SIF Project Registration

Date of Submission

Mar 2022

Project Reference

10025656

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Project Title

Predict4Resilience

Project Reference

10025656

Project Licensee(s)

SP Energy Networks

Project Start

March 2022

Project Duration

2 Months

Nominated Project Contact(s)

Michael Eves

Project Budget

£133,368.00

Project Summary

We will develop a "Weather Fault" tool which can:

- Forecast severe and extreme weather events.
- Improve the accuracy within the current 7-day forecasting window.
- Double the current forecasting window (to 14 days ahead).
- Predict specific network faults and risks.

Our discovery phase will take our existing network data sets, coupled with weather data supplied by the Met Office and assess if this data is sufficient to support the project aims, or identify the gap to realise the required format and volume.

As a result, the proposed project meets the scope for "how novel uses of data and digital platforms can significantly improve network planning, modelling, and forecasting capabilities" specifically by:

1. Applying novel probabilistic techniques to our data sets

2. Developing a digital platform within our control rooms to improve our forecasting capabilities

3. Improving our network planning through proactive decision making based on data driven forecasts and impact analysis

The main users of this innovation are control room engineers and asset managers. Our objectives are fully informed by their needs and they are our internal project sponsor. From our engagement to date, our users need a way to:

1. Reduce customer interruptions & minutes lost due to network asset extreme weather faults

2. Improve accuracy, range, and specificity of fault prediction for network assets

3. Communicate actionable outcomes from control room

This project is led by SP Transmission and supported by SP Distribution and NGET. Both the transmission and distribution systems can be adversely affected by severe and extreme weather.

Arup is selected as partner because their previous experience on the NIA project Forward Resilience Measures collaborated with NGET. Moreover, Arup's own underlying energy resilience framework provides a holistic, practical and evidence- based approach to assess resilience, taking into consideration both the physical aspects and the less tangible aspects associated with human behavior in order to enable a common understanding of interdependencies and vulnerabilities, sudden shocks and chronic stresses.

The MET office is a partner for their scientific knowledge and expertise, and their previous experience on NIA projects such as Advanced Weather Forecast for Dynamic Line Rating. The MET office is also the owner of the weather data. The Met Office is recognized as a world leader in Numerical Weather Prediction.

The University of Glasgow, as the academic partner, have expertise in probabilistic forecasting, decision-making under uncertainty, and their extensive experience in energy forecasting.

Nominated Contact Email Address(es)

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Problem Being Solved

Severe and extreme weather events have a major impact on the electricity network, resulting in widespread network outages for significant periods of time. Evidence has shown that climate change has contributed to longer and hotter heatwaves, more persistent droughts, more frequent wildfire, and more extreme rainfalls.

As examples:

· In Texas February 2021, a perfect storm of failed supply and historically high energy demand during extreme cold weather caused 4.5million households and business to lose power.

· In July 2021, severe flooding following unprecedented heatwaves in western Germany caused 200,000 households to lose power.

· In July 2021, central China, record shattering rainfall led to 749,600 households losing power.

While we cannot control the weather, we can seek to predict it more accurately with longer visibility and identify its impact in order to protect our customers’ supply.

Opportunity

Our opportunity is to use the recent advances in supercomputing and numerical weather prediction to combine state-of-art weather forecasting, novel statistical post-processing, power system modelling and resilience metrics to predict short-term extreme weather impacts further into the future, identify weather-related faults in the 7-14 days window, and resultant faults on the network.

As a result, engineers will make informed decisions based on actionable fault and risk predictions communicated to the control room. This project will empower control room engineers and asset managers to improve their ability to protect network assets, increase the efficiency of operation practice, and ultimately reduce customer minutes lost, extend asset lifespan, reducing thereby both cost and carbon footprint.

The National Infrastructure Commission has recommended there is a need for a new framework for resilience which anticipates future shocks and stresses; improves actions to resist, absorb and recover from them by testing for vulnerabilities; values resilience properly; and drives adaptation before it is too late. We will address all six aspects of resilience: anticipate, resist, absorb, recover, adapt and transform.

