SIF Round 4 Project Registration

Date of Submission

Jan 2025

Project Reference Number

10143004

Initial Project Details

Project Title

I-LAD (Innovating Losses Analysis and Detection) Discovery R4

Project Contact

Dot Revill

Challenge Area

Accelerating towards net zero energy networks

Strategy Theme

Optimised assets and practices

Lead Sector

Electricity Distribution

Other Related Sectors

Electricity Distribution

Project Start Date

01/02/2025

Project Duration (Months)

3

Lead Funding Licensee

SSEN - Southern Electric Power Distribution Plc

Funding Licensee(s)

SSEN - Southern Electric Power Distribution Plc

Funding Mechanism

SIF Discovery - Round 4

Collaborating Networks

Scottish and Southern Electricity Networks Distribution

Technology Areas

Measurement

Network Monitoring

Project Summary

Electrical Losses are the difference in the energy that enters the electrical network and that which reaches consumers premises. Without intervention losses are forecast to increase with increasing electrification. They not only directly impact on customer's bill and our carbon footprint, but losses due to theft often lead to serious safety incidents. Current methods of identifying and monitoring losses are outdated and inefficient. The I-LAD project will utilise modern data techniques to improve: automating and modernising losses data collection, identification and modelling, understanding of total losses landscape improving cross sector coordination of losses interventions automating ongoing losses monitoring and measurement.

Add Third Party Collaborator(s)

CGI

Frontier Economics

ScottishPower

Project Budget

£176,005.00

SIF Funding

£149,167.00

Project Approaches and Desired Outcomes

Animal testing

- ○ Yes
- ◉ No

Problem statement

The Innovating Losses Analysis and Detection (I-LAD) Project addresses Challenge 4 of R4 SIF - Accelerating towards net zero (...), with the Aim: Develop solutions to reduce efficiency loss in the GB electricity transmission and distribution system. Electrical losses are an unavoidable consequence of transferring energy across electricity networks, where they have financial and environmental impacts, and are forecast to increase significantly as we accelerate electrification of heat and transport. Typically, transmission and distribution losses account for between 5% - 8% of total distributed units, which Sustainability First estimates cost a typical household around £100pa. In terms of carbon, losses account for around 90% of a DNO's total Greenhouse Gas emissions. Whilst, DNOs have a license obligation to manage losses where reasonably practicable, challenges in identifying losses and delivering cost effective interventions limit what can currently be achieved. New data sources such as smart metering offer the potential to address some of these issues. Additionally, tackling losses requires greater coordination across the electricity supply chain involving generators, suppliers, network operators and regulators. Electricity losses are classified as either Technical Losses (TL) (resulting from the movement of electricity through our network) or Non-Technical Losses (NTL) (resulting from electricity accounting issues or theft). Whilst methods for calculating TL are better understood, current methods of identifying NTL are outdated, manual and very time consuming. Previous innovation projects focussed on reducing TL through improved technologies, however, there are currently no efficient methods of identifying and monitoring either type of losses. I-LAD aims to address this by: Automating and modernising losses data collection, identification and modelling Fully understanding total losses landscape (volume, source, type) Provide actionable insights to drive intervention Automating ongoing losses monitoring and measurement Initially, the Project will focus on applying a selection of techniques developed in the Smart Meter Innovations and Test Network (SMITN) with advanced network load models to assess the full losses landscape and isolate TL. The remainder will be assumed to be NTL, where further techniques will be developed to validate with additional data sources used to categorise these into subtypes. Modern data science techniques will then be used to automate and monitor levels
of both TL and NTL on enduring basis. Many different users will benefit from this new tool:
DNOs and Suppliers --improved monitoring and intervention ; Customers -- reduced impact on energy bill, Local Authorities etc -- unmetered supplies management, Police -- energy theft intervention.

