SIF Discovery Round 2 Project Registration

Date of Submission

Apr 2023

Project Reference Number

UKRI10051585

Project Registration

Project Title

INSIGHT (Innovative Network Status Intelligence Gathered by Holistic use of Telemetry and Simulation)

Project Reference Number

UKRI10051585

Project Licensee(s)

Scottish and Southern Electricity Networks Transmission

Project Start

Apr 2023

Project Duration

3 Months

Nominated Project Contact(s)

SIFProjects@SSE.com

Project Budget

£98,245.00

Funding Mechanism

SIF Discovery - Round 2

SIF Funding

£83,515.00

Strategy Theme

Net zero and the energy system transition

Challenge Area

Whole system integration

Lead Sector

Electricity Transmission

Other Related Sectors

Electricity Transmission

Funding Licensees

NG ESO - National Grid ESO

Lead Funding Licensee

SSEN-T - Scottish and Southern Electricity Networks Transmission

Collaborating Networks

National Grid Electricity System Operator

Technology Areas

Control Systems, Electricity Transmission Networks, Network Monitoring, System Security

Equality, Diversity And InclusionSurvey

Yes

Project Summary

INSIGHT addresses SIF Innovation Challenge 2 Theme 2 "Novel ways to reliably support low stability systems" by developing innovations in technology and standards that help the power system be ready for Net Zero by 2035. INSIGHT seeks to understand, classify, predict, and define actions to manage potential new forms of instability (e.g oscillations in voltage, power and/or frequency) on a system dominated by power electronic sources (such as wind generation, HVDC converters, STATCOMs etc). The overall aim is to create a virtual, real-time alert and control system that can highlight oscillatory instabilities on the network and then automatically inform control actions required to dampen/remove them.

INSIGHT will also recommend to industry new standards and codes to manage these emerging stability risks.

Network innovation
Currently, there is only a reactive approach to combatting oscillations on the network and no real-time monitoring or control is in place. Instability risks related to new phenomena are not underpinned by normal practices/analysis and not covered by existing industry classifications, codes and standards, therefore the networks do not have enough understanding or the correct tools to react effectively to new instabilities and reduce their impact.

Experience/capability
The consortium has all the necessary skills to deliver Discovery (see AppendixQ12_Project_Management_Book_INSIGHT):

SSEN-Transmission (SSEN-T) - leading INSIGHT with expertise from the
System Performance team; Operational Planning team; and the National HVDC
Centre. The HVDC Centre has extensive experience with modelling and derisking the existing network. The System Planning and the Operational Planning teams are experts in current oscillatory instabilities on the network and can share real event data.

University of Strathclyde (UoS) - extensive experience in power system monitoring, modelling and control, along with expertise in converter control, interaction of converters, and system oscillation, which are all critical to the Project's scope. The team has been involved extensively with major projects focusing on power system digitalisation for addressing challenges with integration of renewables.

National Grid ESO (NGESO) - the Network Operability team will share system operator expertise and ensure that learnings from their DOME project (NIA desktop study on early warning of emerging oscillations) can feed into INSIGHT.

Users
The innovation will prepare the above outlined internal users, NGESO and other networks to deal with new oscillatory instability in a future Net Zero system, and better plan and operate the networks to an improved level of risk management. Therefore, providing a more reliable and stable service to customers.

Project Description

A key policy commitment within the UK government's Net Zero strategy is to fully decarbonise the power system by 2035 and therefore the volume of renewable generation on the networks is expected to increase dramatically. However, most renewable forms of energy, such as wind and solar, are types of non-synchronous generation, meaning they do not produce a consistent amount of electricity all the time. An increase in the volume of non-synchronous generation on the network combined with more high voltage direct current (HVDC) systems to transport the electricity, will lead to new types of network stability challenges, particularly
increases in the prevalence and severity of fluctuations in voltage, frequency and
power (system oscillations). The oscillations will occur in new areas of the system and be driven by different factors compared to historic instability events.
Without innovation to address these new stability challenges, there will likely be a significant decrease in system strength and security, increasing the potential for severe instability events such as electricity blackouts. This problem would also hinder our ambitions to achieve Net Zero because we would continue to rely on synchronous fossil fuel generators to be on stand-by. Currently, there is no systematic real-time monitoring directed at the identification
of, and response to, these new oscillations. There are also no classifications, codes, or standards for how to predict, plan against and manage these new oscillation events experienced in a renewable generation dominated network. A standardised approach across the industry is required.

