Milence**[x] is a planned trans-European network of HGV chargers, supported by investment from Daimler Trucks, TRATON Group and Volvo Group. The company aims to install 1,700 charging stations across major routes throughout Europe in support of the AFIR ambitions. The first site at Venlo, Netherlands in November 2023 with a 30-charger site at the Port of Antwerp-Brugge due to open in May 2024.
- **Commercial operators** are also beginning to implement eHGV charging stations, examples include BP at six locations in the Rhine-Alpine corridor in Germany[xi] as well as Circle K[xii], Göteborgs Lastbilcentral[xiii] and Einride[xiv] in Sweden.

Electric Freightway will continue to monitor progress in HGV electrification projects and policy interventions worldwide as we design, implement and evaluate the demonstration. We will look to draw on successful policies worldwide as we make recommendations based on the project's findings.

What use cases will the project investigate?

One of the aims of Electric Freightway is to demonstrate the capability of eHGVs in a wide range of different use cases. We aim to test vehicles by including the routes that are most difficult to electrify in the demonstration, alongside routes that involve a range of factors that may impact battery performance or ability to charge.

At this stage of the project, the consortium partners are planning the detailed routes that will be operated by their eHGVs in the trials and are in the process of ordering and receiving their new vehicles. The project does not yet therefore have a final view of the use cases to be covered in the demonstrator as these will be determined by the real-world needs of the haulier partners.

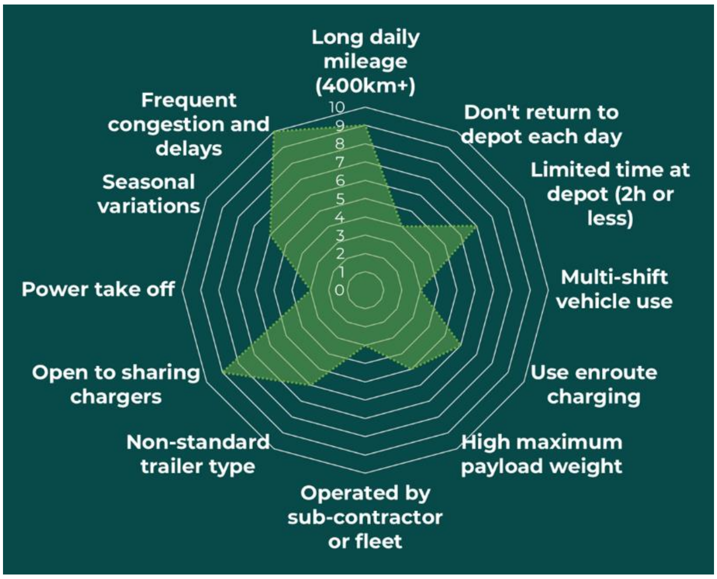
The aim of the Electric Freightway partners is however to test a comprehensive set of use cases that cover a wide range of challenging factors including (but not limited to):

- **The ability of eHGVs to operate longer distance routes**
- **The practicality of eHGVs on routes that do not return to depots, that have minimal down time between shifts or are operated on multiple shifts per day**
- **The impact of load and different trailer types on vehicle efficiency**
- **How use of power take-off can impact the range of eHGVs**
- **Seasonal impacts from both weather and variable loads**
- **The impact of congestion and delays on ability to charge and operate routes**

- **Sharing of infrastructure on depot or customer sites.**

Figure 5 below shows the key factors that the project partners expect to address in their demonstrations and the number of hauliers that anticipate that they may encounter these on their routes at the start of the project.

Figure 5 - Expected use cases in the demonstrations

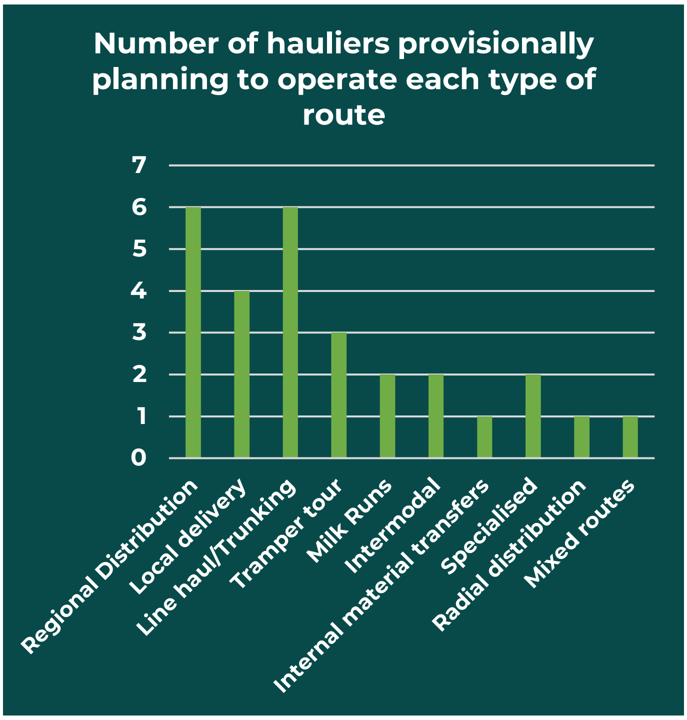


The consortium partners operate a diverse range of types of logistics operations as illustrated in Figure 6. This variety of operation will help ensure the applicability of the project results to a wide variety of haulier operations.

Figure 7 gives an overview of the types of routes that may be covered by the demonstration, and the number of project hauliers expecting to operate each type of route.

This analysis was based on the initial plans of hauliers at project launch and will be subject to change as routes are analysed in more detail and the feasibility of charging at planned public and private locations is ascertained.

Figure 7 - Route types in operation by partners



It is also expected that the use cases will evolve, as the demonstrator progresses and hauliers become more used to the capabilities of their eHGVs, allowing them to trial more challenging routes and adapt routes over time to meet evolving customer needs.

Figure 6 - Examples of common types of HGV operation

04 Data Science Approach

Electric Freightway will collect extensive data sets from multiple sources to analyse the practical and commercial realities of operating eHGVs and related charging infrastructure. A range of data science approaches will be used to process and develop insights from this data.

What is data science?

Data science is the process of extracting, analysing and interpreting large amounts of data from a range of sources in order to extract meaningful insights. It is a multi-disciplinary field combining mathematics, statistics, advanced analytics, artificial intelligence and machine learning with specific subject matter expertise.