Video Description

https://vimeo.com/1021780032?share=copy

Innovation justification

I-LAD addresses Challenge 4 - Accelerating towards net zero (...), specifically: Develop solutions to reduce efficiency loss (...).It's currently impossible to fully understand true level, location and source of losses across the energy systems, directly impacting on Customers' bills.TL, while inevitable, are directly dependant on demand at the time. Current technologies only allow for estimations of losses, making it challenging for DNOs to target losses reduction technologies effectively. While NTL are somewhat preventable, current identification methods are piecemeal, rely on 3rd party intelligence, use of tools like google maps and manual information exchange between all parties. Additionally, no tools exist to monitor all losses in real/near-real time. Improvement in losses management requires a radical new approach rather than refinement of existing processes. I-LAD proposes to address this by:

1.Developing novel approaches to automating and modernising losses data collection, identification and modelling: e.g., currently energy theft is difficult to detect, and even when it is, by the very nature of bypassing the meter, DNOs won't have a load profile dataset from a smart meter which can be used train a model. To address this, we will use techniques like synthetic data (where very small amount of "real" data available is used to generate "fake" examples of NTL

to train the model). Those techniques have been applied in other industries (e.g. fraud detection) but are untested in this context.

2.Fully understanding total losses landscape using model developed in item 1 create a new digital service allowing DNOs to automatically identify, model and record losses at a granular level through innovative use of Machine Vision, AI and Machine Learning and traditional analysis of network data.

3.Novel approach to losses governance: develop new data sharing options to address data privacy barriers (GDPR) and drive improved cross-sector collaboration. Improved visibility of losses will give better clarity on their sources and who is best placed to address them.

4.Automating losses monitoring and measurement: to evidence effectiveness of losses mitigation. This will be unique and will help reflect the dynamically changing network we expect during the energy transition.
Use of complex, sensitive data and novel data techniques is risky and innovative, making this project well suited to SIF criteria.
The project builds on previous technology and innovation with a reasonably high TRL level 6 and IRL level 4 with core innovation looking at processes and algorithms that could bring it to commercial readiness.

R4SIF_Discovery_ILAD_Appendix_FINAL.pdf

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

Financial - cost savings per annum for users of network services

Environmental - carbon reduction – direct CO2 savings per annum

Others that are not SIF specific

Impacts and benefits description

This project will deliver tools to identify, classify and monitor electricity losses more efficiently using novel data and modelling techniques, resulting actions and coordinated losses interventions, leading to measurable losses reduction at a higher level than is currently achieved. It's estimated that losses account for 5% - 8% of the total distributed units, costing a typical household around £100pa and accounting for around 90% of a DNO's total Greenhouse Gas emissions. Whilst already high, losses are expected to significantly increase in coming years from electrification of heat and transport, increasing volumes of low carbon technology altering and increasing power flows and heightened cost of living pressures impacting the levels of NTL. Although one of the key outcomes of this project will be full quantification of the possible value of benefits of improved losses identification and coordinated intervention methods, we know that a reduction in losses will provide two main streams of benefits: Financial: the greater the losses, the greater the costs to customers through their electricity bills. This is due to having to generate more electricity to cover losses.
Therefore, losses reduction will directly contribute to a relative reduction on customers' bills.
E.g., It is estimated that total annual losses due to theft across the networks are approximately 2.2TWh. The largest source of theft is believed to be cannabis farms, accounting for around 0.75TWh. A methodology which improved their detection allowing even 10% of them to be removed would save a staggering 75GWh. Using standard values in Ofgem's ED2 CBA this equates to a saving of over £4mpa, and nearly 20,000 tCO2 Environmental: The greater the losses, the greater the carbon emissions and environmental impact to society. This is due to losses representing fuel consumed and emissions produced in the process of electricity generation. Other: Reducing different sources of losses can have widely varying social benefits. E.g., theft can be associated with significant health and safety risks. Illegal modification to the network is often linked to other illegal activity,

therefore
better identification of these may support identification. While reducing losses can lead to substantial benefits (including bill savings for consumers and emissions reductions), however, they are notoriously difficult to identify. For example, in its RIIO-ED2 final determination, Ofgem removed the Losses Discretionary Reward in part due to the challenges in accurately measuring activities to reduce losses. The techniques developed as part of I-LADwill help mitigate this issue.

