SIF Round 4 Project Registration

Date of Submission

Jun 2025

Project Reference Number

10158670

Initial Project Details

Project Title

Conductor

Project Contact

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Challenge Area

Faster network development

Strategy Theme

Optimised assets and practices

Lead Sector

Electricity Distribution

Other Related Sectors

Electricity Distribution

Project Start Date

01/05/2025

Project Duration (Months)

3

Lead Funding Licensee

UKPN - South Eastern Power Networks Plc

Funding Licensee(s)

UKPN - South Eastern Power Networks Plc

Funding Mechanism

SIF Discovery - Round 4

Collaborating Networks

UK Power Networks

Technology Areas

Low Carbon Generation

Control Systems

Demand Response

Distributed Generation

Photovoltaics

Energy Storage

Project Summary

Traction Bulk Supply Points are large capacity grid connections designed to support peak demand on the rail traction system. Because traction power is typically very peaky in nature this capacity is not optimally utilised. Installing battery storage facilities at traction BSPs and unlocking connection agreements to enable two-way dynamic flow could shift rail energy demand away from peak periods, unlocking capacity for other customers; support regional balancing of supply and demand; fulfil unmet demands for flexibility services in areas with network constraints; and increase the commercial scope for new tractionconnected generation capacity, replacing curtailment with load shifting and export capability.

Add Third Party Collaborator(s)

Energy Systems Catapult

Riding Sunbeams Apollo Ltd

Project Budget

£153,894.00

SIF Funding

£138,894.00

Project Approaches and Desired Outcomes

Animal testing

- ○ Yes
- ◉ No

Problem statement

One cost-effective way to accelerate new connections (Challenge 1) while avoiding expensive network upgrades is to optimise the use of existing large connections, potentially releasing latent capacity back into the distribution network. This could then be used to meet future low carbon demand or generation needs. To achieve this optimisation, a range of system challenges – both technical, regulatory and commercial -- will need to be overcome.

A particularly promising opportunity lies in the distribution network of South East England is the 33 existing rail Traction Bulk Supply Points (T-BSPs) across Network Rail's (NR) Southern Region's DC traction system, with 20 connected to UKPN. In 2019/2020 around 1.43 TWh flowed across these 33 T-BSPs with exclusively one way power flow.

Many of these T-BSPs are connected to network areas where there is growing demand for flexibility services, and the physical capacity of the connections means they could be attractive assets to enlist in regional balancing efforts. Just three TBSPs supplying the busy London to Brighton mainline have a combined capacity of 115MVA.

In 2019, Riding Sunbeams measured one of the feeders supplied from the Eastbourne T-BSP, which demonstrated how traction power is typically very peaky in nature. Huge capacity exists that is not efficiently used and could be better used to support the network elsewhere. Meanwhile, the commercial scope for embedded solar PV generation for self-supply on the rail network is needlessly limited by the lack of integrated storage or permission to export from T-BSPs, meaning any surplus yield must be curtailed.

The vision for BaU is to enable rail demand flexibility by installing large scale battery storage facilities at T-BSPs and offer:

1. Load shifting and peak shaving capabilities to the traction energy client,

2. Increased liquidity of flexibility markets for DNOs to access,

3. Release of capacity to the DNO,

4. Enabling export of surplus solar yield through power conditioning – supporting much more solar PV capacity to be connected to the traction network on commercial terms.

Video Description

https://www.youtube.com/watch?v=6qWL7xmUJ_M

Innovation justification

As one of the UK's largest electricity consumers, railways should participate in flexibility markets as given their scale, they offer significant benefits. The challenge is overcoming unique barriers preventing T-BSPs from becoming flexible. The Southern Region (DC-railway) is the densest part of the GB electrified rail network, consuming around one third of all traction electricity used by NR.

This project addresses the challenge of transforming non-flexible demand into dispatchable and dynamic demand, releasing capacity across the network and enabling faster demand and generation connections (SIF R4 Challenge 1). This differs from the existing SIF HUBs project, which designs power electronics for charging battery electric trains where grid capacity is limited.

For dynamic power electronics on the DC rail system, we estimate to be -- IRL3; CRL4; TRL3. These levels will be investigated during Discovery but will likely not change until future phases.

Appropriately designed battery storage assets can minimise peaks and troughs from rapidly changing traction demand and provide reactive power compensation to manage the power factor. Railway demand cannot be made flexible without either adding generation or storage to the railway system, although power quality issues on the DC networks means this is not currently possible.