Data science is at the core of the Electric Freightway programme as it offers a powerful and efficient solution to testing our hypotheses. Most importantly, it enables this analysis to be deployed at a sufficiently large enough scale for the results to be statistically significant.

How are we collecting data?

In order to perform data science activities, Hitachi will collate and save project data to a secure central repository.

Hitachi is working with the project partners to establish the systems to be used to monitor vehicles and charging activity, identifying the key data points that will be needed by the project. Data will principally be gathered from connections to existing systems such as telematics services, including those provided by vehicle and charge point manufacturers. These may be supplemented by additional data from other sources such as third party telematics services.

The data being collected and analysed by the project will sometimes include items which individual hauliers may consider to be commercially sensitive to their operations. The project team are mindful of these potential concerns and will ensure that the published reports and project communications benefit the wider sector by providing stakeholders with valuable insights without revealing any confidential information. Agreements between the project partners have been developed to specify the data being shared, how it will be collected, stored, anonymised and used in line with good data handling practice, and how the aggregated results will be disseminated.

What data are we collecting and why?

We will collect a comprehensive set of data for each project vehicle and charger for the initial phase of the demonstration. Beyond this, Ricardo (the technical evaluator for the programme) will work with Hitachi to ensure they can continue to collect this data after the Hitachi phase has completed in 2025 until the end of the demonstration in 2030. This will enable Ricardo to publish insights for the full duration of the programme.

In addition to the data collected from vehicles and chargers, supplementary data sets will be gathered to help characterise each individual fleet and identify the operating conditions that may affect how we interpret the data. While the exact data available for each vehicle may vary due to technical constraints (this is discussed further in Section 05), Table 1 details some of the key data sets which we expect to gather and analyse.

Table 1 – Example of data that will be collected and analysed

Dataset	Description
Vehicle telematics	Enables tracking of vehicle performance metrics at a detailed level throughout each day of operation, including how battery power is used by different vehicle systems. Data will be gathered for both the funded eHGV fleet and the

Dataset	Description
	existing diesel fleet. This will ensure there is a comparable performance baseline available for evaluating the performance of the eHGVs.
Vehicle metadata	Parameters such as vehicle age, mileage and fuel type enable the identification, characterisation and comparison of each vehicle within the fleet.
Vehicle maintenance logs	Maintenance logs are essential in understanding costs and vehicle downtime – these potentially differ by propulsion type.
Tyre data	The rate at which tyres wear and require replacement is dependent on factors such as vehicle weight, road surface, duty cycle, etc. Tyre type and condition can also impact on eHGV range and performance.
Charge point operator data	Monitoring the charging activity of each individual vehicle provides data on the consumption / supply side of energy being delivered to eHGVs. We will also analyse charger utilisation.
Fleet operations data	Additional operational data will be gathered to allow us to capture the context around the performance of each fleet and aid the understanding of fleet behaviour derived from the telematics data.

What techniques are we using for analysis?

A number of approaches will be utilised in order to test the demonstration hypotheses in a rigorous, data-driven manner. These will be described in detail throughout the series of programme reports as results become available for publication. An overview of some of the key techniques that we intend to use are described below. Section 07 will explain how these relate to each of the hypotheses.

Statistical analysis

The goal of statistical analysis is to characterise the operations of vehicles and fleets. We will be looking for the best ways to segment the journeys to create a set of different archetypes and operational classes. Example features that we want to investigate include distance travelled, payload and area type (urban, rural, etc). Time-based features may also provide useful project insights. What we intend to consider in creating these scenarios is discussed further in Section 05.

Simulation modelling

We will use the data collected to create models that simulate real-world scenarios and assess the practicality of eHGVs in various conditions.

Geospatial analysis

The analysis will leverage the vast quantities of geospatial data, such as vehicle location data, to investigate and develop insights related to geographic location dependent features, such as terrain, weather and road type.

Comparative analysis

We will use statistical methods (descriptive statistics supported by statistical tests) to evaluate differences in key metrics, accounting for variables like distance travelled, payload carried, time of year, environmental conditions, etc.

Forecasting

Predictions will be made for the long-term impact and feasibility of technologies, while accounting for variables where behaviour will change over time. For example, we may evaluate how degradation of battery health could impact the total cost of ownership over the life of a vehicle.

Frequent pattern mining

This technique allows us to identify recurring patterns, relationships or associations within a data set to understand how dynamic variables interact and impact upon vehicle operations.

What are we expecting to achieve?

The output of the data science work will have two main objectives:

- To create information and rules that can inform the analysis of total cost of ownership. This is discussed in further detail in Section 06
- To provide performance insights that can support industry in making data-driven decisions on fleet electrification. The scale and range of the analysis will ensure findings will be applicable to this diverse industry.

The following chapters explain in more detail how we will use the outcomes from the data science work to develop comparisons and inform the business case for HGV electrification.

Introducing our partners:

Renault Trucks

“Renault Trucks are extremely proud to have been chosen as one of the manufacturers supporting Electric Freightway, the most advanced programme to date in bringing charging networks for eHGVs to life here in the UK.

Renault trucks was the first manufacturer to market electric trucks as standard and now have over ten years proven experience in this exciting new chapter within the transport industry.

Working alongside the consortium members, we will continue to offer the very best possible support throughout the period of the trials, ensuring that all parties fully optimise this fantastic opportunity.

Renault Trucks is also committed to our ongoing programme of research and development into all new technologies and will continue to work alongside our partners to find the very best solutions for all operations, speeding up decarbonisation in line with the very latest legislation.”

Simon Calado,
Energy Transition Manager, Renault Trucks

05 Benchmarking and Scenario Analysis

Hauliers considering the transition to fully electric vehicles, need to understand the commercial investment case for eHGVs and how this compares to that of the diesel HGVs currently in use. They also need to know whether eHGVs are able to carry out the duties required of them as there are a wide range of factors that could potentially impact how they perform.

In order to accurately compare the performance and cost effectiveness of eHGVs and diesel HGVs, benchmarks need to be created based on their real-world performance. This section outlines how we will create benchmarks from historical diesel HGV data and the factors that we will be addressing as we create benchmark and TCO scenarios.

Approach to benchmarking

Benchmarks will be created using data supplied from the diesel HGV fleets of our partner hauliers. Average fuel efficiencies will be calculated for different route scenarios operated by the vehicles, taking into account a range of factors that may affect the vehicle's efficiency. These factors are discussed later in this chapter.

