SIF Discovery Round 2 Project Registration

Date of Submission

Apr 2023

Project Reference Number

10060460

Project Registration

Project Title

Scenarios for Extreme Events

Project Reference Number

10060460

Project Licensee(s)

National Grid Electricity System Operator

Project Start

Apr 2023

Project Duration

3 Months

Nominated Project Contact(s)

John Zammit-Haber john.zammit-haber@nationalgrideso.com

Project Budget

£179,559.00

Funding Mechanism

SIF Discovery - Round 2

SIF Funding

£149,999.00

Strategy Theme

Optimised assets and practices

Challenge Area

Improving energy system resilience and robustness

Lead Sector

Electricity Distribution

Other Related Sectors

Gas Distribution, Gas Transmission

Funding Licensees

Lead Funding Licensee

NG ESO - National Grid ESO

Collaborating Networks

Cadent, National Gas Transmission PLC, National Grid Electricity Distribution, Scottish and Southern Electricity Networks Distribution, Scottish and Southern Electricity Networks Transmission

Technology Areas

Modelling, Resilience

Equality, Diversity And InclusionSurvey

Yes

Project Summary

Challenge:

"Black swan" events are low-probability, high-impact events which can have serious repercussions. Currently, for energy networks, these events are addressed as they arise and are not fully considered in strategic decision-making. Major global events over the past few years (COVID, war, economic downturn) have highlighted limitations of this reactive approach: the whole system impacts of, and interactions between, black swan events are not systematically captured. This limits future operational resilience.

Moreover, the climate emergency impacts the GB energy system through increasingly challenging operating conditions (e.g. extreme weather events), while the need for decarbonisation drives system diversification (e.g. different generation types; increased electrification; transitioning from natural gas).

Solution:

A methodology is required to quantify the impact of black swan events, particularly as energy system operation evolves. Novel use of probabilistic modelling will form a key part of the methodology, to account for high levels of uncertainty around such events. This approach builds on emerging thinking in this area from industries where risk management and costing of extreme events is paramount to that industry's success, e.g. insurance, banking. It will also use emerging datasets on infrastructure resilience and weather and climate patterns collated by academia and the Met Office.

Scope:

This project meets the Innovation Challenge of "Improving energy system resilience and robustness", by improving the approach to the identification and analysis of extreme events and their impacts on the GB energy system.

The project output is anticipated to be a decision-making framework, supported by scenario modelling capabilities to allow evaluation of, and build resilience against, future black swan events. This capability would be developed and integrated into business as usual (BAU) activities, including system planning and Future Energy Scenario (FES) work.

Users:

Users of the innovation would be the System Operator and Networks' operational and planning teams, who would use the project outputs to better understand and pre-empt the impact of extreme events on the grid and wider energy system.

Project Team:

NGESO will lead the project, collaborating with:

- Electricity network operators: NGED, SSEN Transmission, SSEN Distribution.
- Gas network operators: NGGT and Cadent Gas.
- Lloyd's of London - insurance costing and risk management experts.
- University of Strathclyde - research partner and expert in electrical systems innovation.
- Met Office - climate data and modelling experts.
- Frazer-Nash Consultancy - probabilistic modelling and systems engineering experts
- Energy Emergencies Executive Committee - management of future power disruption event

Project Description

"Black swan" events are low-probability, high-impact events which can have serious repercussions. Currently, for energy networks, these events are addressed as they arise and are not fully considered in strategic decision-making. Major global events over the past few years (COVID, war, economic downturn) have highlighted limitations of this reactive approach: the whole system impacts of, and interactions between, black swan events are not systematically captured. This limits future operational resilience.

Moreover, the climate emergency impacts the GB energy system through increasingly challenging operating conditions (e.g. extreme weather events), while the need for decarbonisation drives system diversification (e.g. different generation types; increased electrification; transitioning from natural gas).

A methodology is therefore required to quantify the impact of black swan events and thereby improve response to them, particularly as energy system operation evolves.

This project proposes to develop such a methodology. There will be two main strands:

(1) to develop a suitable approach for categorising and classifying types of extreme events, focused around known vulnerabilities in the energy system;

(2) to investigate the use of advanced probabilistic modelling to account for high levels of uncertainty around such events.

Both strands will draw on expertise from project partners, who come from different sectors including electricity and gas systems, insurance, academia and scientific organisations. The approach builds on the latest thinking from the insurance industry where risk management and costing of extreme events is paramount to success. It will also use emerging datasets on infrastructure resilience and weather and climate patterns collated by academia and the Met Office.