Teams and resources

SSEN-Distribution:
As a lead network and a DNO, SSEN-Distribution have an obligation to undertake all reasonable cost-effective steps within its power to minimise electricity loss, whether technical or due to energy theft, as described in License Condition 49. SSEN will provide Subject Matter Expertise on both Technical and Non-Technical
Losses, covering areas of:
Sustainability
Policy
Income, Billing and Pricing (including Unmetered Supplies)
Revenue Protection
Asset Strategy Engineering
SSEN-D will also provide a dedicated Project Manager and utilise the expertise of
Innovation Manager to deliver all Project Management activities.

Frontier Economics:
Frontier's data science team are experienced in building and assessing models to predict behaviour. With their experience using techniques such as neural networks to identify the impact of changes in consumption from smart meter data and building predictive models in the context of enforcement, FE are essential indelivering activities in WP2 - Data and Modelling. Frontier will also provide economic expertise to lead on the development of a highlevel CBA and the Theory of Change. See WP4 - Adoption Assessment and
Recommendations. Frontier's energy specialists are fluent in the operational and regulatory issues facing DNOs and suppliers and therefore are key to inform WP2 activities aimed
at reshaping how coordinated, cross-sector NTL interventions may be designed.

CGI:
CGI has extensive experience in collecting, securing, analysing and using smart meter and other network data to support client business use cases. CGI have energy-specific experience in operating large data systems and network data analytics, including extensive data science techniques. Specifically, CGI currently operates SSEN's smart meter data collection solution and network model project. They are therefore critical to lead on delivery of WP2 - Data and Modelling, and will act as the technical solution architect and technical analysis advisor

ScottishPower Retail
ScottishPower supplies gas and electricity to over 5 million households and businesses across the UK. Through their Revenue Protection and Regulation teams, ScottishPower proactively work to reduce the financial burden on customers caused by energy theft and help to address the inherent safety risk potentially resulting in serious injury or death from electrocution / explosion to the perpetrator, occupants of the property (who are often vulnerable), contractors, neighbouring properties and landlords.
ScottishPower will provide:
Subject matter expertise in Revenue Protection Services including the 'as-is' process and opportunities for improvement.
Advanced smart meter data analysis capabilities.
Expertise in electricity supply industry regulation .

Project Plans and Milestones

Project management and delivery

SSEN-D will lead on Project Management activities. We will use tools provided by UKRI (Risk Register, Project Plan), as well as tools developed internally (Gantt Chart, Project Costs, Finance Tracker) to regularly monitor project performance. The Project Team will meet weekly to review progress and collaborate. We will support the team sessions with focused Workpack collaborations, as well as face- to-face sessions (if/when required) to stimulate thinking and provide effective performance while developing outputs. This approach will enable the project team to monitor across milestones and deliverables' dependencies, ensuring key outcomes complement each other. As shown in the Gantt Chart, all Workpacks have their own distinct targets, but at the same time, they are supporting other Workpacks' deliverables. E.g., WP2 deliverable on Data Model and Collection Approach will inform the proxies used in the CBA and inform the KPIs and Measurements within WP4. Several risks have been identified with top scoring items shown below. A full list of risks and mitigations identified are available in the PM Book. R1: Data Model: Insufficient data availability to validate proposed data models.
Mitigation: Stakeholder engagement will identify what data is available and ensure techniques taken forward can be implemented. Where data is limited (e.g. recorded positive cases of theft) we will investigate use of synthetic / simulated data to train models. R2: Data Ownership, Data Security: changes may be proposed to how nontechnical losses are monitored and intervened on at a whole-systems level. Risks around GDPR and Information Security will need to be assessed and mitigated.
Mitigation: We will collect and monitor potential data and security risks during Discovery, no data will be shared outside of the project during the phase. Appropriate DPIA will be carried out for Alpha, and relevant security measures put in place. R3: Losses Interventions: Inability to act on data and insights the model will generate.
Mitigation: Clear identification of current and potential interventions with applicability and costs. Change in direction for Alpha/Beta to identify better interventions if current cannot be used. No regulatory changes will be required for Discovery/Alpha phases. The project
will, however, as an output of Alpha, deliver a recommendation of any regulatory change needed to make any new approaches a success. The Project is not expected to impact on customers reliability of supply or have any direct or adverse impact on existing or future energy consumers and their premises during the Discovery or Alpha Phase.