Taking this approach will allow us to make a comparison on a more granular level, rather than by making a generalisation of eHGV efficiency or making assumptions based on the actual performance of a specific route. This approach should also help us identify the factors that cause differences in efficiency between diesel HGVs and eHGVs.

From initial work with our partners we recognise that there will be a number of challenges in trying to determine accurate baselines which our proposed granular approach to benchmarking is intended to overcome. These challenges include:

Comparability of existing routes

The routes that will be operated by eHGVs may differ substantially from those that were previously operated by diesel HGVs. The transition to eHGVs may also represent a significant change in operations for hauliers and may impose some limits on which routes can be operated, while presenting the opportunity to redesign operations in a more efficient way to align with eHGV capabilities and charging locations.

As a result, it will not always be possible to make a like-for-like comparison between specific vehicles or routes. To overcome this issue we will look to alternative methods, such as measuring the comparative performance of diesel HGVs and eHGVs on routes with similar business objectives or breaking down vehicle operations into smaller segments that are operated by both diesel HGVs and eHGVs.

Limitations of historical data

While the project partners can specify what data will be captured from the eHGVs being deployed as part of the demonstration, the amount of data available from existing diesel HGVs may not provide the level of detail that we would ideally require. Initial reviews of data have determined that the data quantity and coverage from various diesel HGV telematics systems used by partner hauliers vary significantly.

Where possible we will capture equivalent data from diesel HGVs and eHGVs and, where this is not possible, the closest equivalent data will be used along with any relevant additional data that can be provided by the consortium partners.

Standardisation of HGV data

Telematics data from HGVs is generally standardised in accordance with rFMS[xv]. This standard was updated to version 04 in September 2021, including a number of data points that are specific to eHGVs. Unfortunately, the majority of vehicles coming to the market do not yet conform to this latest standard. Even if they did conform, some of the measures that we would like to collect are not covered by the standard. Manufacturers have addressed these gaps by supplementing the standard data in their telematics systems, however the way this is done can vary significantly.

This variation in available data may impact the comparability of telematics from different fleets and mean that some measurements are not available for all vehicles. We believe that sufficient historical data is available from across the existing diesel fleets to create suitable benchmarks and we are working with the eHGV OEMs to ensure that sufficient data is available to the project, potentially using other third party telematics systems should this be necessary.

Factors impacting HGV efficiency and operating costs

For simplicity of comparison, and to protect the confidentiality of the specific details of routes operated by the project partners, the diesel HGV and eHGV route data will be summarised into a number of scenarios which are representative of the routes that will be operated in the demonstration. This will also help create comparisons which are more generally applicable to HGVs operating in the sector, rather than specific to the vehicle routes in this particular demonstration.

The following section highlights some of the potential variations in vehicle use which will be considered in the analysis of vehicle data and the construction of scenarios. There are many potential combinations of factors that could affect the routes operated by hauliers and the exact scenarios covered will depend on whether the project gathers sufficient data on each factor, and whether the factor is found to significantly influence eHGV performance.

Route types and operating model

The haulier partners in the Electric Freightway consortium operate their HGVs over a wide range of route types including:

- Multiple short trips, same day return to base or long overnight trips
- Single delivery or multi-drop
- Allocation of a vehicle to a single driver or shared vehicles
- One shift per day or multi-shift operations
- Weekday only or seven-day operations.

The operational model could potentially impact the efficiency of the vehicle and the time available for charging could impact the options for charging speed and location or necessitate additional vehicles being needed to service a route.

Vehicle and load types

While the tractor units used by the eHGVs in the demonstration are similar, the trailer types that they haul vary significantly and may include:

- Standard solid and curtain sided trailers
- Double deck trailers
- Refrigerated trailers
- Transporters of bulk materials
- Loads with different weights
- Trailers of different lengths
- Loads that vary throughout or between trips.

Different trailer types may result in varying aerodynamic properties impacting the vehicle efficiency and range.

Due to their increased weight, larger eHGVs often have a smaller payload weight capacity than equivalent diesel HGVs, which may mean that hauliers need to employ more vehicles to move the same weight of goods.

Efficiency of HGVs may also be affected by other factors, such as tyre wear, tyre pressure, engine configuration, electricity use in the cab and power take off (PTO) to the trailer.

Geography and terrain

While routes may be of comparable length, the geography of the route may impact vehicle performance, for example:

- Uphill or downhill sections resulting in higher power required or increased regenerative braking
- Use of motorways, urban or rural roads impacting vehicle speed and stopping patterns
- Congestion impacting speed and frequency of stops
- Where the vehicle enters a low or zero emissions zone (or an area where a zone is proposed).

Where locational data is available, it will be used alongside third party data sets to categorise the route types.

Weather and season

Performance on similar routes may vary throughout the year due to seasonal related issues such as:

- Temperature affecting the use of cab heating and cooling
- Wind speed and direction affecting aerodynamics
- Wet weather impacting speed and braking
- Seasonal demand impacting load types and quantities.

The cost of operating a diesel HGV

The baseline scenario will take a range of costs into account including:

- Diesel cost (and volume required)
- Additives such as AdBlue
- Taxes, tolls, levies and other fees (where these differ than those applied to eHGVs)
- Maintenance requirements and costs
- Duration of lease, vehicle lifetime and/or resale cost.

The cost of operating an eHGV

The baseline scenario will take a range of costs into account:

- Vehicle and capital cost (leased and owned)
- Duration of lease, vehicle lifetime and/or resale cost (residual value)
- Electricity prices for charging
- Maintenance requirements and costs.

While the cost of new eHGVs for this project will be subsidised, the TCO will consider the normal market cost of the vehicles and associated financing to ensure the relevance of the TCO to the wider market.

The cost of infrastructure

Where specific infrastructure is required to operate vehicles, such as charging stations, this should be included in the TCO calculation. In addition to the upfront cost of chargers, costs will be incurred in civil and electrical installation work and ongoing maintenance.

This can either be calculated at a fleet level (taking the capital cost of infrastructure as a one-off cost), or per vehicle day/km (applying the cost of the infrastructure to each vehicle based on the predicted life and utilisation of the assets).

The project will consider both approaches, while acknowledging the difficulty of predicting future asset utilisation.

Organisational costs

In some cases, an eHGV may not be able to undertake the same duties as an equivalent diesel HGV due to different payload capabilities or the time needed for charging.