The Discovery Phase will comprise four workstreams:

WP1 - Categorisation / Classification of types of extreme hazards -- via literature review and discussion with partners

WP2 - Understanding current best practice approaches across industry -- via interviews and workshops with project partners

WP3 - Defining modelling requirements - Building on the outputs of WS1 & WS2, suitable modelling approaches that could be used to meet the needs of the sector will be investigated and inputs and outputs summarised

WP4 - High-level appraisal of benefits in adopting this approach -- and definition of more detailed benefit-scoring methodology for future phases

WP5 - Project Management

The project is innovative for a number of reasons:

- Development of a proactive methodology for dealing with extreme events
- Learning from and adaption of cutting-edge approaches from other sectors
- Developing innovative probabilistic modelling approaches
- Developing a whole-system approach to resilience

Nominated Contact Email Address(es)

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Project Description And Benefits

Applicants Location (not scored)

NATIONAL GRID ELECTRICITY SYSTEM OPERATOR LIMITED

1-3 Strand,London, WC2N 5EH

FRAZER-NASH CONSULTANCY LTD

Hill Park Court, Springfield Drive, Leatherhead, Surrey, KT22 7NL

UNIVERSITY OF STRATHCLYDE

16 Richmond Street, Glasgow, G1 1XQ

MET OFFICE

FitzRoy Road, Exeter, Devon, EX1 3PB

LLOYDS

One Lime Street, EC3M 7HA

NATIONAL GRID GAS TRANSMISSION

1-3 Strand,London, WC2N 5EH

NATIONAL GRID ELECTRICITY DISTRIBUTION PLC

Avonbank,Feeder Road, Bristol, BS2 0TB

SCOTTISH AND SOUTHERN ENERGY NETWORKS POWER DISTRIBUTION

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

SCOTTISH AND SOUTHER ENERGY NETWORKS TRANSMISSION

200 Dunkeld Road,Perth, PH1 3AQ

CADENT GAS LIMITED

Pilot Way, Ansty, Coventry, England, CV7 9JU

Project Short Description (not scored)

This project seeks to develop a proactive approach to identifying and analysing extreme, unexpected events, and forecasting their impact on the electricity grid and wider energy system. Novel use of probabilistic modelling combined with insights from risk management, insurance costing and climate modelling experts will be used to develop a decision-making tool to improve whole system resilience in a rapidly changing world.

Video description

https://bcove.video/3XjlWYG

Innovation justification

Existing approach

Current approaches to system resilience and security of supply need to evolve from models established when the bulk energy system was constructed around 50 years ago. Previously, extreme events did not have as significant impact as the system was supplied more locally, was less interconnected, and energy was not as vital to the everyday functioning of the economy. Now, even short-term power outages can cause serious problems for the systems that the economy relies upon. With a globalised supply chain, the GB energy system is more vulnerable to worldwide events, while the climate crisis regularly provides new challenges.

The current reactive approach to extreme events can result in slower responses, lower system availability and increased costs for network operators. Recent extreme events, such as the pandemic and global economic downturn, have highlighted the need for a refreshed approach.

Novel solution:

The nature of black swan events means they are difficult to quantify, with little data available to validate results. It is therefore proposed to investigate the latest thinking on black swan events from sectors at the forefront of risk evaluation (e.g. insurance, banking) and determine how this knowledge can be adapted and applied to the energy system. Building on this, probabilistic modelling tools will be developed to test various scenarios and predict their impact on the whole energy system.

The modelling results will allow optimisation of responses to extreme events and minimise the impact and cost to energy system stakeholders. Additionally, the results will feed into planning activities, such as FES, ensuring the benefits of the refreshed approach also feed into long-term system reliability.

SIF suitability:

The project is a novel approach that cannot be resourced via existing business processes, as it must be developed and tested separately to avoid impact on the current security of supply. The project brings together partners with significant breadth and depth of expertise across the energy, insurance, and academic research sectors; offering a diverse range of thoughts which will be pivotal in pioneering innovations.

The SIF process offers the best model for development, comprising:

- a Discovery Phase to investigate other sectors' risk approaches and determine their applicability to the energy sector.
- pending a feasible approach, a subsequent Alpha Phase to develop the initial models and consider requirements for integration into existing processes.
- a Beta Phase to develop and test a complete model, alongside a detailed plan for BAU integration.

