SIF Beta Project Registration

Date of Submission

Nov 2023

Project Reference Number

10061710

Project Registration

Project Title

Predict4Resilience (P4R) - Beta

Project Reference Number

10061710

Project Licensee(s)

SP Energy Networks Transmission

Project Start

Aug 2023

Project Duration

41 Months

Nominated Project Contact(s)

Michael Green

Project Budget

£5,020,674.00

Funding Mechanism

SIF Beta - Round 1

SIF Funding

£4,518,605.00

Strategy Theme

Data and digitalisation

Challenge Area

Data and digitisation

Lead Sector

Electricity Distribution

Other Related Sectors

Lead Funding Licensee

SPEN - SP Transmission Plc

Funding Licensees

SPEN - SP Manweb Plc, SPEN-D - SP Energy Networks Distribution, SPEN-T - SP Energy Networks Transmission

Collaborating Networks

Scottish and Southern Electricity Networks Distribution

Technology Areas

Asset Management, Environmental, Fault Management, Resilience, System Security

Summary

P4R aims to "significantly improve network planning, modelling and forecasting capabilities" to "deliver the next generation of user driven digital products […] across transmission and distribution". Through an advanced indication of where inclement weather will affect the network and a better prediction of expected fault numbers, P4R will enable resources (engineers, mobile generation, welfare provisions, customer liaison staff, mobile catering for consumers etc) to be proactively placed in those areas most likely to be impacted, something that is especially important in island locations where travel distances are significant. This is expected to bring forward the travel time to those faults where an onsite presence is required, enabling power supply to be restored sooner than is currently possible. This creates a more resilient network, minimises disruption for customers and brings about financial, social and environmental benefits.

The Discovery Phase demonstrated the potential benefits of the solution. In Alpha, the project utilised data science capabilities and experience in design and software development to further refine the prototype, resulting in a Fault Forecast Engine which uses cutting-edge statistical methods and an Interface that closely meets the user needs.

In Alpha, a prototype fault forecasting model and accompanying data infrastructure was implemented which verified the feasibility of the P4R's innovations. These statistical models have shown forecasts are highly accurate in days 1-7, a key timescale for operational planning for the Control Room. It was also found that the model successfully predicted severe weather events resulting in large numbers of faults.

There was also a strong focus on engagement with users and User Experience (UX) experts to co-design the solution's UX to ensure that it meets user requirements, such as the display of the entire fault probability distribution instead of the RAG status to aid decision-making.

Following the successful demonstration of the prototype's efficacy, Beta will evolve the prototype into a commercial solution that can be rolled out across GB DNOs and beyond, improving resilience with data-driven fault forecasting and decision-support.

Our perception of the problem has not changed. While this technology has been demonstrated in Alpha, there is still further work to refine the solution to ensure its interoperability so that it can be used beyond SPEN / SHEPD. In Beta, we are therefore turning our attention to industrialising the solution and improving the fault forecasting, utilising a broader range of data from both other networks as well as new weather sources to provide a higher resolution reanalysis.

Previous user engagement and literature reviews have demonstrated that an improvement in fault forecasting capability is achievable with further iterations and this broader data input. By running trials with multiple DNOs in parallel with the modelling enhancement, the project team can integrate novel solutions and validate any findings during the trial. The ambition is not only a robust software solution that is interoperable with each DNOs IT architecture but also the evolution of a range of additional, complimentary novel features before the solution is adopted into BAU.

SPEN and SHEPD – will play a key role relating to the control room requirements, ensuring the required features are correctly developed into a viable solution. SMEs within the businesses will input into the functionality testing of the prototype and review any project outputs. They will continually capture learnings from the trials to understand how P4R is driving business decisions and what benefits it is yielding. They will be the end solution users in BAU.

Sia Partners – they bring the relevant data science and software development expertise and experience required for this project. They will build the infrastructure supporting the solution, the software itself, the industrialisation of the models and the user interface. They will also prepare the transition to BAU and set up the organisation for further rollout

University of Glasgow – has world-leading expertise in the application of forecasting in the energy sector and statistical methods required to develop the fault forecasting capability envisioned in P4R. Their deep multidisciplinary expertise spanning energy systems, meteorology and statistics make them an invaluable partner in this project.

The ambition and expectation is that the end software solution will be fit for all GB and international DNOs, as well as any adjacent sectors who suffer weather-related interruptions.

Following some recent high-profile storms, DNOs must be now seen to make a step-change in how they prepare and react to severe weather. Additionally, there is pressure for DNOs to exceed previous performance with network resilience a growing priority from both the regulator and consumers who are increasingly dependable on their power supply and renewable generators who need a reliant connection to the network.

