

SIF Project Registration

Date of Submission

Mar 2022

Project Reference Number

10027315

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Project Title

Rail Decarbonisation Planning

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10027315

Project Licensee(s)

Northern Gas Networks

Project Start

March 2022

Project Duration

2 Months

Nominated Project Contact(s)

DGill@northerngas.co.uk

Project Budget

£124,994.00

Project Summary

This project will develop both an overarching implementation strategy and a methodology to enable the ongoing deployment of the most effective, efficient, and appropriate technological solutions to decarbonise rail transport.

Our approach will lead to a shared implementation plan that will enable electricity and gas networks to factor in rail decarbonisation when they are planning their own infrastructure investments.

TDNS: Through the production of the TDNS, Network Rail already has a strong starting point. However, a key weakness of the current TDNS is that it does not consider the capacity or role of existing and emerging electricity and gas network infrastructure to deliver rail decarbonisation.

Our project will address this. Our analysis will lead to a TDNS implementation strategy and methodology to support decision making on rail decarbonisation options. Our methodology will consider current constraints in the hydrogen/electricity systems and identify the steps needed to overcome these.

Rail Operator Use: Ultimately, our methodology will allow rail operators to identify the parameters, criteria, and recommendations for decarbonisation of specific parts of the rail network. This would identify whether electrification, hydrogen or a combination of both, is the most effective way to deliver decarbonisation of different parts of the rail infrastructure.

Energy System Use: Our implementation plan will identify how the rail decarbonisation can better integrate as part of a wider energy systems approach. For instance, informing the location of future hydrogen filling facilities in locations that intersect between rail transportation and road haulage or enabling energy balancing services through hybrid systems

Project Partners and Supporters: Our project consists of partners from a range of sectors, along with expert consulting organisations. This creates a strong consortium which will help operationalise the plan through using it within their decision-making processes.

Impact: This innovation is essential for the successful decarbonisation of the rail sector. The project will support the decision making of rail infrastructure owners and operators and electricity and gas networks. Ultimately it will benefit both consumers of rail services and energy services by enabling reliable, low carbon transport for all.

Beta Phase: If progressed to the Beta phase, our intention is to pool investments from within the rail sector to demonstrate the technology along a selected line, potentially building a hybrid electric/hydrogen demonstration facility/project.

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Problem Being Solved

The UK Government, as part of its pathway to net zero, has developed a Transport Decarbonisation Plan (2021)

([https://northerngas.sharepoint.com/sites/innovationteam/Shared%20Documents/SIF/2021/1.SIF/202168%20EA%20Technology%20and%20Frazer%20Nash%20Consulting%20Rail%20decarbonisation%20planning/Final%20submission%20documents/SIF%202021%20Discovery%20-%20Rail%20Decarbonisation%20\(FINAL\).docx#_ftn1](https://northerngas.sharepoint.com/sites/innovationteam/Shared%20Documents/SIF/2021/1.SIF/202168%20EA%20Technology%20and%20Frazer%20Nash%20Consulting%20Rail%20decarbonisation%20planning/Final%20submission%20documents/SIF%202021%20Discovery%20-%20Rail%20Decarbonisation%20(FINAL).docx#_ftn1))[1]. This plan sets out the necessity to decarbonise rail transport. For this to happen there is a need to remove all diesel-only trains from the network by 2040. This will only happen if there is an overarching strategic approach to identifying the most appropriate technology to be deployed for specific parts of the rail network.

Electrification: The main strategy for achieving net-zero will be the electrification of existing track. This will enable the use of renewable electricity for passenger and freight trains.

However, one of the key challenges is that this alone will not achieve decarbonisation of rail transport. This is because, although electrification will be achievable on some sections of the network, it is widely recognised that in some areas, particularly rural and remote areas, electrification may not be possible.

Alternative Technologies: This is why the Transport Decarbonisation Plan also identifies the need to develop alternative technologies such as the development of hydrogen and battery trains to achieve complete decarbonisation of rail.

Challenge: There is currently no consistent mechanism for identifying the most appropriate, cost effective, and carbon efficient technology for any specific section of the network that

takes into account the availability of electricity or hydrogen along the route. This is a critical issue which will impact on the solutions available for specific parts of the network. This current lack of an effective methodology, owned by the rail industry and energy stakeholders, is the key problem that this project will seek to address.