Benefits Part 1

Environmental - carbon reduction – direct CO2 savings per annum against a business-as-usual counterfactual
Environmental - carbon reduction – indirect CO2 savings per annum against a business-as-usual counterfactual
Financial - future reductions in the cost of operating the network
New to market – products, processes, and services
Revenues - creation of new revenue streams

Benefits Part 2

We will develop the methodology for calculating project benefits as part of the Discovery Phase. We would expect a rough order of magnitude (ROM) benefit calculation to be carried out as part of the Alpha Phase, with a more detailed analysis taking place in the Beta Phase. For the solution to be adopted as BAU, it will have to undergo independent scrutiny by Ofgem to demonstrate that it offers significant benefits in comparison with existing methodologies. This would be taken into consideration when planning the later stages of the project.

The following gives an initial indication of how we expect to be able to demonstrate project benefits:

Financial: savings in network restoration costs, demonstrated by retrospectively examining system performance in previous black swan events, such as Storm Arwen, and outlining how our proposed model would have improved the response.

Environmental: we will consider the existing response to extreme events compared with the response recommended by our model, and will calculate the resulting carbon benefit using established methodologies for assessing CO2 savings.

New to Market: the benefits of new services that could be developed to improve system resilience can be assessed by reference to the benefits provided to the system by past developments in other innovative areas, such as flexibility services.

Revenues -- Creation of new revenue streams: the potential income streams from leveraging the project's IP (e.g. licensing) will be considered.

For benefits to be fully realised, it is vital that project learning is shared as widely as possible, so that all stakeholders have opportunities to use outputs and provide feedback. This is partly achieved by having a diverse team in the initial stages, but will be enhanced by considering additional project partners for in future (e.g. water companies, transport providers) and by disseminating findings via relevant forums, such as the Energy Emergencies Executive Committee (E3C) and the Electricity and Gas Networks Forum.

Project Plans And Milestones

Project Plan and Milestones

WP1 -- Categorise / Classify types of extreme hazards (Subcontractor1)

WP1 establishes a suitable approach for categorising and classifying types of extreme events. Review of existing publicly-available literature will identify potential causes, probabilities and impacts of individual events.

Specific focus will be given to areas of known vulnerabilities within the energy system, and to the effects of multiple events combining to result in a greater system impact. Although an exhaustive analysis is not anticipated in Discovery, the project will establish reference hazard types to be further developed in subsequent activities.

WP2 -- Understand current best practice approaches across industry (Partner1)

WP2 seeks to understand the existing practices in managing risk associated with black swan events. Interviews will be held with individual network operators to canvass views and approaches to resilience planning in the context of black swan events. Interviews will also be held with Lloyd's to understand forecasting approaches adopted within the insurance sector.

Findings will be collated and form the basis of a combined partner workshop to establish best practices, synergies across industries and gaps where further forecasting / predictive approaches would be of benefit.

WP3 -- Defining modelling requirements (Partner1)

Building on outputs of WP1 & WP2, an outline modelling approach will be developed to:

Identify suitable modelling approaches that could be used to meet the needs of the sector.
Summarise required input data, considering sources, format, and availability.
Provide indicative output information and how this could be used to support whole system resilience planning.
Illustrate an ownership and implementation plan for developing this modelling capability.

WP4 -- Appraisal of benefit in adopting approach (Subcontractor1)

WP4 provides a high level appraisal of the anticipated benefits in developing this modelling approach; to better understand the impact of black swan events, and how to inform and shape future whole-system resilience planning.

A qualitative assessment will summarise the anticipated value, both to ESO and wider energy system, through identifying synergies and overlaps with other utilities & industrial sectors, e.g., water companies, high-demand industries.

We will retrospectively consider recent extreme events, examining whether the proposed model could have identified system resilience investments that would have improved system restoration times.

During Discovery we will develop a project plan for subsequent project phases, taking into account lessons learnt from Discovery.

WP5 -- Project Management (Lead Partner)

WP5 is required to ensure the project is delivered to plan and budget and for effective coordination.

Regulatory Barriers (not scored)

We do not anticipate any regulatory barriers impacting on the Discovery Phase.

However, given the extensive regulations and documentation covering NGESO's role in ensuring system resilience and security of supply, it is likely that there will be some impacts on certain aspects when implementing a new methodology as BAU.

The Discovery Phase will therefore conduct a review of the applicable regulations (including Licences, the SQSS, Grid Code and SO-TO Code) and will highlight areas where the later stages of the project will need to consider any potential issues.

Given the short timescale of the Discovery Phase, we will initially focus on electricity system documentation. We recognise that similar documentation applies to the whole energy sector as well as other sectors and that it will also be necessary to review these in detail at a later stage of the project. Given the partners we have on this project, however, we would anticipate that the Discovery Phase interviews would highlight key areas in other sector regulations where there are (a) similarities with and (b) major differences to the electricity industry documentation. We can then build this learning into our plans for future project phases. It should also be noted that widening the project to include other energy vectors will increase the resulting benefits that have been outlined in our answer to Question 6.