By providing Control Room operatives short-term predictions regarding the expected level of faults in each district across the licence area, DNOs can better prepare for a storm and restore power supply sooner than is currently possible and minimise disruption for customers.

Project Description

Predict 4 Resilience (P4R) will provide accurate fault insights and forecasts for its users during adverse weather events. By predicting both where network faults are most likely to occur and their expected volume up to 7 days in advance, networks can pre-emptively allocate resources and materials to the right locations ahead of time.

P4R utilises probabilistic fault prediction and related decision-support for the first time in a GB innovation project, transforming human-centric decision-making and leading to an improved response to faults on the HV network.

By utilising hourly data from state-of-the-art weather forecasts and overlaying this onto historic network fault data, LIDAR data and land cover data, P4R will provide Control Room operatives short-term predictions regarding the expected level of faults in each district across the licence area.

Existing commercial offerings are unproven with limited/restricted features, leaving a significant weakness in DNOs' predictive capability and the opportunity for P4R to exploit this gap in the market. This proactive response will enable power supply to be restored more quickly than is currently possible, reducing Customer Minutes Lost (CMLs) and generating considerable direct benefits to consumers, network operators and the environment, estimated at more than £1m per year per DNO.

Preceding Projects

10037451 - Predict4Resilience (P4R) - Alpha

10025656 - Predict4Resilience

Third Party Collaborators

University of Glasgow

SIA Partners UK

Nominated Contact Email Address(es)

innovate@spenergynetworks.co.uk

Project Description And Benefits

Applicants Location

SPEN and SHEPD licence areas

Project Short Description

Predict 4 Resilience (P4R) will provide accurate fault insights and forecasts for its users during adverse weather events. By predicting both where network faults are most likely to occur and their expected volume up to 7 days in advance, networks can pre-emptively allocate resources and materials to the right locations ahead of time.

Innovation Justification

DNOs must minimise outage periods and the associated CMLs. With currently available information and BAU processes, estimating the impact of severe or extreme weather on maintenance and fault volumes relies on user judgment. P4R is developing a fault forecasting system that will provide short-term fault forecasts and early warning of fault volumes up to one week ahead. P4R combines multiple complex data sources with novel statistical learning techniques to produce accurate fault forecasts. Furthermore, by quantifying forecast uncertainty, P4R empowers users to act and manage risk proactively for the first time, aided by a user interface developed in collaboration with control room engineers. Beta phase SIF funding is required to operationalise and enhance the prototype developed in Alpha and trial the system in a live environment.

Most relevant state of the art product: Existing commercial offerings are unproven with limited features, such as lacking fault-specific forecasts and detailed uncertainty quantification. No past innovation projects have considered probabilistic fault prediction and related decision-support, leaving a significant gap in DNOs' predictive capability. The one related fault forecasting product on the market today has been developed for the US for very different network design, weather conditions and user needs, and so far has a limited client base. The key technical feature of P4R, accurate fault prediction for GB's electricity networks (and data) and unique weather conditions, has not been demonstrated by any other product.

Compared to the most relevant state of the art product, the fault forecasting capability being developed by P4R represents a step-change in forecast quality and utility. Engagement with end-users in Discovery and Alpha has produced a detailed specification for forecast information and communication which is not met by any existing product or service. Users require predictions not just of the most likely number of faults, but the probability of exceeding key thresholds that impact service levels and decision-making. P4R forecasts the probability distribution of the number of faults at multiple time points over the next seven days and communicates this via traffic-light system for key thresholds. Our testing of the Alpha prototype correctly predicted the risk of "red" fault levels (the most severe) 85% of the time at one-day-ahead and provided early-warning of this risk 5-7 days ahead in the majority of cases.

Beyond incremental innovation: P4R represents a major shift in practice away from exclusively human interpretation of basic weather forecasts to sophisticated data-driven analytics. End user assessment has verified that P4R forecasts are actionable and expected to lead to multiple immediate benefits, which will be enhanced by continuous improvement, opportunities for which have been identified in Alpha (see appendix).

Integration and Commercial Readiness: The current IRL is 4 (quality and assurance of integration) and estimated to be IRL-7 (verified and validated) at the end of Beta. The current CRL is 6 (product optimisation) and estimated to be CRL-8 (market introduction) at the end of Beta.