Work to Date: Network Rail as part of a wide group of rail industry stakeholders has already developed its Traction Decarbonisation Network Strategy (TDNS). This already provides recommendations on which technology to deploy on each route. However, the TDNS has been developed without a mechanism to ensure that the energy infrastructure to support those solutions is in place. To achieve this requires collaboration and co-creation between rail networks and major energy stakeholders.

Opportunity: To support the full decarbonisation of the rail industry there needs to be a coordinated planning process to identify the appropriate decarbonisation technology within the wider context of issues such as availability of energy along rail routes. For instance, this could identify challenges around electricity network capacity and hydrogen refilling opportunities and how the use of these technologies may enable other opportunities

Project Approaches And Desired Outcomes

The Big Idea

Aims: This project will directly support the growth of low carbon rail, integrate multi-modal and multi-vector energy supplies, and enable low carbon long haul rail solutions. It will improve coordination of emerging innovations across networks, generators, consumers, and other key stakeholders.

Carbon Reduction: To achieve net zero 2050 the UK needs to decarbonise transportation whilst ensuring that consumers still have access to reliable, cost-effective transportation. Electrification of transport is one solution but is not suitable in all situations, particularly for rural routes. Alternative technologies are needed (hydrogen, battery power), but these require the energy infrastructure to support them. Decision making about energy infrastructure and rail decarbonisation need to be more closely aligned. Developing a mechanism to achieve this is the primary project aim.

Solution: Our project will bring together the work to date across the three core sectors (rail, gas and electricity) and synthesise into a clear roadmap and implementation plan that helps identify barriers and solutions to decarbonisation of rail. The project involves a wide range of partners with the reach and networks to ensure that the identified solutions can be implemented.

Deliverable: Key project outputs will be an implementation plan, a methodology, and a toolkit (during the Alpha Phase) that combine the requirements of rail infrastructure and owners and energy networks in order to simplify collaboration across the sectors and support decision making. This will build upon existing work and technology developed by EA Technology and Frazer-Nash. The toolkit would:

- Identify whether specific routes are best served through electrification or conversion to hydrogen.
- Factor in a range of inputs to support investment decisions around the distribution network or hydrogen delivery.
- Identify routes where electrification is the only option (because hydrogen capabilities are insufficient) and routes where hydrogen is needed (because there is no realistic likelihood of electrifying the route).
- Identify locations where battery support systems will be required to supplement the OHL rail network, or to provide a level of top up charging for battery trains.
- Determine the best locations for these given the available land and distribution network restrictions.

In combination, this would allow a CBA to be undertaken on each route providing a recommended order of investment to maximise return for implementation cost, and passenger benefits.

Future Phases: The Alpha Phase may also develop more detailed local area roadmaps and system designs. The Beta phase would seek pooled investment to develop a potential demonstrator project.

Innovation Justification

The Government has committed to the decarbonisation of the GB rail infrastructure by 2040. The approach to achieve this is detailed in the Transport Decarbonisation Plan and supporting material in the William-Shapps Plan for Rail.

Cross-sector Collaboration: Translating these commitments into BAU delivery requires new thinking, new approaches, and new tools. This cannot be achieved without effective coordination between Network Rail and energy infrastructure providers across gas and electricity. This collaborative approach is at the heart of our project. This is because, at present, responsibility for delivery sits across a number of different organisations and sectors. The BAU for all involved organisations involves looking at only one aspect of developing and implementing solutions. This is why additional funding and support is required for a process that creates collective ownership of the challenges and solutions.

Current Approaches: Current strategies and approaches have taken a top-down approach to rail decarbonisation. This essentially takes a three-step approach: *Complete electrification of existing main routes

- Electrify other lines where technically and financially beneficial
- Consider the use of batteries or hydrogen everywhere else The weakness of this approach is that these decarbonisation plans have been established without consideration of the existing electricity networks, potential barriers and opportunities for hydrogen refuelling or wider infrastructure requirements. Our innovation will lead to a standard BAU methodology to support detailed options appraisals for electrification, hydrogen or battery-based solutions across the rail network.

