Notes on Completion: Please refer to the appropriate NIA Governance Document to assist in the completion of this form. The full completed submission should not exceed 6 pages in total.

NIA Project Registration and PEA Document

Date of Submission

Mar 2025

Project Reference Number

NIA2_NESO056

Project Registration

Project Title

Impact of New Technology HGVs

Project Reference Number

NIA2_NESO056

Project Licensee(s)

National Energy System Operator

Project Start

February 2025

Project Duration

0 years and 10 months

Nominated Project Contact(s)

innovation@nationalenergyso.com

Project Budget

£250,000.00

Summary

This project aims to create the most realistic within day profiles as possible for the future GB electric heavy-goods vehicles (HGVs) fleet. This project will output a model, which can produce NESO's required inputs to Plexos, and enable periodic updates/sensitivity testing to enabling lasting value to the NESO's processes and stakeholders.

Nominated Contact Email Address(es)

box.so.innovation@nationalgrid.com

Problem Being Solved

In 2021, the UK Government committed to "all new HGVs sold in the UK to be zero emission by 2040." The government has put funding aside to trial 3 potential technologies on the road: Battery Electric (BEV), Hydrogen Fuel cell (FCEV) & pantograph 'electric road' (ERS).

As of 2022 Q3 there were around 515,000 registered heavy goods vehicles (HGVs) in Great Britain1, and of these over 99% run on diesel (Figure 1a). Almost a quarter (~127,000) of these vehicles are over 41 tonne gross vehicle weight (GVW)2, which are the most energy intensive vehicles. Around three-quarters of all heavy goods transportation in GB is undertaken by trips longer than 100km (Figure 1b), and the average annual mileage for articulated vehicles registered in GB is around 84,000 km. So-called 'zero emission vehicles' (ZEVs) are being introduced as one of the means of reducing impacts from HGVs. Whilst battery electric vehicles (BEVs) are anticipated to be the predominant technology for shorter distance/smaller vehicle urban and regional applications, both battery BEVs and fuel cell electric vehicles (FCEV) anticipated to play an important role for the largest vehicle categories, possibly in combination

with dynamic charging via catenary (overhead line) systems on key routes. There is therefore a need to explore the potential impacts on the wider energy system of deployment of these vehicles into the GB fleet. Long-haul articulated battery electric trucks can have an energy consumption of ~1.5 kWh/km3, which results in around 490 kWh required per day (assuming annual activity is distributed across 260 working days) for long-haul battery electric trucks in GB.
This energy demand (plus the energy demand form the other HGV weight categories) will need to be recovered from charging infrastructure at certain locations, including depot charging, opportunity charging and charging at a motorway service area or truck stop.
It is likely that at least 50kW chargers will be required at long-layover time stops (either at depot or truck stops), and therefore the grid system could require significant reinforcement or upgrades to support electric HGVs in future, particularly if higher-powered chargers are favoured to give the operators increased flexibility from their vehicles. For shorter layover times (i.e. opportunity charging or charging at a Motorway Service Area (MSA) the charging power required could be 350kW or higher4. To increase operational flexibility, HGV operators may prefer to install higher-powered chargers at depot locations. This will charge the electric HGVs faster, allowing for greater vehicle utilisation but coming at a much higher infrastructure cost and demanding a higher peak power demand from the electrical grid.

Method(s)

The project will be delivered in 3 main phases, with each phase split into consecutive sub tasks.
Work stream 1 will involve a literature review including research on HGV operation, uptake and projected future trends. This will then be used for a segmentation exercise in preparation for the modelling work stream. Relevant data sets identified in the work stream will also be fed into the demand model and profiles.
A stakeholder engagement workstream will be run in parallel to gather additional insight from key industry stakeholders. This will be carried out through surveys and stakeholder interviews; with the findings and analysis summarised in a stakeholder engagement report.
The final workstream will involve demand modelling and profiling. An initial stock model will be developed and then modified to include vehicle activity and energy consumption, charging profiles and geographical mapping identified in work stream 1. Modifications will also be made to ensure the model outputs are consistent with the stakeholder feedback identified in work stream 2. The final product will be validated and handed over to NESO for implementation into BaU.