Scale, SIF objectives and the relevant Innovation Challenge: The proposed scale of P4R's Beta phase represents the multi-party effort required to industrialise the code base, data pipelines and user interface prototyped in Alpha, add further innovative enhancements, and run live trials to verify the performance and utility of the system in an operational setting with the view to scaling the solution to meet the needs of other sectors and stakeholders in due course. Once implemented, P4R will bring immediate benefits to network customers though enhanced resilience and robustness. This project directly addresses the Data and Digitalisation Innovation Challenge by making novel use of data and digital platforms to significantly improve "network planning, modelling and forecasting capabilities". The P4R forecasting system is a "user driven next-generation digital product" designed to improve weather resilience. P4R is presently focused on electricity distribution, but engaging with electricity transmission (NGET, SPT) and the rail sector (Network Rail), and potentially others in the future.

This project cannot be funded elsewhere or considered as part of BAU activities because the solution is as yet unproven and requires innovation support to both increase the TRL and enable BAU adoption, something not permitted within price control funding.

P4R does not undermine the development of competitive markets. It will bring a new product to an existing albeit nascent market, and far from undermining the development of this market, it will stimulate the market by injecting fresh competition.

Counterfactual approaches have been explored throughout Discovery and Alpha, using multiple candidate weather data products, statistical modelling approaches, and user-interface designs, amongst others. Quantitative (accuracy metrics) and qualitative (user feedback) have been employed to identify and develop the most appropriate solutions. Alpha concluded (Deliverable 3) that multi-model ensemble weather forecasts and non-parametric modelling produce the most accurate fault predictions, and that a “traffic light” system with options to drill-down into forecast data provides users with optimal user experience and access to information, thus facilitating decision-making.

Impacts and benefits

By accurately predicting how many and where network faults are likely to occur up to 7 days in advance, P4R will have resources onsite earlier, enabling power supply to be restored sooner than is currently possible and minimising disruption for customers to bring about financial, social and environmental benefits.

Having established those faults where P4R would enable an earlier restoration time, the size / scale of that time saving was applied to potential benefits. The impact of the new restoration time was modelled for the relevant faults and the new value compared against the counterfactual.

The modelling utilised actual fault data from the last 5 years and the values for actual CML costs have been taken directly from SPEN's Reporting System for Exceptional Event Claims. Should the number of extreme weather events vary significantly from these 5 years then the benefits realised would also vary.

Following this modelling, the following benefits are anticipated with Year 1 taken as 2026 when BAU begins, and the discount starting in 2021. The values below reflect the preferred option of 2 DNOs generating benefits from P4R.

‘Cost savings to consumers (£m)’

A loss of power supply increasingly inconveniences individuals and businesses, especially the vulnerable and with working from home becoming more prevalent. Living without modern conveniences can cause anxiety, with appliances’ battery-life diminishing, particularly for the medically dependent. Places of work may be closed, causing lower-income families further stress because of lost wages. P4R’s social benefits have been calculated by multiplying the expected CML savings from P4R by the societal CML value in the CBA.

Year 1: £583,008

Year 3: £3,254,791

Year 5: £6,011,850

Year 10: £12,128,932

Cost reductions in operating the networks and wider energy system (£m)

CML Savings: DNOs are set targets for the number of unplanned CMLs on their networks (the outage duration multiplied by the number of customers affected). Performance against these targets is linked to financial rewards and penalties. Having resources strategically positioned ahead of time in those areas most likely to be impacted will lead to a reduction in outages which in turn creates a financial CML payment saving to the DNO. These figures do not include extreme weather events which are excluded from the incentive mechanism.

Year 1: £66,995

Year 3: £374,016

Year 5: £690,837

Year 10: £1,393,766

Guaranteed Standards of Performance (GSP) savings: GSP sets out how quickly DNOs must restore power following an interruption in supply. Should DNOs not meet these standards, customers are entitled to statutory compensation. With quicker restoration, some customers' outage duration will therefore be brought under a GSP time threshold, creating a financial saving to DNOs.

Year 1: £19,868

Year 3: £110,918

Year 5: £204,873

Year 10: £413,333

Storm Support: As part of DNO's Storm Support, they provide meal vouchers, alternative accommodation (eg hotels) and warm packs (eg hats, gloves, blankets, torches etc.) to customers who are off supply for extended periods. P4R will drive a reduction in the need to provide Storm Support to affected customers, creating a financial saving to SPEN.

Year 1: £47,580

Year 3: £265,630

Year 5: £490,638

Year 10: £989,865

Fuel Savings: When power supply restoration is anticipated to be longer than usual, DNOs will provide onsite diesel generators to supply back-up power to its customers while that fault is repaired. P4R will result in both a reduction in the need to provide a generator as well as shortening any time they are required. A reduction fuel consumption creates a financial saving to SPEN.