Commercials

Route To Market

A detailed review of existing best practice will be undertaken, to enable integration and accelerate adoption as BAU. Other innovations that have successfully been implemented as part of BAU (e.g. RIIO infrastructure payment, Common Network Asset Indices Methodology, ISO 55001) will also be examined to extract learnings. A feasibility study will then be carried out, to fully define the requirements of the approach, in particular the necessary inputs for the probabilistic model. Risks to the proposed approach will also be characterised and quantified as part of the feasibility study. For example, acknowledging that a proactive approach may be more costly in the short term than a reactive response to extreme events, the likelihood of there being no immediate tangible benefit to consumers, and difficulties in measuring the success of the tool considering the low likelihood of extreme events.

This project and its outputs do not undermine the development of competitive markets. In fact, it may enhance markets by:

- finding a use for existing datasets that are not being fully exploited at present (e.g. Met Office climate data used beyond weather forecasting purposes).
- identifying areas where innovative approaches can enhance system resilience. This will provide benefits by further opening the energy market to new participants, products and services; replacing existing high-cost items with more innovative solutions.

The responsibility of developing this innovation further after the end of the SIF timescale and implementing it as BAU, lies with NGESO. Items to be considered include:

- Training requirements: The new approach will have new operational requirements. The workforce will need training, which incurs costs and time.
- Failure mode and effects analysis: Any new system's failure modes will need to be understood so that assets can be managed, and suitable maintenance routines developed and written into technical specifications.
- Technology impacts: Impacts on business processes, systems and data need to be determined during the innovation phase, before implementation as BAU.
- Post-delivery support agreements (PDSA): PDSA and system recovery will need to be established for the new approach.

The primary customer segment for this innovation is electricity and gas network operators. It is hoped that in later stages of the project, further development could enable other infrastructure providers (e.g. water, transport) to benefit from its outputs. It could also be adapted for the use of operators outside of the UK, who will be facing the same system resilience challenges.

Intellectual property rights (not scored)

All Project Partners will treat Intellectual property in accordance with Chapter 9 of The SIF Governance Document.

It Is noted that foreground IPR is unlikely to be developed in the Discovery Phase. If further details are required on each partner's compliance with Chapter 9 when IP is developed at later project stages, this can be supplied to project assessors at the relevant point.

Costs and value for money

Total Project Cost: £179,559.00

Total Project Funding Required: £149,999.00

Project Contribution: £29,560.00 (equivalent to 16.46% Project Contribution)

Contributions in benefit in kind that relate to partners' time and expertise are as follows:

- ESO (lead partner): 25%
- NGED: 10%
- Cadent Gas: 14.31%
- SSE Transmission: 100%
- Lloyds: 100%

Self-funding contributions from other partners are as follows:

- Frazer-Nash Consultancy (subcontractor): 10%
- Met Office (subcontractor): 29%

- University of Strathclyde: 3.90%

Partners seeking 100% funding costs are SSEN Distribution and National Grid Gas Transmission.

Subcontractor Frazer-Nash has extensive systems engineering and technology expertise and a strong track record of delivering multi-disciplinary analysis of innovation projects and will be supporting the lead partner in the delivery of the project.

Subcontractor Met Office is providing crucial weather data that will help inform the scenarios for extreme weather events.

The balance of costs/ SIF funding across partners reflects the effort required from partner for delivery of the work packages/ milestones.

Value for Money:

The discovery phase is an opportunity to establish best practice approaches in preparing for, and responding to, extreme events and the impacts such events can have on the UK energy system. The proposed approach will canvas the views of electricity and gas network operators, both at Transmission and Distribution, to identify current best practices, as well as identifying risk management and forecasting approaches from the finance and meteorology sectors.

The bringing together of this cross-industry expertise will offer immediate value for money benefits, providing a forum for networks to have visibility of existing best practices and initiating discussions on how to better prepare and plan for extreme events. Improved network resilience have the potential to provide immediate direct benefits to customers, specifically for vulnerable customers who are increasingly reliant on a dependable energy supply.

More broadly, the project offers significant potential in future phases to be developed into a tool that can be used to inform and substantiate future investment planning decisions. By taking a whole system view, the project will support the development of a UK energy network that is better prepared for the effects of future unplanned extreme events.

Document Upload

Documents Uploaded Where Applicable

Yes

Documents:

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This project has been approved by a senior member of staff

☑ Yes