Scope

The scope of this project includes the assessment and modelling of the future impact of HGV charging on the GB energy network. The aim is to create realistic within day profiles for the future GB electric heavy-goods vehicles (HGVs) fleet. This will be achieved in three main phases:

- Desk top study of HGVs, their travel patterns and the likely uptake of electric HGVs summarised into a literature review report.
- Extensive stakeholder engagement of HGV operators and wider industry stakeholders to understand constraints to smart charging and their likely price sensitivity. A stakeholder survey and targeted stakeholder interviews will be held over the first 3 months of the project, analysis of the results from these will then be used to modify and validate the final model.
- Production of a model outputting the within day electricity demand profiles of electric HGVs and their capability to shift their load.

Objective(s)

- To understand the GB HGV operator likelihood to smart charge, under different use cases and duty cycles, and also understanding the price signals required for operators to uptake smart charging.
- Modelling of the in-day charging profiles for different operator segments and vehicle types at each charging location, and how this scales up to the GB level fleet as a whole.
- To understanding the opportunity for smart/managed charging at the different charging locations, and what this overall opportunity looks like at a GB level.
- To understand the scope for demand matching supply and DSR vs electrolysis.

Consumer Vulnerability Impact Assessment (RIIO-2 Projects Only)

NESO does not have a direct connection to consumers, and therefore is unable to differentiate the impact on consumers and those in vulnerable situations

Success Criteria

- Output of the defined python-based model or a spreadsheet producing the required inputs to Plexos and to enable periodic/ updates and sensitivity testing.

- Stakeholder engagement framework clear, with partners across the energy industry identified and actively engaged

Project Partners and External Funding

,No external funding

Potential for New Learning

- A step change in understanding of HGVs system impacts, moving the EIA Road Transport team towards its strategic goal of being GB leaders in the within day system impacts and flexibility of future demand.
- Outputs which can quickly be captured in NESOs network investment assessment processes (Future Energy Scenarios, Electricity Ten Year Statement & Network Options Assessment – Soon to be Centralised Strategic Network Plan).
- Having spoken to the Department for Energy Security and Net Zero and NGED, it is likely outputs will inform the modelling of other infrastructure planners

Scale of Project

This project will be delivered in three work packages and will span 9 months.
The project covers projections for future low carbon HGV uptake and usage profiles from research and stakeholder engagement. All aspects of the study are of high value for the NESO energy network and system operation planning, while taking onboard key stakeholders input that is an essential part of NESO's requirements.

Technology Readiness at Start

TRL4 Bench Scale Research

Technology Readiness at End

TRL6 Large Scale

Geographical Area

This project has a geographical scope of Great Britain.

Revenue Allowed for the RIIO Settlement

None

Indicative Total NIA Project Expenditure

£250,000

Project Eligibility Assessment Part 1

There are slightly differing requirements for RIIO-1 and RIIO-2 NIA projects. This is noted in each case, with the requirement numbers listed for both where they differ (shown as RIIO-2 / RIIO-1).

Requirement 1

Facilitate the energy system transition and/or benefit consumers in vulnerable situations (Please complete sections 3.1.1 and 3.1.2 for RIIO-2 projects only)

Please answer **at least one** of the following:

How the Project has the potential to facilitate the energy system transition:

HGVs are very diverse commercial assets, and a deeper understanding of infrastructure is required to align with zero emission targets.
Whilst battery electric vehicles (BEVs) are anticipated to be the predominant technology for shorter distance/smaller vehicle urban and regional applications, both battery BEVs and fuel cell electric vehicles (FCEV) anticipated to play an important role for the largest vehicle categories, possibly in combination with dynamic charging via catenary (overhead line) systems on key routes. There is therefore a need to explore the potential impacts on the wider energy system of deployment of these vehicles into the GB fleet. Long-haul articulated battery electric trucks can have an energy consumption of ~1.5 kWh/km3, which results in around 490 kWh required per day (assuming annual activity is distributed across 260 working days) for long-haul battery electric trucks in GB.

