SIF Discovery Round 2 Project Registration

Date of Submission

Jun 2023

Project Reference Number

NPG_SIF_003

Project Registration

Project Title

Artificial Forecasting

Project Reference Number

NPG_SIF_003

Project Licensee(s)

Northern Powergrid

Project Start

Apr 2023

Project Duration

3 Months

Nominated Project Contact(s)

neal.wade@northerpowergrid.com

Project Budget

£160,000.00

Funding Mechanism

SIF Discovery - Round 2

SIF Funding

£127,000.00

Strategy Theme

Data and digitalisation

Challenge Area

Preparing for a net zero power system

Lead Sector

Electricity Distribution

Other Related Sectors

Funding Licensees

NPg - Northern Powergrid (Yorkshire) Plc, UKPN - London Power Networks Plc

Lead Funding Licensee

NPg - Northern Powergrid (Northeast) Limited

Collaborating Networks

Northern Powergrid, UK Power Networks

Technology Areas

Demand Response, Digital Network, Distributed Generation, Modelling

Equality, Diversity And InclusionSurvey

Yes

Project Summary

This project addresses Challenge 2: "Preparing for a net zero power system", theme 1. Novel ways to reliably support low stability systems.

As DNOs transition to DSOs, the current annual load forecasting process must become increasingly frequent (monthly, weekly, and daily), to support flexibility dispatch. The scope must also extend at least SO-fold to capture HV/LV substations, as low-carbon technologies connect to LV systems. Given networks have typically employed manual/disaggregated approaches to forecast load and

account for the diversified contributions of new loads, novel approaches are required to enable system flexibility and support network stability under these new conditions.

This project will develop innovative AI-based approaches to augment load forecasting capability. In turn, flexibility will become more realistic as a reinforcement option, and the available capacity in the network for new low-carbon loads will expand, increasing the speed, and lower the cost, of decarbonisation.

Specifically, this project will:

1. Test machine learning algorithms to produce load forecasts at EHV-to-HV transformation points, suitable for the shorter-term forecasting DSO systems require.

2. Produce HV-to-LV forecasts, and develop AI techniques for modelling the connection of load.

Capabilities delivered:

This approach will enable:

- The ability to integrate, ex-ante, demands on the network such as EV charging, local PV and heat pumps;

- The understanding needed to promote targeted reinforcement options such as flexibility, moving from annualised to e.g. daily timescales.

- A step change in the scope of load forecasting, needed as the 230/400V system

becomes the focal point of the energy system, without a step change in technical staff requirements.

User needs:

This project would benefit a wide set of users and the system at large, including:

- Connectees of low-carbon load who, given better network capacity information, would see reduced timescales and costs associated.

- Flexibility providers and controllers, who will have a better understanding of the likely value, call-off and effectiveness of flexibility services.

- Network customers who will see lower price pressure, given more effective and efficient flexibility and network reinforcement investment.

- Other electricity distribution companies, who benefit from the knowledge sharing mechanisms inherent to the SIF.

Partners:

- Northern Powergrid is the electricity distribution system company for Yorkshire and the Northeast.

- Faculty Science Limited specialises in the implementation of custom AI systems for critical national infrastructure.

UKPN, the electricity distribution system company for South East England, the East of England and London.

Project Description

The effective connection of low carbon technologies, use of flexibility and general operation of networks is based upon reliable forecasts of network loading. A manual annualised process for EHV-to-HV transformation points presently exists, but as the active nature of the energy system becomes centred ever closer to the end consumer's premises this will not suffice.

The annualised nature of the existing forecasting must become monthly, weekly, daily and potentially hourly to support flexibility dispatch. Additionally, the existing forecasting process must be extended at least 50-fold to cater for the need for HV to-LV transformation points as low carbon technologies connect to LV systems.

Furthermore, traditional load flow modelling of power systems is based upon either single phase systems or balanced three-phase systems. The GB low

voltage network does not conform to either of these arrangements and a statistical method (ACE49) is generally used instead. As low carbon technology grows significantly, the capabilities of such statistical modelling will lag the situation seen on the actual power network, as they are based on statistical observations of demand and diversity and will not account for the impact of flexibility.

These ongoing sector developments require the augmentation of existing approaches through the novel application of artificial intelligence (AI) techniques. AI methods are better able to account for the changing nature, growing scale and frequency of data collected on the EHV, HV and LV networks, and are more adept at balancing the multiple, complex, factors that influence network demand, relative to the existing statistical methods employed throughout the network and the sector at large.

To develop these techniques, this project will take existing load data, combined with weather data and connections data with a view to:

1. Training and testing machine learning algorithms to produce reliable load forecasts at EHV-to-HV transformation points, suitable for the shorter term forecasting DSO systems will require.