Year 1: £7,730

Year 3: £43,157

Year 5: £79,715

Year 10: £160,825

Carbon reductions – direct or indirect (MTCO2e)

Renewable generators need a reliant connection to the network to operate and sell their electricity. Long network outages therefore prevent renewable generation accessing the grid with potential carbon impacts.

Additionally, as part the Storm Support, when any power restoration is anticipated to be longer than usual, DNOs aim to provide onsite diesel generators to supply back-up power to its customers while that fault is being repaired (the assumption was taken that diesel generators were provided to 1 in 5 faults when the outage went beyond 8 hours). P4R is expected to deliver a potential improvement to those restoration times resulting in both a reduction in the need to provide a generator as well as shortening any time they are required. This reduction diesel has an associated carbon emission reduction benefit.

Year 1: £3,416

Year 3: £19,435

Year 5: £36,442

Year 10: £76,230

Predict4Resilience also anticipates other, wider benefits which are captured within the Benefits Map. These include the associated benefit for other agencies. In a storm scenario, DNOS work with a wide range of partners and some vulnerable residents are relocated.

Project Plans And Milestones

Project Plans, Milestones & Risks

WP1: Project Management

Lead: SPEN

Description: Management of the delivery of all work packages & dissemination of the results

Relevant Success Criteria: Successful delivery of the project, on time and within budget.

SIF funding allocation: £120,152

WP2: Solution Implementation

Lead: Sia Partners

Description: Implementation of the prototype designed during the Alpha phase, including building the infrastructure supporting the solution, the software itself, the industrialisation of the models and the user interface.

Relevant Success Criteria: Live forecasts produced automatically, user interface developed and endpoints connected and successful in penetration testing. Secure solution ready for trial.

SIF funding allocation: £1,869,253

WP3: Business Live Trials

Lead: SPEN

Description: Test the solution in live conditions by a team of Champions with multi-disciplinary skills

Relevant Success Criteria: Solution supporting decision in fault response during the winter and summer.

SIF funding allocation: £1,870,385

WP4: Enhancement

Lead: University of Glasgow

Description: Provide additional capabilities to the solution and improve the accuracy of the fault forecast

Relevant Success Criteria: New model published using multiple weather models, extreme theory, new fault types and license area level.

SIF funding allocation: £456,738

WP5: Commercialisation

Lead: Sia Partners

Description: Prepare the transition to BAU for DNOs, investigate future potential of other projects and set up the organisation for further rollout

Relevant Success Criteria: Commercial organisation agreed amongst partners

SIF funding allocation: £202,076

Main risks

While no major risks have been identified, as with any innovation, other less significant risks are to be expected and will be mitigated as part of the process. Known opportunities and benefits significantly outweigh the risks, and these benefits to the sector and customers are sufficient to justify the acceptance of the identified risks. The full risks associated with this project are captured in the Risk Register, with the main risks being:

Project Set Up Delayed: with funding notification in June, the project will have to mobilise quickly if it is to have built the solution in time for the winter trial phase in Autumn 2024.

Weather: the project will require a series of severe weather events for the solution to be rigorously tested during the trial phase. Should the UK undergo an extended period with little or no severe weather, then it may be necessary to delay the transition into BAU until the solution has been tested.

Business as usual adoption risks

Alignment and integration with other systems: any new, integrated IT solution must undergo rigorous testing with existing infrastructure and security before it can be accepted into BAU. This will be mitigated through an ongoing dialogue with the relevant individuals throughout the Beta Phase, ensuring that any potential issues are identified and resolved in a timely manner thereby avoiding any delay to the implementation of the solution.

Risk management strategy

P4R has put in place a clear, rigorous and pragmatic approach to identifying and managing the key programme risks, with assurance from necessary individuals to ensure an appropriate approach to mitigating these for the foreseeable future.

The Project Manager will take ownership of managing project risks. The Project RAID log has been built as part of this application and ensures that risks are clearly documented to effectively track and manage them as part of achieving the project delivery. A review of these Project Risks will also form part of the standing agenda within the regular project progress meetings with any mitigations assigned within the team. These sessions will also be used to review best use of resource and ensure that internal experts are prepped for providing support. Finally, an internal escalation process is established to be used if required.

Stage-gates

These are critical to assessing whether the current business strategy remains relevant throughout the project. The take into consideration the programme performance and provide assurance that it can demonstrate core KPIs are being met / exceeded and that performance meets projections. They will also highlight key barriers to scaling the solution, while monitoring and recommending ways forward.