Smart charging can be used to reduce peak demand by regulating the power delivered from the charger at times where the demand on the grid may be high (or based on pre-defined user preferences), therefore reducing the peak demand on the grid. For passenger cars, the majority of EVs are expected to/currently do park on a driveway overnight. Smart charging can be utilised in this case to provide electricity to the EV when the demand on the grid is low (and the price of electricity is cheap). For electric HGVs, the potential for smart charging is more complex. The operational cycles of the vehicles may mean that there are shorter windows for charging the vehicles (compared with passenger cars), and operators may wish to utilise their vehicles as much as possible. There are also the parking aspects to consider, with HGVs often parking in public spaces (such as truck stops) which may be more challenging to implement smart charging. There could however be a chance that HGVs park/charge during the day when energy demand is naturally lower, and therefore smart charging would not be of much benefit to the grid network.
Whilst there are a number of potential barriers to smart charging for electric HGVs, there is also an opportunity for operators to save cost on electricity. There will likely be a trade-off between retaining operational flexibility (through faster charging) and cost savings (through cheaper electricity prices at off-peak times) for operators to consider, which may change depending on the type of operations, types of vehicles, and size of the operator.

How the Project has potential to benefit consumer in vulnerable situations:

N/A

Requirement 2 / 2b

Has the potential to deliver net benefits to consumers

Project must have the potential to deliver a Solution that delivers a net benefit to consumers of the Gas Transporter and/or Electricity Transmission or Electricity Distribution licensee, as the context requires. This could include delivering a Solution at a lower cost than the most efficient Method currently in use on the GB Gas Transportation System, the Gas Transporter's and/or Electricity Transmission or Electricity Distribution licensee's network, or wider benefits, such as social or environmental.

Please provide an estimate of the saving if the Problem is solved (RIIO-1 projects only)

N/A

Please provide a calculation of the expected benefits the Solution

N/A as this is a research project

Please provide an estimate of how replicable the Method is across GB

This project will cover HGV use across all of Great Britain.

Please provide an outline of the costs of rolling out the Method across GB.

TThe implementation of the model will not necessitate any additional investment.

Requirement 3 / 1

Involve Research, Development or Demonstration

A RIIO-1 NIA Project must have the potential to have a Direct Impact on a Network Licensee's network or the operations of the System Operator and involve the Research, Development, or Demonstration of at least one of the following (please tick which applies):

☐ A specific piece of new (i.e. unproven in GB, or where a method has been trialled outside GB the Network Licensee must justify repeating it as part of a project) equipment (including control and communications system software).

☐ A specific novel arrangement or application of existing licensee equipment (including control and/or communications systems and/or software)

☐ A specific novel operational practice directly related to the operation of the Network Licensees system

☐ A specific novel commercial arrangement

RIIO-2 Projects

☐ A specific piece of new equipment (including monitoring, control and communications systems and software)

☐ A specific piece of new technology (including analysis and modelling systems or software), in relation to which the Method is unproven

☑ A new methodology (including the identification of specific new procedures or techniques used to identify, select, process, and analyse information)

☐ A specific novel arrangement or application of existing gas transportation, electricity transmission or electricity distribution equipment, technology or methodology

☐ A specific novel operational practice directly related to the operation of the GB Gas Transportation System, electricity transmission or electricity distribution

☐ A specific novel commercial arrangement

Specific Requirements 4 / 2a

Please explain how the learning that will be generated could be used by the relevant Network Licensees

Through engagement with DESNZ and NGED, outputs of this project are likely to inform the modelling of other infrastructure planners.

Or, please describe what specific challenge identified in the Network Licensee's innovation strategy that is being addressed by the project (RIIO-1 only)

N/A

Is the default IPR position being applied?