Build on step 1 to produce HV-to-LV forecasts, and subsequently develop AI techniques for modelling the connection of load

Nominated Contact Email Address(es)

yourpowergrid@northernpowergrid.com

Project Description And Benefits

Applicants Location (not scored)

Northern Powergrid, 98 Aketon Road, Castleford, WF10 SOS

UKPN, Newington House,,237 Southwark Bridge Road, London, SE1 6NP

Faculty Science Limited, 160 Old Street, Level 6 London EC1V 9BW

Project Short Description (not scored)

Harnessing the power of machine learning and readily available data to develop the dynamic load forecasts and predictive modelling approaches that an active low carbon DSO network requires.

Video description

https://youtu. be/vq6QdtWOgLO_{httP-s ://y_outu. be/vg6QdtWOg LO)

Innovation justification

As DNOs transition to DSO, the current annual process used to forecast load is required to become increasingly granular, at the monthly, weekly, daily and hourly level to support flexibility dispatch. Additionally, this process will need to be extended at least 50-fold to capture HV-to-LV transformation points as low-carbon technologies connect to LV systems.

At present load forecasting is labour-intensive requiring engineering input to understand the validity of data and spot outliers. Novel techniques are required to allow machines to undertake this work. Load modelling has traditionally been done either using numerical methods based on engineering models, or using an estimate for a typical network load mix built up over many years. As new loads arise, flexibility introduces new probabilistic elements and the load mixes change rapidly. Moreover, given this occurs at different rates across different networks, existing methods become less accurate. This project is ultimately experimental in nature (given the nature of data science), however the availability of data from network substations provides every opportunity for this to represent a successful AI use case.

Other attempts to improve load forecasting, like UKPN's Envision (NIA_UKPN0070), have endeavoured to use dataflows from individual low carbon technology installations and the information systems associated with them. These are making some progress, but are presently more cumbersome and costly relative to a centralised solution using network load information. Our 'network based' solution also minimises data privacy issues. We intend to contrast the results of our approach with those of UKPN's Envision, a potentially higher accuracy, but more data hungry and granular, approach.

The method proposed avoids using circa 50 dedicated engineering staff per DSO to undertake load forecasting for flexibility relative to traditional methods. Such staff are both expensive and scarce. It should also be significantly less expensive than acquiring data feeds for all low carbon technology installations and avoids the uncertainty associated with individuals and organisations withholding the data at some future time

Benefits Part 1

Financial - cost savings per annum on energy bills for consumers
Financial - future reductions in the cost of operating the network

Benefits Part 2

The benefits selected in Benefits Part 1 (Q5) were:

- Financial - future reductions in the cost of operating the network
- via fewer staff required to forecast and model than the counterfactual
- via lower and better targeted flexibility payments
- Financial - cost savings in consumers' network part of the bill

- via lower and better targeted network reinforcement requirements leading to lower DUoS bills

Referencing the benefits selected in Benefits Part 1 , the metrics and indicative quantitative measurement with their associated timeframes are:

- Metrics:

1. Staff employed in load forecasting - currently circa £2m pa expenditure

2. Level of flexibility payment per kilowatt reduction and magnitude of kilowatt reduction required

3. Annual connections reinforcement and discretionary reinforcement expenditure

- Measurements (values based on NPg; GB distribution values would be circa 7x NPg's):

1. Reduction in ED2 opex by up to c.£2m pa (value realised from time of transfer to BAU and will be ongoing)

2. Neutral or slight reduction in flexibility (opex) payments relative to ED2 forecasts in DSO sections (value and timing dependent on evolution of flexibility market)

3. 5-10% reduction in reinforcement capex - ED2 reinforcement forecasts of

£348m would give c.£17-34m over a given 5 year period (actual value realised from time of transfer to BAU but will be ongoing)

Project Plans And Milestones

Project Plan and Milestones

The Discovery Phase will provide the evidence base for the development of proof of concept solutions at Alpha. It is formed of three work packages:

- WP1: AI Discovery - Understand the core problem statement and conduct activities to begin development of AI solutions. (Lead: Faculty)
- WP2: Alpha Planning - Development of an Alpha Phase project plan (Lead: NPg)
- WP3: Discovery Phase closedown - agreement of next steps and delivery of

SIF outputs. (Lead: NPg)

WP1-M1: Define problem statement and identify user needs

- Identify key stakeholders (delivery/technical) to develop the core problem statement(s) addressed by the AI solution(s). This will confirm the scope and networks considered, to effectively target outputs.
- Conduct user research to understand scope for benefits from improved forecasting capability, together with potential challenges. Research will include network, engineering and operational staff, to promote effective solution integration.
- Output: An articulation of the refined problem statement(s) and qualitative view of the benefits and risks associated.