The change from diesel fuelling to electrically charging a vehicle may also result in additional costs associated with eHGV operations such as:

- The cost of additional vehicles needed to cover routes
- The cost of additional driver or staff hours needed to operate eHGVs.

Environmental impact

HGVs have the potential to impact the environment in a number of ways – through CO_2 emissions, other pollutants such as nitrogen oxides and particulates, and as a result of noise generated by engines and rolling resistance.

We do not expect to be able to directly measure the emissions from the vehicles in the trials, so will need to rely on alternative means to estimate the environmental impact of eHGV and diesel HGVs based on the fuel use and distance travelled during the demonstrations.

Carbon dioxide emissions can be estimated based on the quantity of diesel fuel consumed, or for electric vehicles based on conversion factors taking account of the UK's power generation mix[xvi], and considering potential future changes over the lifetime of the vehicle.

Lifecycle carbon emissions are also an important consideration, with significant amounts of carbon embedded in the materials used to make each vehicle. Some of these materials may be recycled or go on to second uses beyond the life of the vehicle, so we need to consider this in accounting for the true carbon footprint of an HGV. The project will work with vehicle manufacturers to determine as accurately as possible the lifecycle carbon footprint of the vehicles used in the trials.

Introducing our partners: **A. F. Blakemore & Son**

As part of the Electric Freightway Programme, two electric HGVs are set to be delivered in spring 2024 to service A.F. Blakemore's Bedford depot, further expanding the company's zero-emission fleet. The two new Volvo FM Electric trucks are equipped with innovative battery technology and regenerative braking, offering a clean and efficient solution for long-distance deliveries.

"We are thrilled to be at the forefront of the electric vehicle revolution in the convenience retail sector. The addition of these electric HGVs demonstrates our commitment to reducing our environmental impact. We believe this is just the beginning of our journey towards becoming a net zero carbon company by 2040 and we are excited to see the positive impact these vehicles will have on our operations and the environment."

Caoire Blakemore,
Responsible Business Director, A.F. Blakemore

06 Total Cost of Ownership

There are many factors, including environmental concerns and government policy, which will encourage hauliers to make the switch to eHGVs, however if the transition is not economically feasible, the willingness of fleet owners to adopt eHGVs will be limited.

The TCO model will consider the factors that impact the cost of adopting eHGVs in order to identify the true costs of transition from diesel HGVs and the changes that may be needed to encourage widespread adoption. In addition to economic costs, environmental factors will also be considered.

The importance of total cost of ownership

Haulage companies operate in competitive markets, providing a commodity service at relatively low margins – the cost of acquiring, fuelling and servicing vehicles can have a significant impact on the haulier's profitability and on the price people pay for transported goods.

Due to the current high cost of batteries and smaller production volumes, eHGVs are currently significantly more expensive to purchase than equivalent diesel HGVs. However, the difference in the cost of charging vs. diesel fuelling and lower cost of maintenance over the vehicle's life may offset this higher upfront cost.

There may also be some competitive benefits in the short term from offering zero tailpipe emission haulage in advance of wider adoption throughout the industry, in that a demonstrably sustainable haulier is likely to be more attractive to potential clients. We will investigate this through surveys of haulage partners.

The questions we are trying to answer

In the TCO workstream we will be developing a model and using findings from the demonstration to uncover the real cost of operating eHGVs over the lifespan of the vehicle.

The TCO analysis will aim to answer a wide range of questions from analysis of the real-world evidence gathered through the demonstrator including:

Are eHGVs more or less expensive to run than diesel HGVs in different scenarios?

We will benchmark eHGVs against equivalent diesel HGVs that are currently used by freight operators. (More information about how we will benchmark this is described in Section 05.)

The project will identify specific route types and scenarios that should be prioritised because they are more economically viable, as well as those that need additional support and solutions to support conversion to eHGVs.

What factors drive eHGV efficiency? How does this impact cost?

We will investigate what causes variations in efficiency and battery range between routes e.g. does weather, terrain or payload have the greatest impact on eHGV operations and what is the cost impact, in terms of electricity and time, of less efficient routes?

What is the environmental impact of eHGV adoption?

We will analyse how much industry can reduce CO_2 emissions by adopting eHGVs and what additional benefits can be realised such as reduction in particulates and other air pollutants.

Can public charging be an economical and practical option for eHGV operations?

We will assess whether it is cheaper to charge at depots compared to public charging, taking the associated cost of charging infrastructure into account. We will also investigate how this varies for different fleet sizes and what types of routes and operations benefit the most from on-route public charging.

Does increased infrastructure investment allow more intensive use of eHGVs?

Intensively used eHGVs may be more cost effective but have less available time for charging. As a result they may need more powerful and consequently more expensive charging infrastructure. Hauliers may also need to decide between fewer High Power charge points or more low power units. We will explore the economics and practicalities of these different charging options.

Developing industry understanding of eHGV TCO

A number of projects and researchers have attempted to quantify the TCO of eHGV operations. These studies have taken a range of factors into account and have attempted to estimate the cost of transitioning to eHGVs now and in the future. Table 2 gives an example of some of the key conclusions of recent analysis of the cost of operating electric and alternative fuel HGVs.

Table 2 - Selected outcomes of eHGV TCO analysis

Source	Key Outcome
Battery Electric Truck Trial (BETT)[iv]	19p/km average cost saving across the trial
Transport & Environment/ Element Energy[xvii]	Local rigid eHGV operations approaching breakeven, long-distance trucks may take until 2032. 65-75% of operations only need depot charging.
ICCT 2023[xviii]	BEV trucks will be TCO positive (10-25% cheaper than diesel) across all main use cases by 2030. Hydrogen will follow by 2040.
International Transport Forum - Decarbonising Europe's Trucks[xix]	BEVs reach parity between 2020 and 2040 with 80% routes competitive by 2037.
Green Finance Institute - Delivering Net Zero[xx]	Electric TCO is between 105% (10 year) and 123% (five year) of diesel TCO for large trucks in an average scenario. Can be cost positive in a 'low-cost' scenario over 10 years.

There are also a number of research publications that aim to identify the factors that impact the efficiency of HGVs. Table 3 gives some examples of findings from recent studies. Electric Freightway will make use of these findings as appropriate to supplement our own analysis and also to calibrate them in relation to our own real-world demonstrator.