The potential uses cases, financial value and internal business case for lineside storage on GB railways remain unassessed. NR's Southern Region has a live R&D project exploring DC-third-rail-connected flywheel storage for regenerative braking, which this project will build on.

A potential commercial barrier for optimising T-BSPs may be the need to modify legacy connection agreements, which can be over 70 years old and certainly never envisaged these demand assets as bi-directional nodes in a flexible system.

NR has little experience facilitating dynamic grid interactions using their infrastructure to provide non-rail services to the wider energy system. Currently NR is remunerated for electricity export from regenerative braking under their main traction power supply contract (classed as de minimis activity), though this applies to BSPs supplying AC traction systems, not the DC traction system.

Progress on the potential of utilising the DC rail system flexibly has previously been unfocussed and not considered whole system benefits. A new approach is required to quantify these and demonstrate the aggregated benefits for consumers of both rail and electricity.

Impacts and benefits selection (not scored)

Financial - future reductions in the cost of operating the network

Financial - cost savings per annum on energy bills for consumers

Environmental - carbon reduction – direct CO2 savings per annum

Environmental - carbon reduction – indirect CO2 savings per annum

Impacts and benefits description

The pre-innovation baseline is that the capacity in the rail network continues to be utilised inefficiently with peaks and troughs throughout the day. As the communities around these BSPs decarbonise, they will increase the electricity demand in their region and could be faced with high-cost and time-consuming reinforcement to the network. The potential to shift load on the railway will not be utilised.

Unlocking connection agreements, Conductor will enable two-way dynamic flow across T-BSPs could also support regional balancing of supply and demand within the higher voltage networks. This will increase the amount of flexibility fulfilling unmet demands for flexibility services.

Financial - future reductions in the cost of operating the network

Adding storage assets to NR's T-BSPs will reduce peak demand. Through flexibility services the need for network capacity reinforcement will be reduced. During peak demand periods, NR can supply electricity to the distribution network, releasing

capacity and helping balance the load. This benefit will be tracked by measuring avoided and deferred reinforcement costs.

Financial - cost savings per annum on energy bills for consumers

Lower costs of upgrading the infrastructure and operating the network will reduce the network cost element of consumer bills. This will be tracked by annual customer bill savings.

Environmental - carbon reduction -- direct CO2 savings per annum

Optimising installation of lineside renewables could enable faster and cheaper rollout of low carbon train operations, should rail ways adopt ownership of these assets, therefore achieving immediate reduction in direct CO2 emissions. This will be measurable through tonnes CO2 reduction per annum.

Environmental -- carbon reduction -- indirect CO2 savings per annum

Conductor will unlock new flexibility enabling more potential for storage and PV to be connected, and connected faster. . The increase of storage within the distribution network could enable more demand to be met by locally produced renewable electricity therefore indirectly reducing the CO2 of electricity consumption. A greater utilisation of renewables reduces CO2 impact of electricity generation. This will be measurable through tonnes CO2 reduction per annum.

Teams and resources

UKPN is the UK's largest electricity distributor delivering power to 8.5 million customers across the South East of England. UKPN is responsible for owning and maintaining the cables and assets in their licence area.

Role: UKPN has a proven track record of delivering SIF projects and will be responsible for overall project management and dissemination of information across the industry

Riding Sunbeams are world-leading net-zero innovators with expertise in connecting PV directly to rail traction systems, providing clean energy to power trains and bankable Power Purchase Aggreements to underwrite capital investment in new solar. They have collaborated closely with NR to develop connection solutions for solar to supply railways. They have a good working knowledge of UK traction power systems, their operational constraints and priorities, and strong professional networks in the sector.

Role: Riding Sunbeams will identify key stakeholders and their requirements, barriers and benefits; draft an engagement plan and secure in principle support for later stages; lead on establishing requirements for simulations and power quality assessments; identify what data is available, and what relevant assessments/modelling are already undertaken. Working with traction power specialist EneRail, they will establish parameters for the control system needed for a rail-embedded batteries facility to interact with both the grid and the traction power system and define any unique technical features of T-BSPs.

Energy Systems Catapult (the Catapult) was set up to accelerate the transformation of the UK's energy system and ensure UK businesses and

consumers capture the opportunities of clean growth on the way to Net Zero. The Catapult has unique modelling expertise across the whole energy system.

