SIF Alpha Round 2 Project Registration

Date of Submission

Jan 2024

Project Reference Number

NPG_SIF_005

Initial Project Details

Project Title

Diversified Flexible Queue Management

Project Contact

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Challenge Area

Preparing for a net zero power system

Strategy Theme

Flexibility and commercial evolution

Lead Sector

Electricity Distribution

Project Start Date

01/10/2023

Project Duration (Months)

6

Lead Funding Licensee

NPg - Northern Powergrid (Northeast) Limited

Funding Licensee(s)

NPg - Northern Powergrid (Yorkshire) Plc

Funding Mechanism

SIF Alpha - Round 2

Collaborating Networks

National Grid Electricity System Operator

Technology Areas

Commercial

Low Carbon Generation

Demand Response

Distributed Generation

Electricity Transmission Networks

Energy Storage

Energy Storage and Demand Response

Substations

System Security

Voltage Control

Project Summary

A key milestone in the UK's 2050 net zero commitment is to decarbonise the UK's electricity system by 2035. Ensuring our electricity networks are effectively

utilised to support this ambition is of upmost priority.

In this project we are revaluating the assumptions in the design and operation of demand and generation connections to the GB electricity distribution network to explore if the existing system could be utilised more efficiently. By exploiting the rich, emerging vein of high volume, real/near time energy data from both sides of the connection, can we unlock capacity and remove/manage constraints and enable swifter new-connections timelines?

Add Preceding Project(s)

NPG_SIF_002 - Diversified Flexible Queue Management

Add Third Party Collaborator(s)

Energy Optimisation Solutions Ltd

WSP UK Limited

Project Budget

£302,000.00

SIF Funding

£245,000.00

Project Approaches and Desired Outcomes

Problem statement

As the UK responds to the global effort to reduce greenhouse gases to a net zero level, we are rapidly electrifying our transport, heat and power systems to take advantage of our abundant renewable resources such as wind and low carbon dioxide emissions technologies such as nuclear power.

The transition is in full swing but to continue our progress in decarbonisation, the UK's electricity distribution and transmission grid needs to maintain and accelerate its support in enabling the pace of new connections of generation of electricity from these sources.

However, the integration of these energy sources poses significant challenges. The rapid increase in new connections to the electrical grid has resulted in interface constraints at the Grid Supply Point (GSP). While challenges associated to operation and control are widely discussed and addressed in literature and industry, one crucial aspect that requires attention is the effective management of the connection queues at the Grid Supply Point (GSP). GSP serves as the interface between the distribution network and the transmission network and can potentially be a bottleneck in timely integration of RES (Renewable Energy Systems) and storage. Traditional solutions to address these constraints, such as network reinforcement can be costly and have long planning timescales causing unintended delays.

A key element in managing the connection queue is to evaluate the capacity of the grid to accommodate new renewable power generation and storage, crucial in ensuring a safe and reliable operation of the network. Traditional approaches of capacity assessment in connection queue management at the high voltage levels of the network predominantly rely on uniform / fixed power import/export frameworks. These do not generally take account for the diversity in generation profile among renewable energy sources or flexibility in customer demands. The existing process takes a 'one-size fits all' approach. We believe there is scope for innovation here. Novel approaches to capacity assessment at GSP taking into consideration the characteristics of the RES and storage such as it's type and scale could unlock more capacity.

The focus of this project is to explore methodologies in network operations and processes to effectively manage connected assets and connection requests. By doing so, we are addressing the challenges associated with integrating available renewable generation and storage into the electrical network. It is anticipated this work will refine the assumptions by taking a more granular approach considering the viability of, and make recommendations for, Diversity Factors. It will take into account a study of:-

uncertainty/risk of this approach

the type and scale of technology requesting connection

network location of the connection (including spatial/geographic) temporal - (seasonal, time of day)

electrical impacts - (connection point, fault current, thermal limitation) penetration of that technology type in that network area (risk factor)

the impact to existing design and planning assumptions made in the connection processes both at a distribution and transmission level

the often market-driven operation of the technologies connecting to the networks

the impact of flexible energy storage on the increase in generation capacity that can be connected as a result

To achieve this, we are exploring various technical innovations in energy data analysis that facilitate faster and more efficient connections and their post- connection management. Considering the natural diversity of the generation and demand and the dispatchable flexibility services they can provide. Additionally, we will leverage existing and enhanced network data to empower organisations like NPg and NGESO in identifying congestion, tracking the status and capabilities of their connection queue. It is anticipated that in turn this will facilitate a streamlined process for actively managing the queue, enabling the more rapid and cost-effective onboarding of innovative and flexible resources.

