SIF Alpha R2 Close Down Report

Date of Submission

Dec 2024

Project Reference Number

10078787

Initial Project Details

Project Title

Scenarios for Extreme Events - Alpha

Project Contact

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Project Start

01/10/2023

Project Duration (Months)

6

Lead Funding Licensee

National Grid Electricity System Operator

NESO - National Energy System Operator

Funding Licensee(s)

WPD - Western Power Distribution (West Midlands) Plc

Project Summary

High impact low probability "extreme events" can have serious impacts on the GB energy system. The GB energy system is rapidly transitioning, with an increased dependency on renewable generation and an increased reliance on electrification: a combination which will lead to greater system vulnerability. The increasing frequency of extreme weather events along with influences of other geopolitical events (COVID / war) can have both direct and indirect impacts on the system. This project sets out to better understand how whole-energy system resilience can be impacted by extreme events, identifying vulnerabilities, and informing future investment planning decisions.

Performance and Outcomes

Project phase summary

Challenge Alignment

Scenarios for Extreme Events (SfEE) addressed the 'Improving Energy System Resilience and Robustness' Innovation Challenge by developing a whole system risk assessment approach to model the resilience of the GB whole energy system to extreme events.

Problem

We live in an age of change, driven partly by technological advances, geopolitical events, and our changing climate. The energy industry must adapt to these changes and address the additional system resilience challenges. Existing resilience approaches focus on localised asset management without considering wider infrastructure or the impact to different types of consumers. Therefore, a proactive, systems approach to assessing risk and identifying mitigations for the GB whole energy system, which also captures interdependencies with essential services (water/telecoms), is required.

Project Evolution

In Alpha, under Work Package 1 (WP1) we further developed our vision from discovery phase, agreeing the use cases and stakeholders.

In WP2, the project evolved as we built a framework for defining scenarios and used it to identify a high wind scenario to input into the model. We engaged network partners (Cadent Gas, National Gas, and SSE) in update meetings, a vision drop-in, and workshops, to discuss our scenarios, modelling methodology and resilience metrics. We translated this feedback into an updated vision, a realistic gas supply failure scenario and specific transmission network resilience metrics, such as "Energy Not Supplied" (WP3).

A key innovation from WP3 was the definition and prioritisation of quantified, consumer-focussed resilience metrics that assigned impact thresholds (High/Medium/Low), which can be applied to any extreme event. Discovery's risk assessment framework was updated with risks and reporting proposals aligning with the UK National Risk Register, which would enable NESO to quantitatively understand system vulnerabilities, compare stress event scenarios, and inform better value resilience investments.

In WP4 we developed an innovative, scalable prototype model (using SSEN asset data) to demonstrate novel interdependencies between gas and electricity networks. We prototyped the highest risk elements of model development with an architecture that enables asset failure inputs from any scenario type.

Project relationship within energy network functions

This project identified vulnerabilities in energy network functions including the interdependencies between gas and electricity networks, as well as non-energy sectors. The aim was to enable NESO to escalate risk assessments to government along with advice on possible changes to standards. Any changes suggested must be efficient and effective, to keep cost to consumers as low as possible while ensuring a resilient system. Energy consumers, network operators and government would have benefited from NESO's enhanced ability to quantitatively assess risk and resilience of the networks and provide a coordinated strategy to meet the GB network's needs and report progress against agreed metrics.

Innovation outcomes

Alpha innovation included our ability to:

- Efficiently run weather and non-weather scenarios
- Model whole system energy flows between gas and electricity networks
- Cascade risks along gas and electricity networks and demonstrated the ability for networks to interact and failures to cascade across the networks.
- Leverage different innovative techniques to reduce computation by analysing input scenario types using only relevant model layers. If carried forward, this speed up would enable development of probabilistic approaches to scenario modelling

User needs

Scope Boundaries

In Alpha WP1, the project boundaries were developed through discussions with Subject Matter Experts (SMEs) from both NESO and other networks. This enabled a set of use cases to be defined and the vision for the project to be set. The lead end user, NESO's Resilience Team, were active participants through discovery and alpha phases of the project, as this tool would ultimately support the annual energy resilience assessment reports that are provided to government. As a result of this project, Alpha showed that a resilience model would allow NESO to quantify whole system impacts for multiple scenarios, adding value to the subjective assessments that are currently planned, and subsequently provide increased insight for government through the advice provided.