Existing Solutions: Key to our project is to learn from approaches taken in other areas. Project partner, EA Technology, has already developed the ConnectMore tool. ConnectMore takes details of the local electricity distribution network and overlays a transport layer. This tool was originally developed for the purposes of identifying optimum electric vehicle charging locations taking into consideration road usage and electricity network constraints. In addition, Frazer-Nash have worked with Northern Gas Networks and RSSB previously to develop digital twin and machine learning models aiming to decarbonise road and rail fleets. Further details on this tool are included in the Annex. Learning from these and other tools shall be utilised and built upon to be made specific for this challenge. Research gaps: To achieve this, our project will take a deep dive into the current constraints and barriers that Network Rail and energy networks face. It will then take learning from the ConnectMore tool, and adapt it to meet the needs of both the rail and energy sectors.

Project Plans And Milestones

Project Plan And Milestones

The Discovery Phase has two main work packages.

WP1 - Baseline Assessment:

The first work package shall bring together and summarise the work already completed in each core sector (rail, gas and electricity) and assess its relevance to the rail sector with a particular focus on rural / challenging to decarbonise routes. It will focus on three key areas of investigation:

WP1a: Consolidate decarbonisation work within the rail sector and highlight gaps in the context of energy requirements.

WP1b: Map current and emerging hydrogen supply chains in the contexts of rail and wider transport decarbonisation.

WP1c: Identify key barriers, constraints, and opportunities for the electricity sector to support electrification of the rail industry.

Milestones: WP1 will result in three short reports covering:

***Context:** Work to date in each area.

Gaps: Research gaps that require filling to join up the work across each sector.

Requirements: Future requirements that would need to be filled to ensure that the rail sector can decarbonise in a timely and coordinated manner.

WP2 - Roadmap: The second work package shall synthesise these reports into a consolidated 'road map' report outlining an implementation plan for achieving the project goals and detailing the required work in future Alpha and Beta Phases.

This road map report will identify:

- A way forward based on the outputs of WS1a-WS1c for the appropriate development route to accelerate rail decarbonisation. This will take into consideration the electricity and gas network challenges and opportunities.
- The logistical, funding, and regulatory requirements for consortium partners developing and delivering a demonstrator project.

Milestones: WP2 will result in:

- A road map report.
- A way forward report.

Final Deliverable: Taken together the two reports will be synthesised into a final report and implementation toolkit. This will assess the current context, assess current activity in this area, and make clear recommendations for the next phase of activity. This will include recommendations and initial discussions with project delivery partners, leading to multiple potential future workstreams.

Risks and constraints

There are no major foreseeable risks for the project from a delivery perspective. However, risks and constraints that may limit the success of the project might include:

- Inability to secure time of key sector personal.
- Unavailability of data and unexpected gaps in current research.
- A more detailed work breakdown structure and risk summary are attached.

Route To Market

The primary outcome of this discovery phase will be an implementation plan setting out practical steps that rail networks and energy networks can take to align infrastructure investment in way that will deliver decarbonisation of rail. Following Discovery Phase, our route to market will take a twostep approach:

*The Alpha Phase will develop practical implementation tools and more detailed local area roadmaps and system designs.

*The Beta phase would seek pooled investment to develop a demonstrator project. In the case of hydrogen or/and battery powered trains, this demonstrator will stimulate the market and identify where hydrogen/battery technologies present a viable option where it has been determined that electrification is not appropriate.

Taken together, these steps will provide a tested and evaluated approach to support future investment decisions. Mainstream Adoption: Following the Beta phase we will have a proven planning tool that is able to rank the most appropriate decarbonisation options for different parts of the rail networks. This will factor in local rail infrastructure, utilisation forecasts, and distribution and transmission networks in the region. The wider scale roll out of this tool would be achievable through engagement with the other networks.

Routes to Market: Once the Beta phase generates proof of effectiveness, then rapid industry adoption as BAU will take place. The key adopter will be project lead Network Rail, as the owner and infrastructure manager for the railway network in Great Britain. Network Rail already has developed the TDNS as a strategy to support decarbonisation as a mainstream part of its work. This innovation will provide a practical toolkit that supports the effective implementation of that strategy in a way that is aligned with other infrastructure investment.

Other project partners will also play a key role in ensuring adoption, in particular Northern Gas Networks and UK Power Networks. This would be further supported with regional stakeholder engagement as potential areas are identified.

Wider Impacts: Although this tool is specifically focused on decarbonisation of rail transport, our project will generate learning that is relevant to other sectors. In particular, as an infrastructure for hydrogen is developed, other users and industries will need to ensure that there is a fit with their own business requirements and location. Our tool could potentially be adapted to support their decision making.

Costs

Total Project Costs

124944

SIF Funding

113594

This project has been approved by a senior member of staff

Yes