Project Approaches And Desired Outcomes

The Big Idea

Our big idea is to improve our control room's preparedness against the faults caused by severe and extreme weather events, which can be forecasted up to two weeks ahead via the "weather fault tool". We see this as improving data quality (to be used in our statistical post-processing), and access (to both our data and the Met Office) to improve the security and resilience of the network. These techniques convert weather forecasts into impact forecasts, in this case forecasts of network faults, which are more accurate and result in better decision-making than using raw weather forecasts only (current BAU).

The result should be a proactive, optimised approach to securing network assets, preventing failure and network outages from extreme weather. Not only should this optimise costs to the consumer, but a reduction in CO2 as we enable a low carbon, stable network.

We see our idea manifesting in the control room engineers having the ability to forecast the occurrence of extreme weather-related faults (by the platform compiling weather data and asset health information) more accurately and further into the future. They can then act earlier and more decisively from the information.

Where faults are unavoidable, technicians will be dispatched to areas where faults are identified, for faults to be repaired earlier, and for customer minutes lost to be reduced as a result. This ability to restore network assets to service following weather-related faults will enhance network resilience to all weather risks. By integrating fault prediction and network modelling, the network impact of predicted faults will be understood enabling prioritisation of potential faults for repair and efficient resources allocation.

Current state of development:

In anticipation of the project success, we have

· Reviewed previous projects and ensured that our scope is unique and coordinated with other innovation at the industry level as detailed in Section 5: Innovation Justification.

· Identified the relevant available ensemble and reanalysis weather products to review.

· Engaged with other UK TOs and ESO to discuss the subject viability and ensure an inclusive, open and coordinated approach.

Furthermore, we will do work pre-Discovery phase to ensure the data can be correctly transported and formatted to enable the analysis tasks.

This project will identify the relevant background IP, seek to capture foreground IP and learnings following the default IP arrangement in SIF governance document.

Innovation Justification

We have conducted extensive research through a review of previous projects, engagement with UK TOs and ESO, as well as an online literature review.

Network fault innovations have focused on asset design, fragility and response to past weather conditions, and modelling the fault events over long periods of time for planning purposes; learning shows that the existing capability are both limited to short-term forecasting (hours to days ahead) or planning timescales.

Operational forecasting innovations have focused on supply and demand and dynamic line rating. Engagement with our users estimate many processes can be improved by quantifying these uncertainties and impacts.

No past project has considered probabilistic fault prediction and related decision-support, leaving a significant gap in control rooms' predictive capability.

This project requires innovation:

· Weather-related fault prediction has not benefited from advances in digital technologies due to historic records not being digitised and an only small number studies have combined what is available with appropriate weather data. We will leverage newly digitised asset health data with numerical weather predictions in order to learn the relationship between predicted weather and actual faults in order to accurately predict the likelihood of fault occurring on across an entire electricity network for the first time.

· Extended range forecasting using numerical weather prediction to quantify the probability of future weather and related fault occurring in the days and weeks ahead. However, this weather data requires post-processing via statistical or machine learning methods in order that forecasts are calibrated (i.e. that frequency of fault occurrence matches the predicted probability). The required statistical and/or machine learning methods do not exist.

· Probabilistic power system analysis is required to evaluate the impact of predicted fault (with associated uncertainty) into network impacts, such as customer minutes lost. Novel schemes for identifying key regions of the network where faults are most likely to impact service level are required to prioritise resource allocation and take preventative actions.

For BAU adoption, we must:

1. Establish and validate the precise relationship between numerical weather predictions, actual weather, and network faults.

2. Create the necessary statistical methods to post-process weather and fault forecasts exist.

3. Create the data pipeline for handling numerical weather predictions from vendors.

4. Digitise the historic and current asset health data required to train and validate models.

5. Create the power system modelling and decisions support processes to quantify the impact, including associated uncertainty, of predicted faults

Project Plans And Milestones

Project Plan And Milestones

Task 1: Defining our needs - Weeks 1-2 (Lead: Arup)

Arup will use existing literature and projects to define and propose the criteria for success which will be agreed by SPT. This will be a decision meeting including agreement of:

· Key parameters required.