Table 3 - Efficiency findings from past studies including ICE HGVs

Study	Key Findings
Model-Based Range Prediction for Electric Cars and Trucks under Real-World Conditions[xxi]	Winter conditions and hilly terrain can reduce range by 7-9%
Effects of payload on the fuel consumption of trucks[xxii]	0.112 mpg per tonne impact of payload on performance of trucks 44t vehicle efficiency can exceed that of 32t vehicles when payload exceeds 17t
Effects of semi-trailer modifications on HGV fuel consumption[xxiii]	Lightweight trailers can result in a 17.7% fuel use reduction and with aerodynamic trailers seeing 3% savings and a combined effect of 20.2%
How Adverse Weather Affects Fuel Economy[xxiv]	A 9°C drop in temperature, can result in a 6% increase in fuel consumption. A 20°C drop led to a 18% fuel consumption increase.
The Effect of Road Grade on Dump Truck Fuel Consumption[xxv]	A 1% increase in road grade can result in fuel use increasing by between 7 and 24%

Electric Freightway aims to develop this earlier research work further through analysing actual performance data from vehicles on the road and identifying factors that will affect TCO of eHGVs compared to diesel HGVs. Beyond pure data we will also consider the practical difficulties and unexpected benefits encountered by the haulier partners through the operation of the trials.

Table 4 provides a comparison between the TCO factors considered in depth by past projects, and those planned for Electric Freightway.

Table 4 - Comparison of Electric Freightway to existing TCO analyses

Study	Economic analysis	Primary Research	Public Charging	Larger HGVs
BETT[iv]	X	X		
Element Energy/T&E[xvii]	X		X	X
ICCT 2023[xviii]	X			
International Transport Forum[xix]	X			
Green Finance Institute[xx]	X			X
Electric Freightway	X	X	X	X

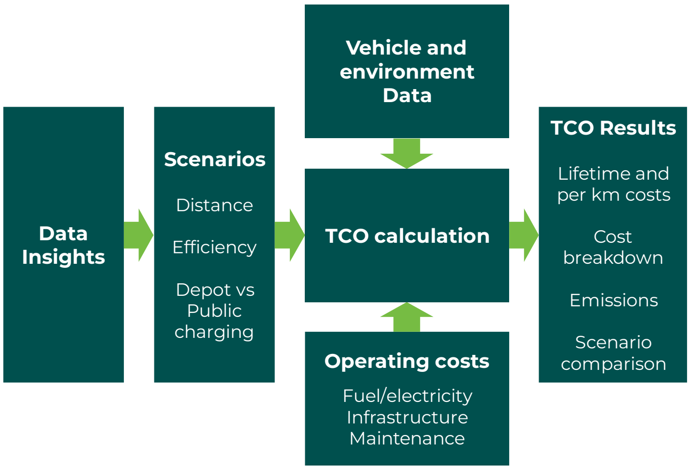
TCO methodology

The TCO approach will build on previous work done by Hitachi in modelling the cost-benefit of electric vehicles for commercial clients as part of the Ofgem Network Innovation Competition Project Optimise Prime[xxvi]. This methodology considers a range of factors that impact the cost of operating electric and ICE (Internal Combustion Engine) vehicles and this will be developed further for Electric Freightway to incorporate aspects relevant to HGV operations.

Data for the TCO analysis will be gathered from several sources, including the results of the data science activity (outlined in Section 04 of this report) together with interviews and questionnaires to gather information that cannot be automatically collated.

Figure 8 shows a basic overview of how the TCO model will work. Various scenarios will be created, based on both average and extreme duty cycles recorded by the partner fleets. These scenarios will include distances travelled, efficiency of vehicles and whether the vehicles charge at depots, on-route or a combination of the two.

Figure 8 - Basic concept of TCO analysis



Relevant costs will be applied to these scenarios, including costs of vehicle purchase, lease, maintenance, electricity, charging infrastructure and charge point operation.

These costs will be assessed together with emissions factors to enable analysis of the environmental impact. The outcome of this analysis will be a lifetime cost for each vehicle in each scenario with details of the source of financial costs, together with an estimate of the environmental cost of operating the vehicle.

As more data from the trials becomes available, we anticipate that the calculation of TCO will become more granular, considering additional aspects that impact vehicle efficiency.

We will adapt the scenarios further to simulate how factors such as weather, terrain, payload and route type impact the efficiency of eHGVs. Scenarios will be developed that analyse the sensitivity to changes in these factors, or combinations of factors. Figure 9 shows examples of how the TCO will be developed.