Innovation justification

Traditional approaches to distribution network connection queue management predominantly rely on uniform frameworks. These use fixed values for capacity based on maximum export and/or import to account for the safety and control requirements of the network operation.

But there is often diversity in the generation or demand export/import profiles. Spatial, temporal and seasonal variations aren't accounted for in the traditional one-size fits all approach. Taking advantage of these 'diversity factors' - distinctive attributes of the connection, during new connection grid capacity assessments could unlock more optimised resource allocation. While diversity factors have been considered when modelling demand at the low voltage level of the

distribution system in the past, no such systematic approach has been adopted for generation or demand at higher voltage levels.

A comprehensive and adaptable framework is necessary to integrate any consideration of diversity in connections queue management. A novel methodology for effective assessment and utlisation of headroom at GSPs was developed within the Discovery Phase of the project. The objective was to explore the untapped capacity that can be harnessed by means of incorporating the diversity and actual power output of RES and storage. The two major innovations can be described as below:

Conventionally, the rated power has been utilised for the calculation of headroom -- a conservative approach to ensure the firm capacity at the GSP is never breached. This leads to suboptimal resource allocation and under utilisation of the distribution assets in some instances. Incorporating diversity factors derived from analysis of historical and real-time power flows will enable the calculation of dynamic headroom at the GSPs. This innovation evolves the conventional planning, operation, and control at the GSP that has been in practice for decades.

Taking into account the renewable resource and spatial characteristics of the connection type more accurate assessment and forecast of the power flows can be carried out.

In the Discovery Phase, the hypothesis that diversity and flexibility in grid connections can effectively release benefits to the connections queue was verified. High level analysis was conducted relying upon publicly available data and relatively unsophisticated models of RES output and storage impact.

The Alpha Phase of the project aims to take a deeper dive into the available network data to validate the approach through utilising real-world data from specific GSPs, the distribution network and asset owners connected in those areas. The project will use statistically led data analysis methods to derive the diversity factors.

If the methodology is verified, the approach will become an integral part of NPg's Business-As-Usual (BAU) toolkit for managing constraints and connections queues, resulting in ongoing benefits for customers. Additionally, the knowledge gained from the project will be shared with other network companies, leading to further customer benefits across the industry.This project builds upon the ongoing work of ENA strategic connections group. Furthermore, engagement with key stakeholders and review of existing policies and literatures during the Discovery phase has confirmed that this innovation will be complementary to the Five Point Plan published by National Grid ESO. In particular, the Five Point Plan's goal to reduce the number of stalled projects in the queue via code modifications and the TEC amnesty. The plan also seeks to change how storage is treated in the connections process, to reflect the unique nature of its operation, provides scope for storage to connect to the network under non-firm contracts. These initiatives

align with the diversified flexible queue management project. An approach based on dynamic headroom assessment represents a step beyond the current measures and has scope to significantly improve the whole system utilisation of the transmission and distribution networks.

Impact and benefits (not scored)

Financial - future reductions in the cost of operating the network

Financial - cost savings per annum on energy bills for consumers

Financial - cost savings per annum for users of network services

Environmental - carbon reduction – indirect CO2 savings per annum

Revenues - improved access to revenues for users of network services

Impacts and benefits description

This project has the potential to deliver a significant impact on reducing queues for connections onto Distribution networks.

1. Financial - future reductions in the cost of operating the network
Currently, network reinforcement would be sized to accommodate, at a minimum, capacity requirements of new connections. Using a data driven approach to identify network capacity will reduce the level of reinforcement needed or avoidance of the reinforcement entirely by unlocking flexibility from the connection stage and prioritising connection of the most flexible assets.

The impact of this will be measured through a cost benefit analysis that compares the counterfactual against the different use cases. Real world operation data will be used if applicable from partners.