Use cases

As the owners of the tool, NESO was actively involved throughout the project and during weekly meetings. As part of WP1, opportunities and challenges to the scope were openly discussed with opportunities for potential users to steer the development direction and to approve key decisions. Any changes to scope were captured to support the next phases of the project and to avoid duplication of effort.

The envisaged usage meant NESO would need to engage with network licensees to gather data for end reports and, in this project, the use case was to understand the type of data available and the format for inclusion in the model. Ultimately, the insight the model was aiming to provide to government was to support changes to the network that would be enacted by network licensees. Regular engagements through the WP were also opportunities for network licensees to validate outputs and support realistic scenario setting.

Output

A prototype resilience model was developed to test assumptions, which was risk agnostic, allowing both weather and non-weather scenarios to be input before calculating consumer impacts in terms of our agreed GB energy network resilience measures.

This demonstrated that, if the model proceeded to beta, it would enable NESO to:

- Support a proactive approach to GB whole energy system impact assessment by quantifying impact and highlighting system vulnerabilities.
- Support the identification of effective and efficient changes to levels of system resilience and the scale of impact, which would then support the advice provided on standards and/or implementation of reduction measures.
- Identify industry "reasonable worse-case scenarios" that would support network partners in the delivery of consumer-focused resilience, as set out by the National Resilience Framework, and as per Network's obligations under the Civil Contingencies Act 2004.
- Draw out data focussing on vulnerable consumers or impacts to other sectors like schools.
- Be able to share outputs, like weather scenario data, with other projects.

Wider Interactions

Other SIF projects, such as CRedO+ and WELLNESS, were engaged throughout the project lifetime as part of WP1. These sessions were important tools in sharing scopes and key insights to avoid duplication of effort.

Through these engagements we identified that SfEE would support the WELLNESS SIF project, which aimed to develop a suite of resilience standards. SfEE could also leverage system configuration, interdependency information and asset information from the CReDo+ project, which aimed to develop an interoperable digital twin of the Energy Network.

Impacts and benefits

The Cost Benefit Analysis (CBA; WP5) undertaken in the Alpha project indicated that the approach had the potential to save consumers and taxpayers hundreds of millions of pounds over the next 25 years. This would be enabled through NESO acquiring the capability to recommend cost-risk optimal system-wide changes (such as the creation and adoption of resilience standards) based on identified system vulnerabilities. Our literature review showed that this would be a more effective approach than asset-specific hardening, which does little to mitigate the costly cascading failures from extreme events.

The GB-wide monetised net benefits (P50) from this project were estimated to be at least £978m over 45 years. The key benefits of this project arise from the possibility of avoiding or reducing costs from large, whole energy system outages, alongside reducing the chances of economic and political damage to the UK. This is on the basis that resilience investment decisions will be improved through insights gained from the resilience model outputs, and therefore there is the potential to either reduce or eliminate the impacts of major whole energy system outage events.

Extreme events happen very rarely. They typically give rise to singular sets of impacts that are potentially wide ranging, affecting consumers, the economy, infrastructure and so on, in unpredictable ways. So, although costs are potentially large, it is not possible to define a typical set of consequences, even less to monetise them.

The approach adopted therefore quantified and monetised only a portion of the benefits - those that arise from reducing electricity system fault occurrence. We estimated that using the model to reduce the frequency and severity of electricity distribution faults could lead to a 22% reduction in the expected number of customer minutes lost through 'large' events each year, once the whole network has been upgraded in line with model recommendations. This gave an estimated saving of £39m per year. However, this is only a fraction of the likely total benefits as it does not include impacts that extend to other elements of critical infrastructure, such as the gas network, telecoms, transport, etc.

It should be noted that there is extremely high statistical uncertainty surrounding the level of benefits that may be realised from improvements in resilience. Benefits will only be observed if an extreme event occurs and if the extreme event is one for which we have made preparation. There is no way to mitigate this uncertainty.

Risks, issues and constraints

A copy of the SfEE Risk Register has been uploaded to the ENA

Working in the open

Sharing

We met regularly with other SIF and NIA resilience projects during Alpha to share progress and lessons learned, and to identify opportunities for efficiency and avoid duplication by sharing project outputs. This included working with the WELLNESS and CReDo+ projects to identify potential areas for work sharing.

WELLNESS intended to use the Met Office outputs in the next phase of their project, and CReDo+ would have contributed future fragility and restoration curves to SfEE.