INSIGHT aims to deliver a virtual, real-time alert and control system that can monitor and mitigate different types of oscillation events experienced on the networks. The Project will combine experience and learnings from past events with new modelling and simulation techniques to better understand the nature of these new oscillations; how to predict them; and how to address them in network design and operation for future events. The first phase of the Project (Discovery) will develop a comprehensive understanding of the problem and the current best practice from across the world. It will also investigate the models/tools that could be used to simulate network oscillation patterns; assessing their suitability; and
developing a list of the key datasets that would be required for a new model/tool. The outputs of INSIGHT will improve the network strength, stability, and reliability, and will avoid alternative operations that would reduce the levels of renewable generation able to run on the network.

Project Description And Benefits

Applicants Location (not scored)

Inveralmond House, 200 Dunkeld Road, Perth, PH1 3AQ

Project Short Description (not scored)

INSIGHT seeks to understand, classify, predict and define actions to manage potential new forms of electrical network instability (e.g. voltage/frequency/power oscillations) on a Net Zero system.

https://www.youtube.com/watch?v=G8z2DnhYW_o

Video description

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Innovation justification

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Benefits Part 1

Environmental - carbon reduction – direct CO2 savings per annum against a business-as-usual counterfactual
Financial - cost savings per annum for users of network services

Financial - future reductions in the cost of operating the network
New to market – products, processes, and services

Benefits Part 2

INSIGHT will deliver the following benefits:
Financial - future reductions in cost of operating the network If no action is taken to understand patterns and improve controls, smaller disruptions will become more common and can quickly escalate to severe events.

The extensive blackout on 9th August 2019 led to widespread disruption and over 1 million electricity customers losing power. Current practice when these issues occur is to constrain generation and implement stability services to increase the fault level. These reactive actions have high operational costs (up to £224 million annually), which is ultimately paid by consumers, and even if potential savings from INSIGHT account for only a small portion of these costs, we are confident that it will be sufficient to justify the total project deployment costs.

Financial - cost savings per annum for users of network services
The INSIGHT solution will avoid the need to invest in unnecessary new stability resources or transmission assets (eg new cable infrastructure, converters, etc), and avoid constraint costs which users of network services pay for through use of system charges. Therefore, INSIGHT should make it easier for generators to connect their assets to the grid in less time and with lower cost. The Project will estimate the cost saving the tool can offer instead of constructing more network assets to balance instabilities.
Environmental - carbon reduction -- direct CO2 savings per annum against a business-as-usual counterfactual.

It is expected that NGESO would need to bring on fossil fuelled generation to manage the increasing risk of oscillations. For example, if one CCGT unit in Peterhead was brought online at a minimum level of output (approximately 200MW) to mitigate instabilities then the annual carbon abatement of this unit could result in 55 tCO2, with a monetary social impact estimated to be over £13m (based on 2020 carbon values (https://www.gov.uk/government/publications/valuinggreenhouse-gas-emissions-in-policy-appraisal/valuation-of-greenhouse-gas-emissions-forpolicy-appraisal-and-evaluation#methodology)). Improvements in grid stability can build investment confidence, increase the system's hosting capacity for renewable generation, and directly avoid CO2 emissions from using back-up fossil fuel generation. Carbon savings will be estimated by assessing at what scale the tool can contribute to meeting the future energy scenarios towards 2050.
New to market -- products, processes, and services
INSIGHT will be a new tool/process proactively identifying and mitigating oscillations and replacing the current traditional reactive strategies. After a successful demonstration the virtual real-time alert and control tool will be available to other network operators to use.