2. Financial - cost savings per annum on energy bills for consumers
Extrapolation of the impact of network reinforcement savings to customer bills, based on the current charging methodology that assigns costs to different voltage levels on the basis of network use factors and assumptions of downstream only flows will be carried out.

3. Financial - cost savings per annum for users of network services
It is anticipated existing users would benefit from faster connections, allowing their connection dates to import and/or export sooner than would otherwise be the case.

Teams and resources

Team remains as per the orignal Discovery project, with the addition of Energy Optimisation Solutions Ltd (EOS).
As a developer of flexible and RES assets EOS will provide real world operational data to support the modelling of the financial impacts from such assets on the queue management innovation. EOS are developing projects on the NPg network and therefore can model the theoretical impact of operational profiles at the GSP (specifically an energy storage project of 40MW/80MWh and a solar PV project of 1MWp plus 1MW/2MWh BESS). Once constructed, the connected flexible assets will then provide actual operational data that will validate the theoretical impact calculated in the Alpha stage.

Project Plans and Milestones

Project management and delivery

The project team will organise a kick-off meeting followed by bi-weekly meetings with project partners and any other associated stakeholders to report the project progress. The meetings will be organised virtually using MS Teams. The meetings will cover discussions on each stage of the project (data, scenarios, modelling, results, etc.), highlighting any identified issues, and general updates against the project delivery plan. It will be concluded with a project close-down meeting to summarise the deliverables and lessons learnt.

In addition, we will follow the Innovate UK / SIF monitoring requirements to arrange SIF mid-point review and end-point review meetings. A show & tell presentation will also be planned and delivered as part of the knowledge dissemination requirements.

WSP's management system complies with International Standard ISO9001:2015, ISO14001 and OHASA18001 as applicable to consulting engineers and construction management. In addition to our CHAS, SMAS and Safe contractor assessments, our health and safety management system has UKAS-accredited third-party certification of compliance with BS OHSAS 18001:2007 which includes regular independent audits. All WSP business activities are planned and controlled within the framework of the system.

Our Quality Management System (QMS) and quality-assurance programme comprises a series of documents available to all personnel through our intranet network. A mandatory quality system training heightens awareness on the importance of assessing all potential risks, of being committed to delivering high quality at every stage of a project and of being actively engaged in the process of continual improvement.

This allows us to guarantee our clients and partners that the work is planned, done, checked and adjusted as shown below. This cycle may be summarised as follows:

Plan: To understand the clients' needs and specific requirements while considering the particular nature and risks of the project. To define the goals and identify processes needed to achieve results that meet the clients' requirements while complying with WSP policies.

Do: To carry out activities defined in the planning stage. To implement everything necessary so as to ensure the client satisfaction according to WSP requirements.

Check: To check that products and services meet the clients' requirements as defined in the planning stage. To assess the results obtained and to define actions to be implemented in order to correct deviations if need be.

Act: Considering the results at the control stage, to analyse data and to adjust when needed so as to meet the clients' requirements. To implement actions needed so as to correct deviations and to continually improve WSP products or services.

The Quality Service monitors client satisfaction through client satisfaction surveys and ensures process implementation through quality audits. Continual improvement meetings are held in all of the company's business units to foster discussions on improvement opportunities. Quality is part of the project; we plan, design and integrate quality at every stage: it is our priority.

Regarding our Quality Management in the Energy Advisory team and in addition to the company Quality System described above, all reports are reviewed by the Project Manager, and approved by the Project Director before submission. Power Systems models are peer-reviewed, and in this case, we propose to have a small team running the studies, to enable knowledge sharing and to speed up the process.

Key outputs and dissemination

The four work packages are:

WP1. Connect Quicker: Solutions to Accelerate Distribution Connections WP2. Cost Benefit Analysis: Establishing Customer and Network Benefits WP3. Delivery Plan for Conversion to Business as Usual

WP4. Communication and Dissemination

WP1 will refine and validate the technical solution for enabling accelerated integration of RES and storage within the distribution network. WP2 will establish the monetary benefit of the approach to the customer and the network. Having established the methodology and its benefits, WP3 will look at developing a plan to ensure its seamless deployment and integration as business as usual within NPg. The communications and dissemination will be ensured through WP4.

