SIF Discovery Round 3 Closedown Report

Date of Submission

Dec 2024

Project Reference Number

10104062

Project Progress

Project Title

Probabilistic Pathways for Energy System Planning

Project Contact

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Project Start

01/03/2024

Project Duration (Months)

2

Lead Funding Licensee

National Grid Electricity System Operator

NESO - National Energy System Operator

Funding Licensee(s)

National Grid Electricity System Operator

NGET - National Grid Electricity Transmission

Project Summary

The FSO will be responsible for future whole energy system planning required to achieve net zero at lowest cost to consumers. Planning for an inherently uncertain future is complex and time consuming, significantly benefiting from the ability to quantify risk within planning decisions, and analyse more pathways.

This project will develop an enhanced end-to-end network planning methodology for the whole energy system. We will explore applying advanced computational techniques, such as artificial intelligence and probabilistic modelling, to capture risk and uncertainty within future energy pathways, enable rapid iterative network needs analyses, risk-based network options

assessments, and deliver optimised planning decisions.

Performance and Outcomes

Summary key findings

Our innovation aligned with Challenge 1, Theme “Digital simulation and advanced modelling techniques facilitate whole-system network planning and development” of SIF Round 3.

One of NESO’s key responsibilities is to assure security, sustainability, and affordability of supply through planning GB's future grid infrastructure. Decision-making and long-term planning is increasingly difficult due to increased uncertainty and complexity associated with the energy system transition. Without a large increase in resources, NESO will need to find innovative ways to improve efficiency and effectiveness.

Our problem perception developed through Discovery, with increased understanding of current planning processes, achieved through conducting four workshops with the NESO Future Energy Scenarios (FES) teams, as well as Electricity Ten Year Statement (ETYS) and Network Options Assessment (NOA) teams from NESO and NGET. Significantly, we identified that the high computational cost of analysing each deterministic pathway to Net Zero limits the extent to which optimal planning decisions can be implemented.

Key developments in our problem understanding included:

- **Speed of analysis:** Assumptions underpinning each pathway can be self-inconsistent, with new data arriving part way through the process without time to re-analyse with new data.
- **Lack of probabilistic analysis:** Calculating network investment decisions must be made on a single most-optimistic pathway, potentially adding to consumer bills by recommending investment that are, with hindsight, either too high or early because of changes to conditions which were not known at the planning stage.
- **Potential for risk-based optimisation:** When understanding reinforcement choices for a future network, it may not be possible to consider the full range of scenarios to take a fully risk-based approach to optioneering. Options may be missed.
- **Potential for automated end-to-end process:** The process for transferring analyses between planning teams is robust and high quality but requires manual steps and takes time.
- **Transition to include gas:** Gas network planning is not currently included in centralised strategic network plans but will become a new requirement following the transition to NESO.

We identified three innovative and risky solutions to these challenges that have never been applied together for whole system energy planning:

1. **Probabilistic Scenario Modelling** for the FES team to explore a range of scenarios quickly, incorporating Markov Chain Monte Carlo sampling.
2. **Faster Network Dispatch Modelling** by applying graph convolutional neural networks to quickly assess the energy dispatch across a range of future network scenarios.
3. **Automated Option Exploration** using reinforcement learning AI algorithms to suggest a set of optimum options to consider for network reinforcement.

User needs

The primary user of the final innovation would be NESO, with our needs being addressed through an enhanced methodology for whole system planning across multiple vectors. The innovation would have helped NESO with our expanded whole energy system planning responsibilities and enable our government advisory role on future energy and infrastructure policy post-transition. Secondary users would include the asset owners, such as National Grid Electricity Transmission (NGET) and National Gas Transmission (NGT).

The scope boundaries were defined over four-days of workshops with teams from across NESO (FES, ETYS and NOA) and NGET to understand the challenges faced throughout the planning process. Solutions were then developed to create an end-to-end solution that would enhance the planning process. Developing the innovation throughout the Discovery Phase involved multiple optioneering workshops with NESO teams, which generated a wide range of interest across the business due to the potential benefits the innovation would have unlocked.