R4Discovery_ILAD_PMBook_Application.xlsx

Key outputs and dissemination

The I-LAD Project has been designed around 4 main Workpackages. Each Workpackage has a set of clear Outcomes and Key Activities, which result in an agreed set of Deliverables.
A named owner has been allocated to lead each package, as well as delivery of individual Key Activity based on their skills, experience and strengths. Full detail can be viewed in the attached PM book -- please see the Gantt Chart and the Project Plan tab, however, below summarises the Project Structure:

Workpack 1 -- Project Management:
Lead: SSEN

Outcomes:
O_1.1_UKRI Engagement [SSEN]
O_1.2_Project delivery management [SSEN]

Deliverables:
D_1.1.1_UKRI_EndOf Phase_slides
D_1.1.2_UKRI_Show&Tell_slides
D_1.2.3_PM Book_FINAL
Workpack 2 -- Data and Modelling:
Lead: CGI/Frontier

Outcomes:
O_2.0_Identify types of losses/indicators with stakeholder engagement

[Frontier]
O_2.1_Building on the SMITN approach, establish data requirements and methodology to better calculate and model total losses on the network [CGI]
O_2.2_Establish suitable data modelling techniques which can be applied to detect and analyse sources of NTL [CGI+Frontier]
O_2.3_Establish data requirements for efficient detection of different types of losses [CGI+Frontier]

Deliverables:
D_2.0_ Trial Proposal
D_2.1_Current State Analysis
D_2.2_D2.3_Data Model and Collection Approach
Workpack 3 -- Losses Governance:
Lead -- SP Retail

Outcomes:
O_3.1_Establish a Working group to investigate most efficient governance of NTL data and interventions to promote Whole Systems collaboration [SSEN+ScottishPower Retail]

Deliverables:
D_3.1_Working Group Proposal
WP4 - Adoption Assessment and Recommendations
Lead: Frontier Economics

Outcomes:
O_4.1_Develop a theory of change [Frontier]
O_4.2_Synthesise learnings and provide recommendations for next steps [Frontier]
O_4.3_Develop a CBA for improved losses identification and intervention [Frontier]

Deliverables:
D_4.1_1_ Theory of change and KPIs
D_4.2_Improving Losses Detection and Intervention -- Opportunities Report
D_4.3_Alpha CBA
The outputs of these activities will inform our decision to progress into Alpha Phase and this knowledge and learning will be disseminated to the SIF community at the end of project Show and Tell. We will promote the work using a multi-channel and multi-party approach, depending on the intended audience. Examples include: Amplification of UKRI, IUK and Ofgem official SIF communications Press releases, Energy Innovation Summit, websites and social media Specific engagement with Suppliers, Police, Housing Association and other relevant stakeholders. The main innovation of this project is the methodology of identifying, modelling and monitoring losses, and therefore it is not undermining the development of a competitive market.

Commercials

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

To ensure clarity is provided to the Project partners, UKRI and Ofgem regarding the intellectual property (IP) landscape, the Project is using an IP register to track the Background IP provided to the Project, the Foreground IP the Project generates, and the use and access rights to all this IP. IP generated by the NGED NIA SMITN will be applied where possible in this project. This project was delivered in line with the default NIA IPR arrangements. The main contract governing the Project (the Collaboration Agreement) will include detailed, mutually agreed terms governing IP that are in line with the SIF Governance Document. For the Discovery Phase, all the IPR arrangements will follow the default recommendations of Chapter 9 SIF Governance Document.