WP1-M2: Initial data ingestion and checks

- Identify and agree proposed data ingestion and management methods.
- Develop an information request, to receive a sample of network load data vital to the development of forecasting techniques. Data is anticipated to include a subset of networks, from 132/EHV/HV/LV substations, together with weather and other non-network data. Work will then assess key fields, data completeness and coverage.
- Refine the request for Alpha, such that stakeholders are aligned as to the information required for proof-of-concepts to be delivered.
- Output: A refined data request, together with initial insights from the data checks performed.

WP1-M3: Technical approach research

- Develops an initial solution outline prior to bench testing at Alpha.
- This involves initial methodology development, informed by user needs and data assessments. The proposed forecasting solution outline would be iterated

between the partners such that this meets NPg needs.

- This step would also identify solution-specific risks and mitigations required.
- Output: solution outline to be refined at Alpha, together with accompanying risks and additional inputs required.

WP1-M4: Benefits assessment

- Output: Identify benefits channels and develop initial quantification

WP2-M1: Alpha Planning

- Builds an initial project plan for Alpha, including additional user research, bench testing and solution refinement.
- Output: consolidate key findings into an overall project plan.

WP3-M1: Benchmarking

- Output: Assess the applicability of the proposed solution to other network companies.

WP3-M2: Phase closedown and SIF outputs.

- Output: Wrap-up of Discovery between the partners, including provision of Final Report.

Regulatory Barriers (not scored)

None.

Commercials

Route To Market

We expect the Discovery phase to produce a feasibility for and a route-map to a workable machine learning based forecasting and modelling tool.

The Alpha phase will develop and test a 'proof-of-concept' tool based on EHV/HV data, where base data is relatively complete and both the reporting obligations and flexibility market need is at present.

A successful testing phase would enable quicker implementation of the EHV/HV model at Beta (for example, if the need for additional tuning, testing and development is minimised following a successful Alpha Phase), building on the proof of concept EHV/HV model. There will be expedited cost savings if this is

successful. The Beta phase will develop the Alpha model for use at HV/LV where the data is becoming available and the flexibility need is foreseen, but both will become more notable as ED2 progresses.

Advances in forecasting and modelling will develop a robust relative value for flexibility and traditional reinforcement including the time value of the faster solution. A robust value will encourage sustainable competitive markets.

DSOs will be responsible for the implementation of the innovation as they have a vested interest created by healthy regulation in finding the optimal cost and performance solution for the network customer.

The DSO would purchase and own the product however data from the product would necessarily be supplied to flexibility providers which would allow them to properly value and target their services.

Such advances in modelling would create targeted capacity interventions, such as traditional reinforcement or flexibility, on an optimal performance/cost/timeliness basis. This would produce both performance (in terms of capacity utilisation) and cost (in terms of minimised DUoS and sustainable flexibility payments) for the customer.

DSOs would be expected to fund the roll-out of such innovation as part of their normal business operations. As it ought to reduce operational and capital costs this seems reasonable.

Intellectual property rights (not scored)

All partners acknowledge and accept the requirements to make methods, approaches and functional specification available in line with Section 9 of current SIF Guidance Document - 9 September 2022.

Costs and value for money

The total project costs

Requested: £126,721

- Plus contributions totallings: £32,779
- NPg - £15,000 (£8.4k in kind)
- Faculty - £14,080 (in kind)
- UKPN - £3,699 (in kind)

Value delivered

- The improved modelling is expected to reduce HV/LV reinforcement cost by around 5-10% or £3.5-7m per annum in NPg (all DNOs might increase this by a factor of 7) after roll out of the beta phase
- Staff cost savings relative to the counterfactual will be around £2m per annum in NPg (all DNOs might increase this by a factor of 7) after roll-out of the beta phase.

Document Upload

Documents Uploaded Where Applicable

Yes

Documents:

pdf.pdf

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Artificial Forecasting (SIF)_Show & Tell_21.06.23 .pdf

Artificial Forecasting - Question 3. Innovation justification - Appendix.pdf

Artificial Forecasting - WP3 - M2 - Final Report.pdf

Artificial Forecasting Discovery (SIF) - WP1-M1 Deliverable - Final.pdf

Artificial Forecasting Discovery (SIF) - WP1-M2 Deliverable - Updated.pdf

Artificial Forecasting Discovery (SIF) - WP1-M3 Deliverable - Technical approach for Alpha.pdf

Artificial Forecasting Discovery (SIF) - WP1-M4 Deliverable - Benefits assessment (1_2).pdf

WP2 - M1 - Final Alpha Plan [As inputted in PMT].pdf

This project has been approved by a senior member of staff

☑ Yes