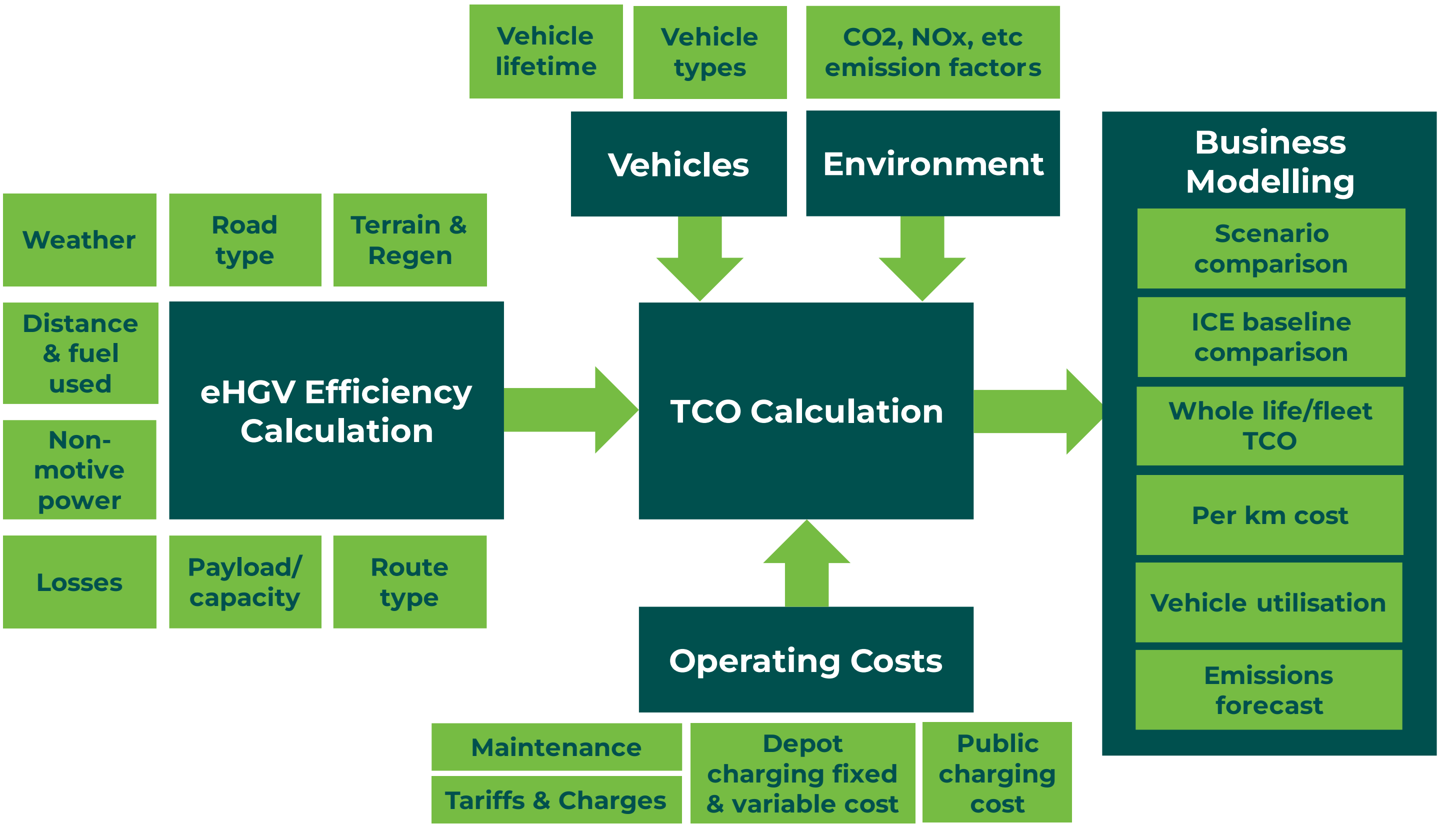


Figure 9 - TCO analysis with example inputs and outputs

Vehicle and fleet level TCO

Electric Freightway will calculate the TCO for each vehicle as well as for each HGV fleet so that the TCO can be extrapolated to any eHGV fleet that operates across a variety of route types and conditions and shares infrastructure between multiple vehicles.

The need for assumptions

In some cases we may not be able to gather all the data that we need for the project from the demonstrations. This may be for a number of reasons such as confidentiality of data including commercially sensitive information, and also for future variations in the price of vehicles, electricity and charging infrastructure. In such cases we will need to make assumptions, use average values or extrapolate published data and forecasts within our TCO modelling.

Due to the current lead times for eHGVs, the vehicles will be gradually introduced during the initial phase of the project. As a result, the project will need to base early iterations of the TCO analysis on several assumptions, based on the expected performance of vehicles.

The TCO model will continue to develop throughout the project, as more accurate information becomes available from the demonstration. Results will be disseminated in future reports, highlighting where they are in variance from the baseline.

Assumptions and predictions that will be used during the project

Inflation

When modelling costs into the future it is important to consider how prices for goods and services will vary over time. In general, the UK Government's predictions for price inflation are applied to the cost of items included in the TCO. There are, however, significant exceptions to this as many of the costs of operating eHGVs are not expected to vary in line with inflation. Specific examples of this include diesel, electricity and vehicle prices.

Future electricity and diesel prices

Diesel and electricity prices are key variables that impact upon the relative cost effectiveness of eHGVs and diesel HGVs. In recent years global events have resulted in significant variation in the cost of both diesel and electricity, making future costs difficult to predict with any accuracy.

Electricity and diesel prices reached highs during 2022 however, while there has been a 25% fall in diesel prices since October 2022, reductions in wholesale electricity prices have not yet resulted in significant reductions in non-domestic electricity tariffs or public charging rates.

Due to the potential for externally driven price shocks and the global nature of markets, electricity and diesel prices do not generally vary in line with inflation and a separate index is needed to adjust future prices. We will take a conservative approach to future cost movements, utilising industry forecasts and assuming that electricity prices will not fall significantly beyond the recent price declines.

We will consider applying the benefits of flexible electricity supply pricing – such as time of use tariffs and demand response services – based on the products available to our haulier partners and their ability to respond to price signals. As part of this we will look at what ability the hauliers have to shift their electricity demand, considering whether the potential financial benefits outweigh the operational constraints these options may impose.

Future price trends for EVs, batteries and related services

The eHGV market is in its infancy and the cost of vehicles and their components is currently high. It is expected that as production volumes increase and technology matures prices will decrease. Caution must be taken with any such assumptions, as the speed of cost declines will depend on a range of factors such as future government policy, technological advances and supply chain constraints.

Electric Freightway will initially use current costs as the basis for modelling eHGV purchase prices during the demonstration, highlighting the required price changes that would be needed to achieve TCO parity with diesel HGVs. To forecast future prices we will be guided by the expertise of our OEM partners and industry forecasts.

Cost of electricity connections

Upgrading electricity connections to depots and public sites can be a significant cost element of installing EV charging infrastructure as well as potentially introducing significant delay. The cost and timeline for upgrades will vary by site, depending on the existing site connection agreement, the proposed charging infrastructure electricity needs and local electrical network capacity. Sites that require significant upgrades may not be included in the project due to limited budget and timescales of the project.

Applying the 'real-world' cost of site electricity connection upgrades from the demonstration to a generic TCO model will probably skew the results in an unrealistic way. Instead, we will provide additional commentary on the range of upgrade costs experienced and may consider using a standardised cost of charging infrastructure that includes connection upgrade and required civil engineering work in the TCO model.

Data from project contributors that will be used throughout

Information on vehicle routes

Electric Freightway will collect extensive data sets from the project contributors' telematics systems to inform the TCO model. Where possible, truck OEM telematics systems will be used to limit the number of data sources and ensure that the data is as comparable as possible between fleets. Where this is not possible, hauliers' telematics systems or additional devices may be used to provide the required detail.

Charging sessions

Charging session data relating to the vehicles in the trial will be collected by GRIDSERVE, the charge point operator for the public sites and in the majority of the project's depots. This data will enable us to understand how much electricity is being delivered to vehicles and when and how frequently the charging infrastructure is being used.

Business information

In addition to the vehicle telematics data, the project will collect a range of information from hauliers about their operations, including details of the eHGV vehicles, the routes being operated and the payloads being transported.

External data

The project will use external data from a number of sources to enrich the analysis and provide context to the vehicle journey data, including:

Weather data

Weather data will be collected from a commercial source. This will include a range of factors including temperature, wind speed and precipitation.