Outputs would have had wide-ranging benefits across the sectors, as the optimised planning decisions would support network owners as well as reduce costs for end consumers. Planning assumptions were tested against the user needs of the FES team, NGET and lead economists at NESO to ensure that it would meet all the user's requirements.

Impacts and benefits

The innovation would have allowed the efficient development of multiple probabilistic future energy pathways. This would support long-term network investment decision-making that could accommodate multiple factors in a consistent manner and promote a more optimal allocation of National Grid's planned £118bn pot for network investment (over the 10 years to 2035). It would allow for risk quantification, improved risk-based investment and planning decisions, and promote the balancing of costs and performance across all credible pathways that are identified. This would facilitate faster, low-cost and low-carbon generation connection, improving the efficiency of network operation, cutting consumer bills and lowering grid carbon content.

For the Discovery Phase, the projected benefits were assessed through consideration of a case study that considers the benefits that would have arisen if the transmission system upgrades had been brought forward by 6 years, balanced against the implementation costs of the proposed advanced modelling techniques. Two variations were examined:

- The first assumed a 100% reduction in Scottish wind curtailment, assuming that all curtailment results from capacity constraints on B6. The net present value (NPV) of this is £3.8bn over 45 years, with an associated carbon saving of 11.8m tonne CO2e.
- The second assumed a 50% reduction in Scottish wind curtailment. This has an NPV of £1.9bn, avoiding curtailment of at least 28 TWh of Scottish wind between 2023 and 2028, which equates to a reduction in emissions of at least 5.9m tonnes.

Bringing forward upgrades to B6 is the type of network decision that might be informed by an enhanced planning process, which this project aimed to address.

Operationally, the proposed modelling approaches would facilitate the rapid production of future energy system scenarios. This element of the benefits would have been reported in terms of the number of pathways NESO would be able to analyse with the same resources, relative to the pre-innovation baseline of three.

Risks, issues and constraints

Risk register included (uploaded to ENA). Risks were managed and successfully mitigated through efficient project management and strong working collaboration across the project partners.

Working in the open

We worked in the open by engaging with multiple interested stakeholders from across NESO (including very closely with the FES team, ETYS team and economists from NOA), and across the energy networks, including electricity and gas transmission owners, with input form NGT and NGET regarding involvement with future development.

We have shared learning through the show-and-tell and discussions at industry events, such as the Energy Innovation Summit.

Costs and value for money

Spend was in line with the requested funds for Discovery Phase. The project has delivered value for money for consumers as it has identified some key challenges in the network expansion planning process that need addressing and highlighted an innovative combination of approaches to tackle them.

NESO

- SIF funding requested £39,850
- Total actual project spend £46,750
- Total project contribution made (incl. contributions in kind) £6,900

Frazer-Nash Consultancy

- SIF funding requested £95,919
- Total actual project spend £106,584
- Total project contribution made (incl. contributions in kind) £10,665

NGET

- SIF funding requested £13,775
- Total actual project spend £15,306
- Total project contribution made (incl. contributions in kind) £1,531

Special conditions

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.
How They've Been Met : Complete.

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.
How They've Been Met : Spending is in-line with the application.

Condition 3
The Funding Party must make reasonable endeavors to participate in all meetings related to the Project that they are invited to by Ofgem, UKRI and DESNZ during the Discovery Phase.
How They've Been Met : No meeting requests received other that standard SIF requirements.

Condition 4
Prior to the completion of the Discovery Phase, the Funding Party must provide evidence to the Monitoring Officer of engagement with the other Transmission Operators to understand how this innovation will interact with them to support wider scale up of the innovation into business as usual.
How They've Been Met : We reached out to both and held a positive call with SSEN who stated they would be interested in supporting a future Beta Phase application, if successful in progressing to Alpha.

Document Upload

File Upload

No documents uploaded

Documents uploaded where applicable?

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