These Stage Gates provide a formal mechanism to critically reflect on progress made and process to achieve the desired outcomes. The proposed stage gates are:

· Business Trials Go / No Go: decision at the end of the Solution Implementation work package as to whether the solution is fit for trialling. Only when all parties are satisfied that it is ready will the trials commence.

Second Summer Trial: decision taken following the conclusion of the second winter trials (April 2026) to ascertain if the solution would benefit from another trial phase over that coming summer or whether it is not necessary.

Regulatory Barriers

There are no regulatory barriers or uncertainties which have been identified by the project team or expert assessors in either the Discovery or Alpha assessment.

Additionally, there are no derogations, licence exemptions or regulatory sandboxes which would be required to deliver the Beta Phase of this project. Nor are there ongoing conversations with Government, Ofgem, and other relevant organisations which are pertinent to the Beta Phase of this project.

Finally, no longer term policy considerations have been identified which would need to be incorporated into the business-as-usual rollout of this solution.

Business As Usual

BAU adoption as a priority

We will undertake trials of sufficient duration to ensure testing of seasonality and which then enable continual improvement via liaison with the end-user. The solution will be trialled at SPEN over a two-year period during the Beta Phase, with a second DNO joining the trial for the final 18 months . This will enable trials to run over 2 consecutive winters when storms are most prevalent, as well as 2 summers where the certain networks have historically suffered issues with heat-related faults to some assets. These trials will provide invaluable data from a live environment with the intended end-users. They will enable the further refinement of the statistical modelling, the identification of additional enhancements as well as feedback into the operability of the user interface in a live control room setting prior to their implementation ahead of adoption into BAU.

Supporting the innovation from idea to business-wide adoption

This project has buy-in from across the organisation and has ultimately been signed off by both SPEN's Executive Board and Innovation Board. As the end solution user, there are also key individuals within the relevant business functions who have been consulted throughout P4R's development from the outset to ensure the UX is fit for purpose and matches the company needs at a Control Room level and beyond.

Additionally, as project partners both Sia Partners and the University of Glasgow will continue to promote and support the adoption of the solution both within SPEN and more broadly. With a global footprint and DNO / Rail / Telecoms clients across Europe, Sia Partners is well positioned to bring the solution to new businesses and leverage their existing client base to do this.

Championing the implementation of the innovation

Key roles have been identified from those within the Beta Phase project team, who have been involved in the solution's development to date, have a sound understanding of the project's evolution and are important supporters. They will be responsible for training the identified 'Solution Champions' after the trial stages have been successfully completed. These selected Champions will then in turn train the 'Super Users', experienced individuals with a background in learning and development, who will provide wider training and dissemination among the business, acting as advocates within their department.

There will also be designated individuals within the project team who will be responsible for sales, onboarding and training the solution to new organisations. Within the entity that supports the ongoing platform there will be a marketing function which is responsible for promoting the solution to other DNOs (and adjacent sectors) both within GB and internationally. There is a Go-to-Market plan developed as part of the Alpha Phase which considers the approach that this function could take.

Funding strategy for adoption

At this stage, the commitment of the consortium is limited to the Beta Phase. During the Alpha phase, we further developed the commercial model of the solution and agreed the associated funding required. The Commercialisation (Work Package 5) will further develop the arrangements for successful roll out of the solution and each partner will be able to confirm their position regarding their role in the adoption of the final solution.

Adoption of the project's learnings

It's recognised that each DNO will have different network configurations and operational characteristics so likely to be affected differently by inclement weather and acknowledged that further refinement and enhancement of forecasting models will be required to address this.

As part of the Alpha Phase, all DNOs were engaged to understand both their appetite for a solution such as P4R, as well as ensuring that the requirements and perspectives of other DNOs were incorporated into the prototype during its development. As part of the Beta Phase, the project team will engage with these DNOs again, working with the relevant individuals within the interested parties to help them understand how P4R could benefit their organization. By using both the trials from SPEN and SHEPD as well as the ongoing BAU performance as a test case, it will be possible to demonstrate the value that P4R can deliver to both DNOs and customers, as well as sharing learnings which are relevant to them, and which can be readily adopted.

Indication of interest

The overall feedback from the engagement in Alpha was positive. The project team held workshops with both ENWL and SHEPD, as well as Network Rail. With SHEPD agreeing to join the Beta Phase trials.