☑ Yes

Project Eligibility Assessment Part 2

Not lead to unnecessary duplication

A Project must not lead to unnecessary duplication of any other Project, including but not limited to IFI, LCNF, NIA, NIC or SIF projects already registered, being carried out or completed.

Please demonstrate below that no unnecessary duplication will occur as a result of the Project.

Currently, there is no project focused on developing a model that can generate the required inputs for NESO to use in Plexos and allow for periodic updates or sensitivity testing.

If applicable, justify why you are undertaking a Project similar to those being carried out by any other Network Licensees.

N/A

Additional Governance And Document Upload

Please identify why the project is innovative and has not been tried before

This project will bring in new skills and techniques into transport forecasting. The ESO is looking to align how forecasting is looked at on the operational front and exploring the potential next phase of reviewing the forecasting data used within Network Planning.

There is currently no significant current or historical data on electric HGV charging, the within day demands of electric HGVs and their ability to load shift.

Relevant Foreground IPR

A final report identifying the research findings.
WS1: HGV initial segmentation and research report
WS2: Stakeholder Engagement Report
WS3: HGV Demand Model

Data Access Details

Data for this project and all other projects funded under the Network Innovation Allowance (NIA), Network Innovation Competition (NIC) or the new Strategic Innovation Fund (SIF) can be found or requested in a number of ways:
A request for information via the Smarter Networks Portal at https://smarter.energynetworks.org, to contact select a project and click 'Contact Lead Network'. NESO already publishes much of the data arising from our innovation projects here so you may wish to check this website before making an application.
Via our Innovation website at https://www.nationalgrideso.com/future-energy/innovation
Via our managed mailbox innovation@nationalgrideso.com
Details on the terms on which such data will be made available by NESO can be found in our publicly available "Data sharing policy relating to NIC/NIA projects" at https://www.nationalgrideso.com/document/168191/download.

Please identify why the Network Licensees will not fund the project as apart of it's business and usual activities

Given there is no existing programme in the energy sector of this kind, and the need for HGV data is crucial and relatively new, it comes with innovation risk.

Please identify why the project can only be undertaken with the support of the NIA, including reference to the specific risks(e.g. commercial, technical, operational or regulatory) associated with the project

The project can only be undertaken with the support of the NIA due to several specific risks and challenges associated with the commercial, technical, operational, and regulatory aspects. Commercially, the project involves significant costs related to the installation of charging infrastructure, especially higher-powered chargers, which are substantial and require financial support to mitigate underfunding risks. Additionally, market uncertainty regarding the adoption rate of zero-emission vehicle technologies (BEV, FCEV, ERS) affects the project's economic viability, making NIA funding essential to absorb financial uncertainties. Technically, developing accurate models to predict the energy consumption of GB's future HGV fleet is challenging and requires advanced modelling techniques and comprehensive data. The project also needs to integrate outputs into NESO's processes (such as Plexos) for periodic updates and sensitivity testing, demanding technical expertise and robust validation to ensure accuracy and reliability.

Operationally, the project faces challenges like significant grid reinforcement and upgrades to support the increased energy demand from electric HGVs, particularly at high-powered charging locations, which requires careful planning and substantial investment. It also involves planning for various charging scenarios (depot charging, opportunity charging, MSA charging), each with different operational requirements and implications for vehicle utilisation and grid impact. Regulatory risks include ensuring compliance with the UK Government's commitment to achieving zero emissions for all new HGVs by 2040 and managing evolving regulations and standards. The project involves collaboration with multiple stakeholders, such as the Department for Energy Security and Net Zero (DESNZ) and National Grid Electricity Distribution (NGED), necessitating effective coordination and regulatory compliance. In summary, NIA support is crucial to mitigate these risks by providing necessary funding, technical expertise, and stakeholder collaboration to ensure successful implementation and lasting value to NESO's processes and stakeholders.

This project has been approved by a senior member of staff

☑ Yes