Investment Needs

The following lists the key initiatives which have been taken into account when
designing this project proposal [full list in PM Book]
SMITN [NIA_WPD_066]
Funding: £914,771
Description: SMITN uses aggregated half hourly load data and MPAN specific voltage data within algorithms to determine customer phase and feeder connectivity, detect Low Carbon Technologies (LCTs) and generate feeder and substation profiles for planning purposes. The algorithms are applied on a test network where phase and feeder connectivity has been validated by a physical survey using an existing phase identification unit and a feeder finder developed as part of the project.
New Approach to Losses [NIA_SSEN_0068]
Funding: £390,000
Description: As electricity is transported across the distribution network some of it is lost. The volume of lost electricity is apportioned across network users according to their responsibility for those losses. The current losses apportionment model, 'newLAF', was created in 1995 when distribution networks were almost entirely demand based systems. As more generation connects to the distribution networks, regions such as SHEPD are becoming increasingly generation dominant with periods of net export to the transmission network. There is an
emerging risk that the current model was not designed for this background. This project proposes to develop a new losses apportionment model and supporting engineering models using best available data to ensure the apportionment of losses across network users remains accurate and fair.
Losses Investigation [NIA_WPD_005]
Funding: £2,580,000
Description: This project aims to further our understanding of technical losses on the distribution network and help us target them in a cost-effective manner. As 72% of technical losses occur on the HV and LV networks, these will be the focus of the project. Losses before the feeder circuit breaker, beyond the meter as well as non-technical losses will not be investigated. The initial investigations will cover the effects of different loading types and patterns on the various networks, determining their effects on losses and where they are most prevalent. This will be incorporated into an initial losses model to test our understanding against the measured values. The second stage of the project will move to predicting losses
with reduced data sets. The accuracy of these predictions will be tested against the measured values. This will allow us to determine the minimum information required to target losses and help create the template for a losses register.

Value for money

Total project cost has been set at £176,005, of which £26,838 will be met throughcompulsory contribution (15%). We are requesting £149,167 of SIF funding. The balance of costs and SIF funding requested is as follows:

SSEN-D:
Full costs: £21,621
Funding: £19,459
Contribution: £2,162 (10%)

Frontier Economics:
Full costs: £85,820

Funding: £68,000
Contribution: £17,820 (20%)

CGI:
Full costs: £56,444
Funding: £50,799
Contribution: £5,645 (10%)

ScottishPower Retail:
Full costs: £11,110
Funding: £9,999
Contribution: £1,111 (10%)
Funding is expected to be allocated to deliverables and work packages in the following way:
WP1 -- Project Management: Funding: £12,323 (8% of total)
WP2 -- Data and Modelling Funding: £60,891 (41% of total)
WP3 -- Losses Governance: Funding: £20,363 (14% of total)
WP4 -- Adoption Assessment and Recommendations: Funding: £55,590 (37% of total)
This project delivers value for money, as if funded, has potential to directly contribute to a reduction in consumer bills through the reduction of network charges. SSEN have carefully considered partner selection and deem that both Frontier and CGI are essential to the success of the project. SSEN have benchmarked their costs to comparative consultancies and are satisfied that the rates provided are appropriate for the expertise they will be providing, and that these skills are not available within SSEN's resource pool.

Specifically:
CGI:
uniquely placed for collecting, securing, analysing and using smart meter and other network data
operating large data systems and data analytics,
data science techniques -- Machine Vision, Machine Learning, AI
incorporating techniques and learnings from previous innovation projects
delivered by CGI which are key to developing the proposed model -- SMITN and Network Model Manager

Frontier:

building and assessing models to predict consumer behaviours.
assessing data modelling techniques which bring additional datasets (e.g. DNO/Supplier MPAN level data or wider demographic information) together with the network modelling CGI is carrying out.
economic expertise to lead on the development of a high-level CBA and the Theory of Change.
operational and regulatory issues facing DNOs and suppliers

Supporting documents

File Upload

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R4Disc_ILAD_PDSigned_10143004.pdf - 244.3 KB
I-LAD_Applicaiton_10143004.pdf - 430.5 KB

Documents uploaded where applicable?

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