Project Plans And Milestones

Project Plan and Milestones

Discovery phase will be split into five work packages (WPs) (detailed in AppendixQ12_Project_Management_Book_INSIGHT, and AppendixQ4_Project_Approach_INSIGHT):
WP0: Project management (SSEN-T lead) (SIF funding request = £10,674) Consortium will meet weekly to update on progress, risks, and learnings. Deliver a concise Discovery conclusion document and secure internal approval to proceed to Alpha application.
WP1: Literature review (UoS) (SIF funding request = £23,788) A comprehensive literature review around the fundamentals of system oscillations and the state-of-the-art monitoring and analysis techniques. Produce a summary report detailing the different types of system oscillations; the solutions used worldwide; and any possible technologies being developed
to modernise the current reactive nature of handling grid instabilities.
WP2: Learnig from experience (SSEN-T lead, NG-ESO assist) (SIF funding request = £7,720)
Review data from real system oscillation events in North of Scotland. Create a data repository for the requirements of this project, allowing future analysis of possible trends in oscillation data. NGESO to include real experience from the system operator's perspective.
WP3: Modelling and simulation requirements (UoS) (SIF funding request = £23,788)
To investigate the models/tools that could be used to simulate network oscillation patterns, including surveying available devices and models; assessing their suitability; and developing a list of the key data that would be required for a new model/tool. Deliver a summary report covering all WP3 tasks as specified in project plan.
WP4: Stakeholder engagement (SSEN-T) (SIF funding request = £17,544) To better understand all the complexities of why a virtual real-time system is needed, and what is required from a successful solution. UoS lead interviews/workshops with key subject matter experts from SSEN-T and NGESO and issue questionnaires to external stakeholders (e.g.
international TOs, TSOs, etc). Project risks will be reviewed weekly by the team and managed by the Project Manager. AppendixQ12_Project_Management_Book_INSIGHT details the risks.
Key risks are: Data not being available or taking too long to access (WP2). Mitigation =
identify data owners and request access early. Stakeholders do not return questionnaire on time (WP4). Mitigation = design a streamlined questionnaire to minimise effort and remind stakeholders regularly.
We do not envisage any major constraints to the delivery of Discovery and Alpha. Beta stage will involve recommending new codes/standards to support BaU adoption of the solution, which could be a lengthy process and rely on industry involvement. The Project will begin considering the process for new codes and standards from the start to mitigate this potential constraint.

Regulatory Barriers (not scored)

The oscillations that INSIGHT will be investigating do not represent traditional trends, but instead represent new conditions for the transmission system. There are no existing codes (Grid Code predominantly) or standards (SQSS) that sufficiently describe the process and criteria by which these oscillations should be efficiently managed across all TOs and ESOs. That management includes both the systems and practices that INSIGHT would inform and the potential for performance to be specified/ services to be defined by users of the transmission system.
The main potential regulatory barrier to project outcomes becoming BaU across all the networks (not just SSEN-T) is the adoption of new codes and standards. The need for new codes and standards will be considered across all stages of project, but it is not expected to hinder any project delivery in Discovery or Alpha ahead of the outputs of early investigations becoming known. At the Beta phase, INSIGHT will provide recommendations for new codes and standards, but it could be a lengthy process to finalise these new codes and standards and ensure industry adoption which would allow the INSIGHT solution to fully transition to BaU.
To remove this potential barrier to the transition to BaU the Project will deliver all the recommendations and evidence necessary to facilitate changing of codes/standards. We will also engage with industry stakeholders throughout the project, including having partner involvement from NGESO from the outset and we would look to bring other TOs on board as partners in later phases.

Commercials

Route To Market

In Alpha phase, INSIGHT will launch a competitive open innovation challenge to invite industry to propose a solution to create a virtual real-time alert and control system which addresses the problems defined in Discovery. Using this approach, we will secure a range of solutions; understand who can provide a solution (e.g. established energy technology vendors, start-ups); and how they would commercialise it. This approach actively stimulates the market, keeping the process competitive, and the successful solution provider would then join the
consortium for delivery of Beta.
SSEN-T has participation from all the relevant teams within the business to ensure that BaU adoption is considered from the outset. These teams will be responsible for the implementation of the INSIGHT innovation and have the expertise to incorporate the solutions into business practices at the quickest opportunity.
In addition, the planning and operation of a stable GB transmission system is primarily the responsibility of NGESO and TOs to deliver against the requirements of the SQSS and grid code which form the foundations for the efficient operation of competitive markets. INSIGHT will provide clarity within these codes and standards on how instability events should be addressed, therefore minimising the impact of managing these conditions upon the market for the future.