Transparent Collaboration

During Alpha and Discovery our project team worked well together in addressing this complex and multi-faceted resilience challenge. The core team used SharePoint for collaborative working and held weekly calls to report on progress, priorities, risks, opportunities, issues, information, dependencies, decisions, actions and assumptions.

All project partners were active, including network partners who attended several deep-dive engagement workshops that were held with network partners to understand current resilience practices and seek feedback on our resilience metrics and model development. Partners were also involved in monthly progress calls where project performance, outputs and dependencies were discussed, and project decisions confirmed.

All partners were also invited to quarterly review sessions to share progress and agree the medium and long-term project directions and actions.

Engagement Learning

The non-weather scenario was developed in a deep dive workshop, gathering insight from network operators to understand how gas and electricity networks fail and what may cause widespread issues. Further discussion on showing the value of the model then led the team to develop a reasonable worst-case scenario where a failure on the gas network would cause a subsequent failure on the electricity network. It was agreed that this would demonstrate the innovative modelling of network interactions, as well as the ability to cascade risks from a non-weather scenario.

Published Documents

Scenarios for Extreme events was included in NESO's Innovation Annual Summary. This was published on the NESO website under innovation, and it includes an overview of the project, the results seen and the benefits this would have for industry, government and consumers.

Costs and value for money

Spending was as per the forecasts in the Alpha application. The project has delivered value for money for consumers by identifying a route for the development of robust risk identification and mitigation planning for extreme events.

While not successful in Beta, this approach was due to Ofgem identifying the work should be funded under Business-As-Usual (BAU) and this route is currently being investigated.

NESO:

- SIF funding requested £70,342
- Total actual project spend £78,158
- Total project contribution made (incl. contributions in kind) £7,816

UoS:

- SIF funding requested £87,405
- Total actual project spend £97,328
- Total project contribution made (incl. contributions in kind) £9,923

FNC:

- SIF funding requested £218,885
- Total actual project spend £243,206
- Total project contribution made (incl. contributions in kind) £24,321

Cadent:

- SIF funding requested £4,050
- Total actual project spend £4,500
- Total project contribution made (incl. contributions in kind) £450

National Gas:

- SIF funding requested £4,980
- Total actual project spend £4,980
- Total project contribution made (incl. contributions in kind) £0

SSEN(SHET):

- SIF funding requested £4,354
- Total actual project spend £4,838
- Total project contribution made (incl. contributions in kind) £484

Met Office:

- SIF funding requested £67,883
- Total actual project spend £75,972
- Total project contribution made (incl. contributions in kind) £8,089

Total SIF funding requested - £457,899

Total actual project spend - £508,982

Total project contribution made (incl. contributions in kind) - £51,083

Special conditions

The following table was presented to the Monitoring Officer summarising the meeting of the Project Directions:

Condition 1

The Funding Party must not spend any SIF Funding until contracts are signed with the Project Partners named in Table 1 for the purpose of completing the Project.

Response**:** Delay in contract finalisation. Contract now fully signed with all partners

Condition 2

The Funding Party must report on the financial contributions made to the Project as set out in its application. Any financial contributions made over and above that stated in its application should also be reported and included within the Project costs template.

Response: To be reported within project costs template

Condition 3

The Funding Party must make reasonable endeavours to participate in all meetings related to the Project that they are invited to by Ofgem, UKRI and DESNZ during the Alpha Phase.

Response: Any meetings requested have been attended, with NESO proactively engaging with UKRI.

Condition 4

The Funding Party must provide to its monitoring officer by the end of the Alpha Phase a clarification as to under what specific circumstances the Project's anticipatory assessment would be utilised by the Funding Party. As part of this, the Funding Party must include details on how the proposed assessment focus compares to existing processes or methods and the additional capabilities or tools the proposed solution is expected to provide in these scenarios.

Response: Use to inform policy and support investment decision making

Condition 5

The Funding Party must provide to its monitoring officer by the end of the Alpha Phase an explanation of how the interdependencies with other infrastructure networks will be explored and incorporated into the proposed model. As part of this, the Funding Party must also include an explanation as to how the proposed model would incorporate changes or fluctuations in these networks to ensure that the proposed model can evolve as it progresses.

Response: Close working relationships with Electricity Transmission, Gas Transmission, Gas distribution in Alpha, with DNOs being engaged with for Beta.

Document Upload

File Upload

No documents uploaded

Documents uploaded where applicable?

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