SIF Beta Project Registration

Date of Submission

Feb 2025

Project Reference Number

10145998

Project Registration

Project Title

Artificial Forecasting

Project Reference Number

10145998

Project Licensee(s)

Northern Powergrid

Project Start

Feb 2025

Project Duration

24 Months

Nominated Project Contact(s)

Daniel Hoare

Project Budget

£3,664,540.00

Funding Mechanism

SIF Beta - Round 1

SIF Funding

£3,298,086.00

Strategy Theme

Data and digitalisation

Challenge Area

Unlocking energy system flexibility to accelerate electrification of heat

Lead Sector

Electricity Distribution

Other Related Sectors

Electricity Distribution

Lead Funding Licensee

NPg - Northern Powergrid (Northeast) Limited

Funding Licensees

NPg - Northern Powergrid (Yorkshire) Plc

Collaborating Networks

Northern Powergrid

Technology Areas

Comms and IT, Digital Network, Modelling

Summary

As DNOs develop their distribution system operator functions, the current annual process used to forecast load at extra-high-voltage/high-voltage needs to become

increasingly granular, at the monthly, weekly, daily and hourly level, to support flexibility dispatch and defer or avoid reinforcement. Moreover, the increasing prevalence of low-voltage monitoring data enables new use cases to support network planning and the extension of flexibility markets at ED3. The Artificial Forecasting project addresses these unmet needs by building innovative AI solutions to expand load forecasting capability at primary (EHV-HV) and secondary (HV-LV) substations, optimising flexibility procurement and enabling DSO functions across the sector.

Project Description

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Nominated Contact Email Address(es)

yourpowergrid@northernpowergrid.com

Project Description And Benefits

Applicants Location

NORTHERN POWERGRID LIMITED (Lead)
NE27 0LP

EV DOT ENERGY LTD
EC2A 4NE

FACULTY SCIENCE LIMITED
EC1V 9BW

OAKTREE POWER LIMITED
W1D 3SG

Project Short Description

As DNOs develop their distribution system operator functions, the current annual process used to forecast load at extra-high-voltage/high-voltage needs to become increasingly granular, at the monthly, weekly, daily and hourly level, to support flexibility dispatch and defer or avoid reinforcement. Moreover, the increasing prevalence of low-voltage monitoring data enables new use cases to support network planning and the extension of flexibility markets at ED3.

Innovation Justification

How does your Project continue to demonstrate novel and ambitious innovation in energy networks? Why is it suitable to be funded by SIF rather than other sources?
Challenge:
Novel technical, process and market approaches to deliver an equitable and secure net zero power system. The project addresses theme 3, effectively managing peak demand and stability through increased flexibility, by developing AI solutions to optimise flexibility procurement. By sharing information with FSPs, it aims to stimulate growth in DNO-procured flexibility, providing increased opportunities for flexibility tenders to manage peak demand. It satisfies the eligibility criteria on funding and contribution/timelines, including an FSP with direct customer interactions (EV.Energy) and technology provider/significant operator of (commercial) assets that provision flexibility (Oaktree).
Lessons from previous innovation:
Throughout Discovery/Alpha, project partners built a strong understanding of the forecasting solution requirements in the context of flexibility service definition and procurement. Lessons have included how best to overcome data quality challenges, methodology selection and optimising the route to deployment.
DNOs have carried out AI innovation work (NIA_ENWL_020 AI and Machine Learning, UKPN NIA_UKPN0070 Envision, and SSEN_0 Transition). Engaging with peer DNOs highlighted barriers in scaling these concepts, the urgent need to integrate solutions into flexibility decision-making, and the opportunities for novel machine-learning techniques.
Innovative aspects:
Novel forecasting methods: The models developed in this study (e.g. Temporal Convolutional Neural Networks) are novel relative to existing studies, and have been selected based on data needs accompanied by domain-specific performance metrics. These can deliver significantly improved accuracy relative to existing methods.
Load disaggregation: The solution undertakes a novel approach to forecasting HV load, separately modelling gross demand and distributed generation.
Existing studies treat net demand as a single time-series, or estimate distributed generation based on simple heuristics; methods that will become inaccurate as