It is the intention that P4R could be rolled out to all other DNOs and utilities within GB, as well as adjacent sectors such as:

- Network Rail
- Highways Agency
- Telecoms.
- Agriculture
- Air transport
- Marine transportations
- Offshore Oil & Gas
- Offshore wind farms

Commercials

Consumer interaction and engagement

P4R is a software solution for use within the DNO's Control Room primarily and for local coordination of field staff, rather than a visible, tangible asset installed on the network or within a consumer's home. It also won't have an impact on any consumer premises, or create a change to their charging or contractual arrangements. It is therefore anticipated that most consumers are highly unlikely to interact with this project directly, and will be largely unaware of its existence. However, while studies recognise how few customers understand the role of DNOs or how they work, these consumers consider continuity of supply as the major role for a DNO. As such, while they may have limited engagement with P4R as a solution, they will be the direct beneficiaries of its impact.

It is anticipated that they will notice the following impacts of P4R before and during a storm:

1. Restoration of power supply sooner

2. Better advanced information regarding potential outages and the ability of the DNO to provide storm warnings to customers in advance

3. Better customer satisfaction through better communications and an earlier restoration time

A potential collaboration with Resilience Direct will be further explored during the Beta Phase. Resilience Direct is a government portal that enables civil protection practitioners to work together – across geographical and organisational boundaries – during the preparation, response and recovery phases of an event or emergency. P4R may be able to provide proactive information into this forum to enable them to better respond to upcoming weather events.

A key part of the plan is the dissemination of the learnings from the project and there are expected to be regular sessions throughout the trial phase. However, given the technical nature of the project and that it is not anticipated to directly involve the consumer, the attendees are expected to be those relevant individuals from within the industry, academia and adjacent sectors rather than members of the public.

Supply shortages and interruptions

It is not envisaged that P4R will lead to any interruption to the customers' supply. As a software solution, P4R will not require the installation of any physical assets on the electricity network which could require an interruption to customer power supply.

The development and rollout of the software will be done in accordance with SPEN's IT Governance, ensuring it is compatible with the company's current security infrastructure. It will only be implemented into BAU once all relevant members of staff have been trained on the platform and the company is confident in the role it will play in assisting the decision-making in response to an upcoming weather event.

Commercialisation

A Go-To-Market strategy was delivered within the Alpha Phase, utilising a prioritisation matrix which identified two key areas of priority beyond the core focus of GB DNOs.

Target Geographies:

Electricity networks in other countries were identified for roll-out based on the location of other Iberdrola Group subsidiaries and Sia Partners hubs.

USA: Iberdrola subsidiary, Avangrid Networks, operates 4 electricity networks in New York and New England, covering a total of 72,000 miles of distribution lines, 9,000 miles of transmission, and 2.2m customers. Additionally, there is a strong Sia Partners presence with direct links and credentials with Exelon Corp and Pike Corp.

Ireland: Sia Partners have strong relationships, particularly with ESB Networks, which operates the transmission and distribution networks in Ireland. With over 93,000 miles of overhead lines, these outnumber underground cables by 6:1. Weather patterns and the relationship with faults is likely to be similar to the issues facing SPEN.

Spain: Home of Iberdrola Group, and network subsidiary, I-DE Redes Eléctricas Inteligentes, covering around 170,000 miles of distribution lines and 11m customers. Iberdrola has released a call for solutions that make it possible to make predictions that plan and quantify climate-related risks, specifically damage caused by falling trees.

Adjacent Sectors:

Numerous sectors in the UK have been assessed to identify those with networks of infrastructure or individual assets that are subject to weather-related faults/disruption, and where, with limited rework to the solution, there may be benefit in predicting these faults to drive near-term operational decision making.

Transport: Network Rail currently use a weather forecasting service, plus visual and thermal imaging, and review historic failure data alongside weather data to improve understanding, as well as weather stations to monitor live temperature data. Around 250k miles of road in the UK are subject to expensive weather-related disruption and more action is required from asset operators.

Telecoms: Openreach has been reviewing its approach to extreme weather after the extreme weather that occurred in 2022. It has set up a new Storm Response Unit and it is anticipated that there could remain the need for a solution which focuses on the impact of wind events on cabinets, and potential for a power outage forecasting tool.

Water: Heavy rainfall, combined with other weather variables, can lead to stressed wastewater networks and storm overflow spills. There is currently very limited monitoring of spills, and no known use of forecasting tools, but the wider issue is now a major focus for the sector.

Customer Value Proposition:

Severe weather can have a devastating impact and weather risk is front-of-mind for the sector after some recent high-profile issues both in the UK and internationally.