Role: The Catapult will be responsible for a market assessment, project research, identifying the options for unlocking flexibility from behind the meter and evaluating whole systems benefits.

EneRail, a Birmingham University spin-out company, commercialises traction power system models. It recently completed work for NR developing models to explore the use of renewables and energy storage for powering lineside infrastructure and support

traction power.

Role: EneRail will be responsible for reviewing the grid connection characteristics between UKPN and NR; identifying requirements for simulation/power quality assessment; investigating existing data needed for assessments and modelling; developing high-level requirement for control system and determining the flexibility potentials.

Project Plans and Milestones

Project management and delivery

Project management will be led by UKPN using standard best practice methods and tools, including regular management meetings and status reporting. UKPN has an effective innovation governance procedure with robust financial and project controls in place. UKPN, RSA, ESC and EneRail are all ready to swiftly mobilise teams and have support from senior decision makers for this project.

The Discovery work packages proposed are:

WP1: Project Management (UKPN)

Aims: Deliver the project on time, to budget, ensuring that project objectives and learnings are successfully achieved.

Success criteria: Project delivered on time, to budget and to quality.

WP2: Market Assessment (ESC)

Aims: Investigate international examples of similar solutions and/or projects

Success criteria: Market assessment that identifies learning and barriers for behind the meter connection of generation and storage.

WP3: Stakeholder engagement (Riding Sunbeams)

Aims: Map and engage stakeholders. Understand scale of problem, challenges and opportunities.

Success criteria: Key stakeholders mapped and engaged. Scale of problem and opportunity better understood

WP4: Technical Optioneering (Riding Sunbeams)

Aims: Develop outline modelling approach to be applied in Alpha Phase.

Success criteria: Outline modelling approach defined.

WP5: Whole system benefits (ESC)

Aims: Develop Cost Benefit Analysis (CBA) for several whole system planning scenarios.

Success criteria: CBA agreed by relevant stakeholders.

Interdependencies between work packages and milestones are detailed in the Gantt Chart. The project will use a standard risk management approach where the Risk Register generated will be regularly maintained and reviewed by the project partners. The project has identified several risks as well as associated mitigations

Key risks and mitigations include:

Risk: NR are reluctant to negotiate changes to the legacy connection agreements

Mitigation: NR representative is supporting this project and has been involved in scoping. Dedicated WP relating to Stakeholder Engagement will focus on building networks between NR and the project team to ensure that outputs are useful and deployable within NR as well as UKPN

Risk: A project partner or subcontractor withdraws from the project,

Mitigation: Build strong relationships now with benefits to all parties to ensure less motivation to withdraw.

We do not anticipate any planned or potential unplanned supply interruptions for consumers given the nature of the project.

Key outputs and dissemination

The objectives of Conductor are to demonstrate that installing battery storage facilities at T-BSPs and unlocking connection agreements to enable two-way dynamic flow could:

· shift rail energy demand away from peak periods

· unlock capacity for other customers;

· support regional balancing of supply and demand;

· fulfil unmet demands for flexibility services in areas with network constraints; and

· increase the commercial scope for new traction-connected generation capacity, replacing curtailment with load shifting and export capability.

The Discovery phase will undertake a feasibility study that will define the scale of the problem statement, undertake stakeholder mapping and initial engagement to understand and influence decarbonisation strategies of NR, develop a framework to estimate the value of solving the challenge, and prepare stakeholders for later stages of the project.

Key outputs from Discovery include

WP2: Market Assessment

· Review of previous projects from both the UK and Internationally to identify learnings relevant to Conductor.

· Exploration of the opportunities and barriers for the connection of behind the meter generation and storage.

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WP3: Stakeholder Engagement

· Problem statement details, and stakeholder mapping along with the interests, challenges and opportunities to decarbonise.

WP4: Technical Optioneering

· Review grid connection characteristics

WP5: Whole System Benefits

· High-level cost benefit analysis, including decarbonisation scenarios

The outputs will be made available at the end of Discovery, via a combined final report summarising the key learnings.

Knowledge Dissemination

· The Conductor partner team will collaborate to deliver the dissemination activities. We intend to leverage the connections of our consortium to effectively disseminate our learnings:

· UKPN will look to share project successes and learnings via its social media channels with the possibility of publishing external media where appropriate;

· Engagement with stakeholders identified during Discovery ecosystem mapping, sharing learnings and insights from Conductor; and RSA and ESC's networks: will leverage their networks and contacts to disseminate the outcomes ensuring wide reach and impact.