Road network data

This will be used to map the routes taken by vehicles and calculate elevation change where this is not available from the vehicle.

Development of the TCO model

Electric Freightway plans to publish three iterations of the TCO model as the project progresses and more data becomes available.

The interim report, expected to be published in Autumn 2024 will feature an initial analysis, while two reports in 2025 will take the increasing number of eHGVs into account for a more detailed TCO assessment.

Introducing our partners: Samworth Brothers

“Samworth Brothers has a strong responsible business agenda and the introduction of electric HGVs is an important step on that journey. Just one of our key local routes passes 27 schools, nurseries and playgroups within 200 metres of the road and we do this journey 18 times a day. The potential of alternative fuels is very exciting when considering our environmental impact and responsibility to the local community.

Clearly, there are still some limitations around charging infrastructure and vehicle range but technology continues to advance and these are likely to be temporary restrictions rather than long term problems.

We’re excited to take delivery of our first two electric Volvo FM tractor units and couple them to our existing fridge trailers powered by solar energy, axle regeneration and HVO for a completely environmentally friendly combination.”

Alistair Leckie,
General Manager Transport and Fleet, Samworth Brothers

07 Initial Hypotheses

Based on discussions with project stakeholders, and analysis of initial development of the TCO models, we have developed the following hypotheses that will be tested as the project progresses.

The core hypothesis of Electric Freightway is that:

Electric 40-44t HGVs are ready to replace diesel HGVs and can deliver the same function when the right infrastructure is in place.

To help confirm or disprove this through our analysis, we have broken this statement down into a series of subsidiary hypotheses. The table below gives an overview of these hypotheses and how we propose to address them.

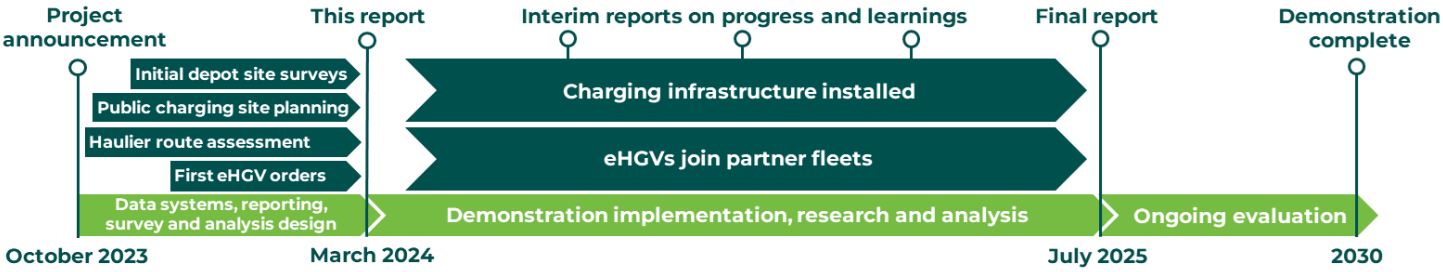
Category	Hypotheses	How we will evaluate
Ability of electric 40-44t HGVs to effectively replace diesel HGVs	Most HGV journeys are possible with current eHGVs and depot-based charging	**Data Collection:** Gather data on electric and diesel HGV journeys, range, fuel and energy efficiency, load capacity, maintenance records and weather. **Statistical Analysis:** Perform comparative analysis to evaluate differences in performance metrics. **Simulation Modelling:** Create models to simulate real-world scenarios and assess the practicality of electric HGVs in various conditions; present results using interactive maps. **Logistics Pattern Study:** Analyse changes in logistics and transportation patterns due to electric HGV implementation. **Efficiency Metrics:** Evaluate overall efficiency improvements, including time, cost and environmental benefits.
	Almost all journeys become possible when suitable on-route charging is available	
	Some trips cannot be completed with the trial infrastructure and will require higher capacity vehicles, more remote charging infrastructure, customer site charging or alternative fuel sources	
	Maximum payloads of eHGVs are less than ICE equivalents. This will impact the ability of some hauliers to directly replace ICE vehicles and impact cost effectiveness	
	Winter conditions reduce the efficiency and range of eHGVs. This can be managed through route planning and top-up public charging so that it is not a barrier to electrification	
Cost effectiveness of electric 40-44t HGVs	Most HGV routes could be technically electrified, but would require incentives to be put in place as they would not be economically viable in the short-term	**Data Collection:** Gather efficiency data from a variety of scenarios together with representative costs and parameters of eHGV and diesel vehicle operation.
	The capital cost of eHGVs is currently higher than diesel HGVs and can only	

Category	Hypotheses	How we will evaluate
	be offset by operational savings where vehicles are used intensively Opportunity cost from charging is negligible as it can be aligned with existing driver and vehicle downtime	**Statistical Analysis:** Perform comparative analysis to evaluate differences in costs and how changing factors impacts TCO.
Infrastructure enabling efficient operation of eHGVs	Public eHGV chargers can be practically implemented into commercial logistics operations Provision of public eHGV charging infrastructure will be commercially viable once the number of eHGVs on the road increases Public charging can be more economical for some fleets because it offsets the need for investment in depot infrastructure and enables longer journeys Securing timely connections to the electricity grid will be a key barrier to the electrification of depots for eHGVs Use of public charging can overcome limitations on charging at depots as a result of connection constraints	**Geospatial Analysis:** Map the locations of charging stations and analyse route efficiency for eHGVs. **Charging Time Studies:** Record and analyse charging times under different conditions (e.g. utilisation scenarios) and compare with operational needs. **Stakeholder Feedback:** Conduct surveys and interviews with drivers, logistics managers and infrastructure partners to understand the real-world impact of charging infrastructure.
Environmental benefits of eHGV transition	Operation of eHGVs has a significant positive environmental impact compared to diesel HGVs. There are lower emissions of CO_2 and other pollutants over the whole lifespan of the vehicle eHGVs provide a more pleasant working environment for drivers, due to reduced noise and emissions	**Emission Data Collection:** Compile data on emissions from both electric and diesel HGVs. **Stakeholder Feedback:** Conduct surveys and interviews with drivers. **Comparative Analysis:** Use statistical methods to compare emissions, accounting for variables like distance travelled and load carried. **Environmental Impact Modelling:** Utilise models to project long-term environmental impacts of switching to electric HGVs.
Electric 40-44t HGVs are ready to replace diesel HGVs and can deliver the same function when the right infrastructure is in place.		By drawing on analysis of all of the hypotheses above.