distributed generation grows.
DNO/FSP coordination: Sharing forecast outputs externally with FSPs is an innovative initiative providing market participants with the information to stack their capabilities; this could also allow FSPs to develop innovative offers that factor in e.g. carbon impact versus peak load reduction.
Scalability: The techniques developed are scalable across all primary and secondary substations; extending beyond the limited PoCs in previous work (e.g. SSEN Transition included c.10 substations). This is particularly impactful at LV where flexibility procurement and forecasting capabilities are more nascent.
Stakeholder Engagement:
Success of this solution has been reliant on stakeholder input. Together with DNO SMEs, FSP partners have informed how technical specifications can meet the needs of market participants (e.g. performance metrics). At Beta we will engage with DNOs through the Energy System Catapult Forecasting Forum and will continue to engage with European partners at CIRED. To optimise sharing of forecast outputs and ensure requisite user testing, we plan to engage FSPs through NPg's in-house flexibility teams. In 2025, we plan to engage with the Central Market Facilitator to coordinate the integration of the solution, facilitating a wider industry rollout.
Current TRL/IRL/CRL:
TRL5; significant step in technology validation from testing multiple forecasting models.
IRL3; increased due to Alpha activity improving understanding of solution integration.
CRL5; progress in understanding the value proposition in Alpha.
Size and scale:
Conducting work with the existing partner set over two years provides the rigour required for a deployment of a robust forecasting solution while minimising time to impact.
Funding:
The approaches developed in this project are being developed at a scale, with an inherent risk of failure, that are incompatible with BAU resources. Moreover, the opportunity to collaborate (via SIF) with partners who are leaders in flexibility service provision and data science enables rigorous solution development, over and above BAU.
Counterfactual solutions:
The alternative to this approach, i.e. expanding existing approaches cannot deliver the requisite scalability, given the extent of human interventions required and frequency of forecasting necessary to optimise flexibility procurement.

Impacts and benefits

Pre-innovation baseline: Our solution represents a critical enabler of NPg's DSO functions, providing new capability over and above business-as-usual (BAU). The baseline therefore reflects BAU expenditure items set out in NPg's ED2 DSO strategy from 2024-2028. BAU expenditure is phased using the rate of asset investment.
To estimate ED3 BAU expenditures, a conservative uplift of 5% is used to estimate aggregate expenditure relative to ED2 for non-reinforcement items. A 5x aggregate multiplier is projected for EHV/HV and HV/LV reinforcement costs in ED3 relative to ED2. This reflects the considerable interventions required as the network evolves over the next decade.
The baseline therefore covers the period 2024-2033, for which reasonable foresight can be provided, and includes line items associated with:
Network reinforcement costs
DSO strategy investment in skills and systems
Benefits/Cost savings from DNO-contracted flexibility
Investment in flexibility market stimulation
Tracking: Baseline expenditures/savings through ED2/ED3 act as an aggregate