· The minimum required data

· An optimal UI

· The preferred database structure

· The preferred interface between weather model and power system model This will be captured as a written report.

Task 2: Assessing our capabilities - Weeks 1-4 (Lead: University of Glasgow)

In parallel to Task 1, UofG will lead a review of the existing methodologies and products, as well as datasets to confirm what the market can offer to the needs identified in Task 1.

This will include:

· Available Ensemble Numerical Weather Prediction products and will compare suitability using published evaluation of relevant parameters (wind speed, precipitation etc).

· Historic weather data, both met stations and re-analysis products (e.g. ERA5), to establish availability and compatibility with project objectives.

· Digitised and non-digitised asset fault records held by SPEN to establish whether digital records contain enough information to meet project objectives, and whether additional records require digitalisation.

This task will produce a written specification of project data requirements, including means of access, storage volume and security requirements.

Milestone 1: All relevant project information has been assessed for availability and compatibility, which will be reported to the team. These reports will be reviewed and approved by SPEN.

Task 3: Functional Specification Drafting - Weeks 4-8 (Lead: Arup)

Following the completion of Tasks 1 and 2, a first draft of functional specification for the digital interface tool. An initial draft will be circulated amongst key stakeholders for comments.

Milestone 2: Approval of the final draft of the functional specification for the digital interface tool.

Task 4: Business case - Weeks 4-8, (Lead: Arup)

In parallel to Task 3, a detailed business case will be written, comparing the cost and benefits of the proposed digital interface tool against current operations and other use cases identified within Tasks 1 and 2. This will be shared with key stakeholders within SPT for comment.

Milestone 3: Completion and agreement of business case Task 5: Next steps

Using MS2 and MS3, a recommendation for Alpha and Beta phases will be made (including outputs, schedule and resources required) to realise the best value.

Milestone 4: Executive summary of the Discovery phase learning and recommended pathway.

Route To Market

Following the project Beta phase, where we would see a demonstration of this platform successfully deployed within SPEN's control room, we envisage the following BAU approach:

· The minimum weather and network data is fed using established data channels and secure SPEN servers following the same protocols that previous projects have followed to ensure continuity of data flow. These policies will be reviewed for appropriateness as part of an Alpha and Beta phase, continuing to involve the end users.

· We expect the method developed and the approach for the analysing/managing of weather data to be fully transferable. We do not anticipate further investment from the Met Office at this time.

· The platform parameters are captured in specifications, methodologies and policies, which are shared with other TOs to allow wider uptake as well as used to inform competitive tender exercises for sourcing the platform from the market.

· We will ensure that UK TOs and ESO are informed of project progress; we have already done this prior to submission to ensure their interests are captured.

· We see that 3rd parties who develop such platforms may need to invest into platform development to realise some of the required functionalities, however we believe that this will be possible using internal R&D funding. The default IP arrangements will enable knowledge sharing to facilitate competition.

· SPT may need to further invest in the Control Room infrastructure, which we would do through our price control review (or a re-opener). In addition, to realise the minimum network data, some investment may be required through our BAU CAPEX; however this will be established in Discovery.

· We do not envisage any regulatory barrier using the identified data sources, but this will be reviewed during Discovery.

· International utilisation could initially happen by onboarding other TOs as stakeholders during a Beta phase. As part of Iberdrola, we would highlight these activities at our global watchdog forums and would invite EU TOs who also are more vulnerable to extreme weather; we have a working relationship with Landsnet (Iceland TO) and Fingrid (Finnish TO) through Horizon 2020 where we have previous developed interoperable control room toolkits.

Moreover, the intention to develop the forecasting platform in close collaboration with the end users of the tool (who have already been engaged to understand needs and potential benefits) will ensure a successful roll-out.

Costs

Total Project Costs

133368

SIF Funding

112683

This project has been approved by a senior member of staff

☑ Yes