Following Storm Arwen, it has been found that some affected customers remained off power for an unacceptable amount of time, received poor communication from their network operator and compensation payments took too long, leading to £44m of payments by DNOs1.

Storm Arwen caused an extra 12,000 faults on the Openreach network in a single week2 and Storm Eunice caused loss of service for over 19,000 customers3. While in the rail sector, weather has cost Network Rail at least £3bn in delays and cancellations, insurance claims and autumn preparation alone over the last 15 years, with weather-related delays accounting for almost £1bn of this4.

In the water sector, overflows are a huge issue with public and political scrutiny and companies are under significant pressure to make massive investments in this space to improve outcomes.

There is a clear need for a tool which enables better storm preparation alongside clear benefits in restoring supply sooner. The key competitors have been assessed and the drawbacks to the other solutions on the market indicate that there is no direct competitor in the UK. The most pertinent differentiators for P4R have been mapped out as part of the GTM and these are the key factors that will support roll-out of the solution to other DNOs, sectors and geographies.

During the Alpha Phase, the project team held discussions with a number of GB DNOs to understand their appetite for the solution as well as their willingness to take part in a trial phase during the Beta phase. The preferred option for the Beta phase involves partnering with one other DNO to enable testing of P4R outside of SPEN's ecosystem, ensuring that this solution can be rolled out to multiple companies and giving greater confidence of its successful adoption as BAU.

Following the trials within SPEN and SHEPD, there are no plans for any additional capital requirements in order to commercialise this innovation. Instead, the ambition is that key stakeholders within the project team will drive business-wide adoption, create a commercialisation strategy for funding the roll-out and be responsible for its implementation with other DNOs prioritised for the first phase of the roll-out.

1 https://www.theguardian.com/business/2022/jun/09/ofgem-fines-energy-firms-44m-for-appalling-storm-arwen-disruption

2 https://www.ispreview.co.uk/index.php/2022/11/openreach-uk-prepares-for-another-winter-of-storm-damage.html

3 https://www.openreach.com/help-and-support/damage-health-and-safety/extreme-weather

4 https://www.networkrail.co.uk/wp-content/uploads/2022/01/Network-Rail-Third-Adaptation-Report-December-2021.pdf

Intellectual Property Rights

All partners have confirmed their position to align to the default IPR position as outlined in SIF Governance Chapter 9. Each partner will sign a collaboration agreement with SPT which contains a specific schedule to align to this position.

Any background IP will be clearly documented, and all Relevant Foreground IP will be captured in an Intellectual Property Register, built from the Alpha Phase. The objective of the register is to ensure clarity and transparency to all partners around the Intellectual Property arrangements.

During the Alpha Phase, the partners have agreed their IP position in principle and an IP register is in place between Sia Partners and the University of Glasgow. At the end of the Beta phase, each partner will be able to confirm their position regarding the final solution. The partners will ensure transparent dissemination of knowledge and potential transfer of ownership of Intellectual Property Rights if required.

The commercialisation work package will further develop the arrangements for successful roll out of the solution and the associated licensing of background and foreground intellectual property rights, in accordance with the Royalties arrangements described in the SIF Governance.

Costs and Value for Money

Project costs: The total cost to develop, trial and implement the P4R model is calculated to be £5,020,671. This is comprised of:

Labour and overhead costs: £4,715,671

Travel costs: £98,500

Material costs: £206,500.

Compulsory contribution: The 10% compulsory contribution will be met via in-kind staff-hours from each of the project partners. This offers clear value for money as this enables the project teams to work flexibly to deliver project aims, calling on further additional resources as and when required. The partners are willing to take on this risk in this phase and are committed to working flexibly to ensure the project deliverables and milestones are each made on time.

Balance of costs and SIF funding

SPEN - £1,172,150 total costs of which £117,215 are SIF Funded

Sia Partners – £2,994,250 total costs of which £299,425 are SIF Funded

University of Glasgow – £488,546 total costs of which £48,855 are SIF Funded

SHEPD - £365,725 total costs of which £36,573 are SIF Funded

(Should any partner not ultimately join for any unforeseen reason, then the associated costs will be returned via the agreed mechanism to preserve the value for money to the customer).

Subcontractor:

The Met Office and NGET, both partners during the Alpha Phase, will remain as supporters of the project but are not expected to be required as a subcontractor with any associated costs.

Delivering value for money: The business case, built as part of the Alpha Phase, identifies and maps the benefits and beneficiaries associated with the functionality of P4R. It clearly demonstrates how the value P4R can create would far exceed its costs, with the enduring value realised by all users, with customers and the environment being the ultimate beneficiaries.