Hypotheses studied may be subject to change as the scope of the demonstration and findings evolves.

08 Progress and Next Steps

The award of funding for the Electric Freightway project was made public on 19 October 2023. Since then, the consortium partners have made significant progress in planning the delivery of the demonstrator vehicles and infrastructure. Technical and commercial agreements have also been implemented to deliver the data needed for the project's reporting requirements. The timeline below gives an overview of the key milestones that lie ahead for Electric Freightway.



Charging infrastructure

A key outcome of the project is the provision of a purpose-built eHGV charging network on major roads throughout the UK, together with depot-based charging at consortium members' premises. GRIDSERVE have been surveying sites throughout the UK to assess feasibility and design infrastructure in partnership with the project partners.

A major challenge in rolling out the required charging infrastructure is in the provision of grid connections and upgrades for the charging stations as these can take a considerable time to complete. Given the relatively short duration of the implementation phase of Electric Freightway, sites that require significant electrical upgrades may therefore need to be excluded from the project.

From a long list of potential sites, GRIDSERVE has developed a shortlist of locations where infrastructure can be implemented within the time and budget restrictions of the programme while supporting the needs of the project's eHGV fleet operators.

eHGV procurement

The OEMs (currently DAF, Renault and Volvo) together with the project's financing partners, have been working with hauliers to help specify the required eHGVs. As a result, orders have now been placed for the first demonstration vehicles and delivery of the first of these is expected during Spring 2024. We will begin capturing data on their use as soon as the vehicles are on the road.

Attitudes research

Haulier drivers and managers are key to the successful transition of HGV fleets to zero tailpipe emissions. Positive attitudes towards eHGVs can make the adoption of new vehicles much smoother and it is important to understand concerns of these stakeholders so they can be addressed in the design and specification of eHGV fleets and operating procedures.

Unlike in the passenger electric vehicle sector, there has been relatively little research conducted to understand the attitudes of HGV drivers towards electrification, with the BETT project conducting one of the few studies to date with drivers of rigid eHGVs.

The Electric Freightway team have designed a series of surveys and interview rounds that will capture the perceptions of drivers and managers in advance of the introduction of eHGVs in their fleets and as they become more experienced in their use.

The research has three key objectives:

- To identify perceived barriers to and enablers of eHGV adoption, in order to propose measures to address them (including policy measures, information and training)
- To measure whether and how the perceptions evolve as the project

progresses and the participants gain more experience with eHGVs (and as other external factors such as technology and policy evolve)
- To capture opinions on the specific technologies and methods applied in the project (e.g. public or depot charging and charge session booking solutions).

The research will take the form of a series of questionnaires surveying drivers together with semi-structured interviews with operations, engineering and senior management at our haulier partners in order to gather both qualitative views on eHGVs and quantitative results that can be compared across hauliers.

Learning from implementation

As a ground-breaking project, we expect the Electric Freightway partners to encounter and have to overcome a range of problems that have not been faced before.

Implementation of eHGVs and related charging infrastructure is expected to bring to light issues relating to:

- Practical and technical challenges of installing charge points at depots and public sites
- Operational implications of replacing diesel HGVs with eHGVs
- Reaction of drivers to the adoption of eHGVs and the need for training and change management
- Experience of using public charging with eHGVs.

Throughout the project we will record the problems encountered, and the learnings for the development of solutions. This will be shared with the industry through project reports and industry event communications.

Data gathering

Hitachi's data scientists and engineers have been working closely with consortium partners to ensure that the project's systems are ready for the arrival of the first demonstration eHGVs on the road. In advance of this, data from OEM test fleets, historical data from fleets and other data sets such as weather are already being processed to test the integration of the systems, to begin the production of benchmarks and to further develop the approach to data analysis.

Future reports

Later this year we plan to publish an interim report, providing initial insights from the first eHGVs on the road, findings from our first-round surveys and learnings from the introduction of the vehicles and infrastructure. You can keep up to date with the progress of the demonstration on our website.

Introducing our partners:

Volvo Trucks

"Volvo Group are fully committed to decarbonisation of transport, delivering fossil free solutions to our customers and striving to be climate positive in our own operations.

To meet our carbon commitments, we need to accelerate the transition to eHGVs. The subsidy allows customers to invest earlier in new technology, understand their future Total Cost of Ownership, and learn how to operate eHGVs in the most efficient way.

Learnings from the demonstrator will allow OEMs to better understand and support customers to roll eHGVs out across their Fleets. This includes everything from battery and vehicle performance to driver surveys on the Electric driving experience.

The technology is here: We now need more vehicles on the road to showcase the capabilities of these amazing vehicles alongside charging solutions – seeing is believing!"

Martin Kearns,
Head of Electric Sales Development, Volvo Trucks

09 Acknowledgements, Glossary, References and Links

Acknowledgements

The Electric Freightway team would like to offer our sincere gratitude to the many people and organisations across the project who worked tirelessly to make this demonstration possible. Without the support and commitment of the hauliers, vehicle manufacturers, site owners, and financiers it would not have been possible to embark on such an ambitious project, that we are sure will be critical for the development of a net zero future in electric freight. We would especially like to thank GRIDSERVE's Sam Clarke and John Whybrow as well as Hitachi ZeroCarbon's Sam Nixson and Anna Maudet for bringing together such a diverse consortium, shaping our objectives, and working with the teams at Innovate UK and the Department of Transport to make this project a reality.

Glossary

BETT	Battery Electric Truck Trial, a UK trial carried out by DAF and Cenex, with financial support from SBRI Zero Emission Road Freight Competition
BEV	Battery Electric Vehicle
CCS	Combined Charging System, the connector standard for High Power DC (except megawatt) charging in the UK
DC	Direct Current
eHGV	Electric Heavy Goods Vehicle, a zero tailpipe emission HGV powered by electricity
HGV	Heavy Goods Vehicle, also referred to as LGV (Large Goods Vehicle) or HDV (Heavy-Duty Vehicle). A vehicle with over 3.5t gross weight
High Power charger	A DC charger capable of charging an electric vehicle at 150kW or over
ICE	Internal Combustion Engine
MPG	Miles Per Gallon
OEM	Original Equipment Manufacturer, a term used to refer to the manufacturer of HGVs
Payload	The weight of goods being transported by a vehicle
PTO	Power Take-Off
TCO	Total Cost of Ownership

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