metric to assess realised benefits. For network reinforcement and flexibility decisions, NPg also assesses the relevant opportunity costs (cost of the next-best option) at the time of procurement, which can enable tracking of costs/savings attributable to the Artificial Forecasting solution (e.g. when used to refine dispatch windows).
The core technical performance of AI load forecasts will be benchmarked using metrics including mean absolute percentage error, incorporating learnings through automated retraining. An intangible success criteria represents their adoption and trust by NPg within flexibility procurement decision-making, following extensive user testing at Beta.
Quantified benefits to date (Option 1):
i) Reduced costs of operating the network
Reinforcement: Accurate primary and secondary load forecasts enable more efficient flexibility procurement and targeted reinforcement spend, estimated at 3% of EHV/HV and HV/LV reinforcement costs at ED2, and 6% at ED3 (derived from prior efficiencies observed from the implementation of PI historian) (c. £65m total 2024-33, pre-discounting).
Flexibility: The forecasting solution enables dynamic, semi-automated procurement, with revision of flexibility service windows closer to the time of use. Semi-automation combined with stimulation of wider FSP participation is projected to reduce costs/increase savings delivered through DNO-contracted flexibility by 25% (c.£10m).
ii) Avoided costs
Resources: Expanding current manual approaches in the absence of integrated AI forecasting solutions would require considerable labour costs, estimated at £0.5m annually conservatively. In practice, the resources required to expand existing methods on a substation-by-substation basis at EHV/HV and HV/LV could be considerably higher.
iii) New revenues for FSPs:
By increasing deliverability of flexibility contracts, and by reducing barriers to procurement, the solution can stimulate wider growth in use of market-based solutions. Based on the proportion of flex-suitable sites identified through NPg's community DSO project, with assumptions on maximum demand, attribution rates and unit prices, c.£1m of additional FSP revenue would be attributed to this solution.
iv) Carbon benefit:
Flexibility not only implies load reduction, but many providers such as Oaktree Power target emissions optimisation, not simply cost. Using the volume of flex attributed to this solution in iii), GHG conversion factors and estimating a 10% attribution, c.700 tCO_2e would be avoided in aggregate until 2033, attributable to this solution.
This will be supported by qualified benefits including the evolution of flexibility products (e.g. 30-min granularity allows for better programme stacking), together with wider AI/data readiness.
The whole-life NPV is c.£60m for Option 1. Option 2 considers wider rollout to 3 additional DNOs following completion of the Beta Phase (whole-life NPV c. £250m).
Benefits realised to date include a centralized understanding of HV/LV monitoring data, and how AI solutions can be applied to network decision-making. By examining readiness for this solution, NPg have gained significant learnings regarding 'live' data availability, quality and deployment readiness.

Project Plans And Milestones

Project Plans, Milestones & Risks

How will you manage your Project effectively? What is your Project plan? What are your milestones? What are the risks associated with your Project?
Beta will deploy a scalable forecasting solution within a dedicated cloud environment (WP1,2,3), identify and implement the change management measures necessary for NPg to adopt the solution post-Beta (WP5), while finalising commercialisation arrangements that define how the solution will a) be scaled and b) deliver commercial benefit by sharing outputs with FSPs (WP4):

WP1: Data collection and user needs (Lead: Faculty)
Collect revised data samples incorporating data quality mitigations established at Alpha. Confirm user requirements and conduct extensive user testing.

WP2: Model refinement (Lead: Faculty)
Finalise primary and secondary substation forecasting models. Refinements will focus on improving forecast accuracy, particularly at LV, including examination of probabilistic forecasting and communication of uncertainty. WP2 begins with EHV-HV as data is readily available.

WP3: Infrastructure development and model deployment (Lead: Faculty)
Set up a dedicated secure environment to deploy forecasting models (primary and secondary) and host the user interface.

WP4: Commercialisation (Lead: NPg / Flexibility Partners)
Finalise commercial arrangements (e.g. for implementing at a future DNO). Test and validate the solution's utility in refining flexibility procurement processes. Develop both the approach and technical features (front-end interface) to share solution outputs that fosters improved DNO/FSP coordination.

WP5: Change management (Lead: Faculty)
Building on assessor feedback, dedicated work package to outline and implement the change management procedures required for successful NPg BAU adoption, including skills, capabilities and process adaptation. Facilitate targeted upskilling and documentation to ensure NPg and any integration partners are prepared for implementation. (e.g. ongoing model governance framework).

Project management approach:

The project will be delivered by a cross-functional team from each partner. Project management will be Agile, with cross-partner meetings held weekly to discuss progress, priorities and mitigate risks, with standard components e.g. daily technical standups to expand as appropriate. Steering Groups incorporating wider internal project stakeholders will be held every 6-8 weeks.

Stage Gates:

We propose 2 UKRI-administered stage gates at Months 6 and 15 to de-risk the project, particularly modelling at LV. The timing recognises that data dependencies and the need to refine model performance introduces greater uncertainty relative to EHV-HV; hence there are two opportunities for input, firstly to confirm HV-LV data feeds will be available and secondly, to confirm model accuracy is appropriate prior to final deployment.