All outputs will be made available to all networks and therefore does not undermine competitive markets.

Commercials

Intellectual Property Rights (IPR), procurement and contracting (not scored)

The project will follow the standard approach to IPR management as set out in the

SIF Governance Document Chapter 9.

This means:

Each Project Participant in the Project will retain all rights in and to its background IPR.

Each Project Participant shall own all Foreground IPR that it independently creates as part of the Project, or where it is created jointly then it shall be owned in shares that are in proportion to the work done in its creation. Where any Project Participant transfers any of its rights, title or interest in or to any Foreground IPR to any other person, for example, if the Project Participant is taken over by another legal entity, it shall only do so where the assignee/transferee agrees to comply with these default IPR conditions. A Funding Party can only transfer any of its rights, title or interest in or to any Foreground IPR to any other person, subject to having regard to the true commercial value of the IPR; and the assignee/transferee agreeing to comply with these default IPR conditions.

We will capture this approach and agreement to follow it in a project collaboration

agreement following award of funding.

For Discovery, Riding Sunbeams are subcontracting EneRail for the technical

feasibility and design work. Because of the size and scope of the work, this could

be directly awarded and arranged prior to the project start so there is no

procurement activity to take place during the project.

Investment Needs

COF-IPS-05 Green Valley Lines

In 2021 the Rail Safety and Standards Board (RSSB) funded a £110,000 feasibility study exploring potential for solar and storage integration to the AC traction power system on the newly electrified Core Valley Lines in Wales.

RIDING SUNBEAMS: FIRST LIGHT

In 2019 UKRI provided £349,514 of funding to a Small Business Research Initiative project to deliver a demonstrator project for solar PV to directly supply the rail traction system on Network Rail's DC Southern Region.

Energy Control System for Energy Storage and Renewables

Since 2022 the Department for Business and Trade in the UK Government in partnership with Innovate UK has been funding the competition inviting teams to propose, deliver and demonstrate innovations in railway construction. This £505,000 project aims to develop a lab-based demonstration to test the feasibility of connecting renewable energy and energy storage to a railway traction

substation for Global Centre of Rail Excellence (GCRE) railway site. As part of this programme RSA has been developing an exploitation plan which includes a global

state of the art assessment and market sizing for storage integration on trams and

light railway. The project will conclude in March 2025.

Value for money

The Discovery phase of the project will cost £153,894 in total and the total SIF

funding requested is £138,335. This is balanced across the project partners as

follows:

UK Power Networks:

Total costs: £40,315

Total contribution: £4,200 (10%)

Total SIF funding request: £36,115

Riding Sunbeams (RSA) including EneRail:

Total costs: £47,179

Total contribution: £4,719 (10%)

Total SIF funding request: £42,460

EneRail's sub-contractor costs are £28,428

ES Catapult:

Total costs: £66,400

Total contribution: £6,640 (10%)

Total SIF funding request: £59,760

Conductor represents good value for the SIF investment because:

Over the last six years RSA has worked closely with NR, including engineers in the Electrification & Plant team at the Technical Authority as well as asset managers in the Southern Region, in assisting them to develop traction decarbonisation strategies and overcome the technical, commercial and operational barriers to sourcing traction energy from low carbon renewable

generators. Their prior innovation work on this frontier has led directly to this proposal and they bring a wealth of know-how around integration of distributed energy resources to traction power systems to this project. RSSB's new Rail Technical Strategy of industry priorities identifies the need for more work to "Assess the technical and economic viability of using lineside energy banks to complement traction power supply" on the critical path in their Low Emissions

Routemap to 2040. Similarly, NR's internal 'Transition to Renewables' (T2R) programme identifies the need to renegotiate legacy connection agreements and explore integration of storage solutions to manage mismatch between demand and embedded solar generation as key to achieving the programme's objectives. Our project can show how these latent needs can be met, paving the way for a pilot Smart Traction BSP and rollout of BESS across the Southern Region.

The Catapult has technical expertise offering insights on networks and energy storage from a whole systems perspective. This includes the impact of new technologies, developing and adapting infrastructure network strategies to enable cost effective energy delivery and examining the detailed interactions between energy storage and other means of providing energy system flexibility. The Catapult has access to a number of specialist practices who will support Conductor. The project will draw upon the Catapult's expertise from the Power Systems, Network and Storage and Business Model Innovation practices

Supporting documents

File Upload

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Documents uploaded where applicable?

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