Customers and value proposition
NGESO and the TOs are the primary customers and could use the innovative solution after Beta to improve how they manage the networks and the service they provide to customers. We will engage with key stakeholders through Discovery (WP4) and invite more partners in Alpha/Beta phases. SSEN-T and NGESO are already engaging with international stakeholders (eg NASPI, EPRI) on related issues so are ideally placed to ensure learnings can be shared internationally.
INSIGHT will give networks the ability to monitor different scales of events; take informed actions to manage instabilities; and ultimately improve network stability and reliability for consumers. More frequent oscillations can lead to severe blackouts if not identified early and current practice when these issues occur is to constrain generation. INSIGHT aims to avoid the high operational costs of taking action to manage network instabilities, and avoid curtailment of renewable energy and our reliance on back-up fossil fuel generation.

Funding
The costs of adopting the solution would become part of the regular capital and operational expenditure of the business and therefore included in future price control budgets following the beta phase, likely RIIO-T3.

Intellectual property rights (not scored)

To ensure clarity is provided to, and amongst, the Project partners, UKRI, and Ofgem, regarding the intellectual property (IP) landscape of the Project, 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 any IP.
We do not expect to generate any new IP in the Discovery stage, but there could be IP generated in later stages as the Project develops the innovative INSIGHT solution (a new system or tool for monitoring and mitigating system oscillations). In Discovery phase the Project will be analysing network data and the process for accessing and sharing data is governed by the System Technical Code which applies to both SSEN-T and NGESO. As a result. there will be some restrictions on what data can be accessed and what can be shared as part of the Project. This risk of analysis/reporting of particularly sensitive data will be addressed by redacting project reporting to avoid otherwise restricting analysis.
The main contract governing the Project (the Collaboration Agreement) which all Partners will sign, will include detailed, mutually agreed terms governing IP that are in line with the SIF Governance Document. For the Discovery phase, all of the IPR arrangements will follow the default recommendations of Chapter 9 SIF Governance Document.

Costs and value for money

The total project cost for the Discovery phase is £98,245. The Project is requesting £83,515 of funding (85% of the total cost), with the remaining £14,730 (15%) being provided by project partners. This level of funding will lead to outcomes that provide value to the consumer.
All project partners are providing a contribution, demonstrating their strong commitment to delivering this project. The £14,730 (15%) of the total cost that is being contributed to the Project by private funds is higher than the minimum 10% compulsory contribution giving excellent leverage of SIF funds.
SSEN-T costs are £33,576 to lead this project and manage the delivery of work.
SSEN-T is requesting £30,218 of funding and will contribute £3,358 from internal funds. The INSIGHT project proposal has been developed to compliment and be additional to SSEN-T BaU activity. There are other pieces of background work and knowledge that

SSEN-T will incorporate into this project, but we have not included the time/costs of that work into our budget as the majority of it is considered BAU.
We believe that the learning/knowledge from other SSEN-T work offers additional benefits over and above the contribution we are making to the costs of INSIGHT.
The University of Strathclyde's costs are £56,928, with a funding request of £53,296, and a contribution of £3,632. NGESO's costs are £7,741 but NGESO are not requesting any SIF funding and its costs will be an in-kind contribution to the Project.
The Project is not using any subcontractors for the Discovery phase.
INSIGHT is not requesting the full amount of funding available for Discovery phase (we are only requesting 55% of the full £150k that is available). The consortium has carefully planned the Discovery phase project plan so that we are only requesting the fewest number of days to deliver a quality output. All day rates are very competitive, and we are not using expensive subcontractors to deliver the work.
We are confident that the likely benefits of the Project significantly outweigh the initial cost of launching the Project through Discovery and then developing it through later phases.

Document Upload

Documents Uploaded Where Applicable

Yes

This project has been approved by a senior member of staff

☑ Yes