Stage gate 1 (Month 6): Provides opportunity to review whether live data feeds have been established for the HV-LV components of WP1, WP2 and WP3 to proceed and put in place mitigations, ensure that the Azure platform for model deployment has been fully configured, while also appraising progress of the EHV-HV solution.
Stage gate 2 (Month 15): Critical review point to evaluate the success of the EHV-HV deployment (including model performance) and the progress of the HV-LV component, prior to final implementation. The EHV-HV solution will be deployed and feedback from user-testing will have been collected. Finalisation of the HV-LV models will be in progress, enabling an assessment of model accuracy.
Dependencies/Risk management:

Outcomes for WP1 (data collection) feed directly into WP2 activities (model refinements), which informs WP3 (deployment). To mitigate knock-on risks, activities across work packages are staggered with margin for addressing blockers from a previous packages, together with practical mitigations. For example, WP2 can commence on data obtained at Alpha if WP1 is incomplete.

Highest-impact risks at Beta relate to achieving appropriate model performance for embedded generation and setup of live HV-LV data feeds. These risks will be monitored through weekly partner meetings and mitigated via risk-specific approaches detailed in the risk register, plus the Stage Gate structure above. Where necessary, risks will be escalated to NPg management or the UKRI monitoring officer.

Supply interruptions/consumer access:

None planned.

Regulatory Barriers

Do you consider there to be any barriers with respect to meeting the requirements of regulations, policy or standards?
We do not consider there to be any barriers to meeting these requirements.

Given current wide interest on AI in the energy sector we will continue to engage with Ofgem, DESNZ and others initiatives and activities in this area to ensure no regulations are proposed during project delivery that would materially impact adoption of this solution. Project partners (Faculty) have provided input into Ofgem's wider 'Use of AI within the energy sector' call for input, and we welcome the opportunity to collaborate further in this regard. At this stage, we anticipate that Ofgem's approach will be to develop specific guidance for the sector, minimising the need for formal intervention while ensuring that the regulator has the tools to act proportionately, if necessary.

Business As Usual

How will your idea become business as usual within your network and across the other networks after successful completion of the Beta Phase? What strategy do your Project Partners have for commercialisation of the innovation?
Our commercialisation strategy incorporates two main elements; 1) NPg BAU integration and 2) scaling to wider DNOs.1. BAU Integration: Beta will collaboratively deploy an MVP of the Artificial Forecasting solution, ready for BAU operationalisation. The technical solution comprises: i) robust back-end infrastructure for data cleaning and quality assessment ii) End-to-end forecasting models to refine flexibility service windows closer to time of use, and; iii) standards for model results and metadata, communicated externally to FSPs. Successful BAU technical integration will be underpinned by:

Deployment alignment: The MVP will be built on an Azure instance that adheres to NPg InfoSec protocols, identified at Alpha. This ensures that technical ownership can be seamlessly transferred to NPg.
Monitoring: The solution will incorporate a framework for performance monitoring, including automatic alerting for model and data quality issues, using standard Azure components.
User testing: Iteration of model outputs with NPg end-users and FSPs to ensure alignment with commercial needs. FSPs will be engaged to shape the direction of the output-sharing interface, with DNOs engaged to ensure interoperability.
We recognise that the characteristics (e.g. retraining) of AI solutions differentiate the skills and capabilities required versus 'standard' software. Our plan incorporates a dedicated change management workstream to ensure adoption post-Beta:

Capability assessment: NPg has established in-house data science capability to oversee model performance and guide BAU operation. The solution will be onboarded through NPg's existing IT software integration process, with monitoring and oversight by data science, IT and flexibility engineers. Any skills gaps identified could be mitigated via hiring strategy, or inclusion into the Functional Specification (below).
Planned maintenance and operation: NPg's current IT capabilities are scaled by a third-party technical partner. Ongoing maintenance and operation of the deployed solution will likely require similar support. The project will develop a Functional Specification for day-to-day operation of the model, incorporating e.g. the required cadence for inference and training, requirements for model monitoring, and handling failure of automated tests. This will provide a clear scope that enables such support to be tendered beyond project partners. An integration partner will be selected by the second stage gate, ensuring sufficient on-project overlap.
Handover and Governance: On-project handover includes a three-month support phase in which NPg operate the solution but Faculty provide support. This will be complemented by documentation and security testing of the solution, including a model governance framework.
2. Scaling: Beta will scale the MVP to all NPg substations with available data. Costs to scale internally are not inhibitive, estimated at <$15 per 1000 substations at HV-LV (and lower at EHV-HV). Methods selected are known to handle this scale.