The preferred option of P4R being utilised and rolled out across both SPEN and another DNO partner would see expected accrued net benefits of over £15.1m in the first 10 years after adoption in BAU. Given the attractive cost to benefit ratio, these financial metrics would only improve as more DNOs incorporated the solution into BAU.

However, should SPEN be the only end-user of P4R, the anticipated net benefits over the same 10-year period would be £7.8m.

P4R also anticipates other, wider financial benefits to SPEN which have not been quantified as part of this analysis, including:

Improved operational practices: with greater advance warning, it is possible to minimise costs associated with cancelling planned outages by either cancelling or relocating work.

Improved Customer Service: better able to communicate storm warnings to customers in advance, which should in turn lead to better scores in SPEN's Broad Measure of Customer Satisfaction, an incentive revenue as part of the regulatory framework which rewards good performance with a financial benefit.

Additionally, all potential costs have been minimised / mitigated and P4R recognises the existing mechanism for returning unspent funds should they not be required.

Cost comparison and project changes:

The project team has ensured that it has the appropriate level of seniority represented on the programme, while giving higher workload to more junior supporting resources. This brings higher value for money to the project by reducing overall rates and total costs yet ensuring quality of delivery.

This approach sees a continuation of many of the same personnel who have been involved in the successful delivery of the Alpha Phase. The team is deeply familiar with the project and can therefore ensure that the project is able to mobilise quickly, helping mitigate one of the key programme risks.

Innovation Justification Appendix: Specific technical areas for innovation

The following specific topics are areas requiring further innovation to realise the full benefits of data-driven fault prediction and have not been explored to date due to time constraints in the Discovery and Alpha phases.

Multi-model ensemble NWP

In Alpha, we have demonstrated that there is a benefit of using a multi-model ensemble, blending the ECMWF Ensemble with ECMWF's high-resolution deterministic forecast. There are many other weather models available, and we may not use any ECMWF NWP in the final solution. Furthermore, the optimal selection and method for combining these NWP products requires development to maximise the benefit of the multi-model approach. Ultimately, we will have to trade-off between the number of NWP products (maximising forecast performance) and the cost associated with each additional NWP product.

Fault modelling: new fault types

The development of fault models has focused on fault mechanisms that affect SPEN's licence areas, which are primarily wind related. As we expand to other licence areas, other fault types will require models to be adapted developed, e.g., in areas where snow/ice are more prevalent (North Scotland).

Fault modelling: extremes

The fault models developed to date have focused on the bulk of the predictive distribution (probability ranges from 5% to 95%). This enables us to quantify the 1/20 risk, however, forecast users must manage more extreme risks, e.g., 1/100, which require special treatment using Extreme Value Theory. Therefore, the existing approach will be extended with models for the right-tail of the predictive distribution of faults (very high numbers of faults) to quantify the risk of low-probability, high-impact events, and "worse-case" scenarios.

Fault modelling: spatial, and spatiotemporal model

The occurrence of faults in neighbouring districts may or may not be correlated, depending on the weather situation. An areal (spatial) model will allow information to be shared between districts, potentially improving model estimation and predictions for each district, while also modelling the spatial correlation structure. Areal models can be computationally demanding; therefore, we will explore the development of inferential techniques that will allow us to estimate models and generate predictions in a reasonable amount of time. Similarly, a temporal modelling will enable forecast to be produced in a flexible continuous time nature, rather than in pre-specified 6 or 24-hour block as in the Alpha prototype.

New feature: weather event matching

Users of the fault forecasting tool have requested a feature which presents to them similar weather/fault events from the past. Methods exist for identifying similar weather types, but these are general purpose and not optimised for considering both weather type and weather impacts. An innovative approach that matches weather events and impacts on electricity networks will maximise the value of this feature to users. One approach would be to consider the distance between distributions to include effect of covariates, weather impacts, and variability of the data generating process.

New feature: integration with resource allocation and scheduling tools

The availability of accurate fault forecasts creates the opportunity for integration with existing and new systems, including resource allocation and scheduling tools. Software for managing and optimising resource allocation is already improving operational efficiency and could be enhanced if combined with fault forecasts that give a consistent view of resource requirements in the days ahead across an entire licence area, and made available to all relevant teams and functions. This opportunity will be explored in Beta.

Document upload

Documents Uploaded Where Applicable

Yes

Documents:

Benefits Map - P4R.pdf

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This project has been approved by a senior member of staff

☑ Yes