Additional DNOs: Deployment on an independent Azure account, with pre-built data ingestion and cleaning pipelines, minimises technical barriers to scaling to other DNOs (conservatively assumed at 3 in the CBA (1x DNO per year)). Successful further deployments would be a function of appetite and data readiness. DNO involvement via the ESC Forecasting Forum at Beta is designed to bolster market appetite and showcase solution utility, facilitating wider adoption. The cost to further DNOs reflects only the build and adaptation of the solution for their data/software environment (i.e. 0 licence cost). Our dedicated commercialisation work package will formalise these arrangements with a refined post-Beta roadmap produced before Stage Gate 2.

Competitive Markets: To ensure competition, the developed Functional Specification will allow the technical integration partner role to be tendered to any supplier demonstrating necessary capability. WP1 also involves the production of a white paper setting out the solution methodology, features and architecture.

Sponsorship

NPg's Head of Forecasting and Executive, have actively steered the project direction at Alpha and will continue at Beta.

Commercials

Consumer interaction and engagement

Describe how you will engage with consumers and how the Project addresses their needs and preferences. How will your Project benefit them?
Direct customer benefits: NPg's commercial and residential customers are ultimately the providers of flexibility services through adjustment to the operation of their assets; they may participate directly, or via an aggregator. By increasing the access to flexibility service provision, these customers will receive payment for their participation. In addition to participation in flexibility services, customers are also involved in behind-the-meter cost-savings programmes such as minimising electricity costs (particularly affecting those under variable tariffs) or maximising CO2 reduction.

Most commercial and industrial clients can sustain their response for 30-60 min (exceptionally for 90-120 min), with the recovery time typically being 2 hours. It is thus crucial to optimise those 30-min slots to extract maximum value across both flexibility markets and behind-the-meter programmes. The current model of multi-hour standby (and, at times, dispatch) makes the optimisation process challenging for the service provider. The increased decision-making granularity of 30-min will allow for better programme stacking, improving the customer's return.

More time-focused flexibility needs, with shorter service windows, would also result in less disruption to users' operations than existing flexibility products. For example, EV charging turn down would only need to last 30 minutes when flex is most needed versus turning down for a four-hour period. As this would be the most critical 30 minutes, the user should still capture a large proportion of the value.

Indirect customer benefits: customers not directly participating in flexibility service provision will benefit from reduced (deferred or avoided, as set out in the CBA) network costs and reduced local disruption due to fewer or deferred network upgrades. Northern Powergrid's flexibility first approach can be applied more often and be more impactful through the market stimulation and targeted delivery windows that short-term forecasting enables, maximising the potential benefits shared through this route.

Requirements of different customer segments: The refinement of flexibility service windows is intended to widen participation for both HV-connected and LV-connected asset operators and aggregators, enabling a wider set of customers having a route to participation. We will seek opportunities to understand how participants in the Community DSO project can benefit from the service window refinement across both residential and commercial customers.

Equitable benefits: Benefits from deferred or avoided network intervention costs achieved through this project would be shared across the set of NPg customers, regardless of participation in flexibility initiatives. Low income and fuel poor households are typically those with some of the highest energy needs; as such, widening their access to DNO-contracted (via aggregators)/ price-driven flexibility aligns fully with the ambitions of this project. This project can support this wider objective by maximising use of market-based solutions and opportunities for FSPs (and hence customers) to participate and benefit.

Customer input in shaping solution design: FSPs have and will be further engaged directly to shape the direction of the interface that shares forecast model outputs, to signal flexibility need, in particular, how outputs should be communicated, accompanying information, standards, metadata etc. This will be achieved via in-house NPg flexibility teams, also leveraging our project partners' networks outside of this. Fostering improved FSP/DNO coordination and promotion of DNO-procured flexibility markets is a key objective of the Artificial Forecasting solution.

Communication with customers: NPg's existing channels of communication with flexibility service providers will be used to signpost opportunities to participate in the short-term forecasting platform trials and workshop activities. NPg will use their regional decarbonisation events and regional insights workshops to communicate with user groups and local authorities on project progress and opportunities. NPg have direct involvement from our flexible service provider project partners to assist us in developing appropriate and timely communications as the project progresses.

Supply shortages and interruptions

None

Commercialisation

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Intellectual Property Rights

All partners will comply with the default IPR arrangement set out in the SIF governance document.

Costs and Value for Money

What are the Beta Phase Project costs and how are they proportionate to the Project delivery?
Total Beta project costs: £3,664,540

SIF Beta funding requested: £3,298,086

Beta Contributions: £366,454 (10%)

This is balanced as: Faculty 84%, NPg 4%, EV.Energy 6%, Oaktree Power 7% (\>100% due to rounding), reflecting the effort required in delivery.

Each partner is making a 10% contribution to the project, given alignment with their strategic interests. These contributions will be funded from ongoing business activities.

For example, Faculty have not explicitly requested compute costs as an expense, or charged for Senior Director oversight. Such costs will be absorbed by Faculty within delivery. Fixed day rates submitted have also been discounted relative to standard commercial rates that would otherwise apply outside of the innovation fund, with conservative inflation applied to like-for-like roles from Alpha.

To build on assessor feedback from our previous submission, we have incorporated WP5, focused on change management and measures to optimise post-Beta operations, at no increase in total cost from our prior submission. Partners responsible (Faculty, NPg) have absorbed these responsibilities within the original proposed funding. Further, having assessed cost, time profiles and recognising that much of the value comes at the point of deployment, a greater proportion of our funding request comes in Year 2 relative to before. This enables greater customer protections given the Stage Gate profiles and tying of payment to final deployment.

Value for money can also be maximised through appropriate governance and opportunity for oversight and intervention from funding partners. We have included two UKRI Stage Gates in our proposal to balance progress of the work with appropriate oversight:

Stage gate 1 (Month 6): designed to address prior assessor feedback indicating a desire for earlier opportunities for critical review and de-risking of HV-LV data flows, while also balancing a need to make material progress against planned scope. It provides opportunity to critically assess whether live data feeds have been established for the HV-LV components of WP1, WP2 and WP3 to proceed and put in place mitigations, ensure that the Azure platform for model deployment has been fully configured, while also appraising progress of the EHV-HV solution. Mitigations include a re-balancing of planned activities, changes to project scope or funding (to ensure value for money), should these be required. At this Stage Gate, c.25% of project funding requested will have materialised, providing opportunity for intervention before more material funding is accrued.

Stage gate 2 (Month 15): This Stage Gate is designed as an opportunity for critical review of the EHV-HV deployment and progress of the HV-LV component, prior to final implementation. At this point, the EHV-HV solution will be deployed and feedback from user-testing will have been collected. Finalisation of the HV-LV models will be in progress, enabling an assessment of model accuracy. By this Stage Gate, approximately two-thirds of project funding requested will be invoiced, which provides opportunity for review with a significant amount of funding still outstanding.

Our value for money proposition also relates to the CBA developed for this project and wider benefits that would result. The payback period for the project is c.3 years in the selected option, which compares favourably with the duration of the project. The NPV from NPg network level rollout is c.£60m over a 10-year period, which represents considerable ROI relative to aggregate SIF funding outlay across Discovery, Alpha and Beta combined (£3,892,646). This provides confidence in benefits even accounting for forecast uncertainty and unexpected developments over the course of the next price controls.

There are no subcontractor costs.

There is no additional funding from other innovation funds.

No specific pre-existing assets or facilities, although the project could not take place without the data at NPg's disposal.

Document upload

Documents Uploaded Where Applicable

Yes

Documents:

AF - Risk Register.pdf

SIF Beta Project Registration 2025-02-14 10_05

Artificial Forecasting SIF Beta - Annual Progress Report - Feb 2026.pdf

SIF Beta Project Registration 2026-03-27 6_40

Artificial Forecasting SIF Beta Annual Progress Report With Audit Letter

This project has been approved by a senior member of staff

- [x] Yes