The anticipated key outputs of the project are summarised below:

A validated methodology to assess and effectively utilise the dynamic headroom at GSPs. Although the analysis will be undertaken for 8 prioritised GSPs, the methodology will be generic and can be applied to GSPs within the license area of any Distribution Network Operator within Great Britain.

Identify and recommend key improvements to connections process

A high-level cost benefit analysis of the potential impact of implementing diversified flexible queue management and the economic benefit to connection customers

An assessment of the impact of faster LCT connections on carbon emissions An initial delivery plan considered to optimally resolve any likely barriers to

implementation of the modelled solution.

Creation of a register of the potential risks inherent in the operation of a diversified flexible queue including mitigating actions.

A plan to move the project to the next phase where we are looking at a trial of the proposed solution.

Commercials

Intellectual property rights, procurement and contracting (not scored)

IPR ownership will be treated in line with Chapter 9 SIF Governance.

Northern Powergrid DNO is the lead partner, partnering with the ESO as the key stakeholder

EOS as the asset owner will provide knowledge exchange as part of their role

WSP will not own any IPR attached to this project, which will be based on inputs from the DNO and customers and modelled using standard software.

Commercialisation, route to market and business as usual

The adoption of the proposed solution will be an adaptation to the process of queue management by the DNOs. It should be noted that the solution is not a tangible product that can be commercialized for sale or use by third parties.

The outcome of this project will be a desktop proof of concept that shows the level of actual constraints on the network at identified NPg's GSPs and the impact that adaptive queue management can have on the time to connect flexible resources and the wider benefit of delayed or deferred reinforcement. If proven (through the Alpha and Beta stages), the BAU roll-out of this approach would be funded through NPg's baseline funding as part of their BAU network management.

The learning associated with this project and this approach to managing constraints, including any potential commercial arrangements, will be shared with all DNOs and relevant network users, including through the knowledge dissemination plan set out in the proposal and dissemination arrangements set out in SIF governance document.

The primary customer segment will be renewable generation, storage and DSR connected to the electricity distribution networks that can provide benefits if connected earlier, but there are no specific limitations on the technologies that could provide these services.

The project will aid the development of competitive markets as the offer will be available to all customers. As with any connection agreement, we expect that investors, new industrial customers, etc., will undertake their own assessment of the trade-off between a faster/cheaper connection against the potential services they need to offer, such as increasing import/export during specific times.

Since the submission of our Discovery project, the networks connection queue challenge has only increased with continued growth in applications for connection to both the distribution and transmission grids. Significant industry intervention has been mobilised to respond to the challenges. The ENA Strategic Connections Group to which both NPg and ESO are members has established a range of actions to address the challenges including those relevant to the NPg area:

1. The NPg Battery Assumptions in connection process

2. Technical Limits at GSP interfaces between NPg and NGET interfaces

3. The Battery Design Assumptions in the ESO 5 point plan

The innovative use of diversity factors as proposed in this innovation will be additive to the benefits of these measures. Indeed, the timeliness of this innovation will actually extend the impact of the items listed above as it provides a mechanism to more efficient utilise any capacity unlocked from the strategic actions.

Due to the more granular nature of the DFQM technique, the methodology will provide a route to refine the assumptions from the strategic actions providing more certainty. This will provide a strong motivation for deployment across the GB network as it will help manage the network planning risks by reducing the uncertainty in the assumptions.

Policy, standards and regulations (not scored)

There is a regulatory risk around applying a different approach to connection queues. Although Ofgem is likely to be interested in an approach that speeds up the connection of renewables and large scale DSR, they may face lobbying from customers who find themselves lower down the queue.

However, the principle of the diversified flexible queue management was discussed in ENA's Queue Management User Guide as part of the Open Networks Project. The issue has been widely recognised and a solution is needed to address the challenges.

The Discovery Phase of this project involved a workstream focused on analysing the existing policies and regulations in the field of connections queue management, the output of which was a report detailing current queue management arrangements. The key conclusions of the report were that the existing system of regulations and policies will allow for the adoption of Distributed Flexible Queue Management (DFQM) as described in this proposal. Furthermore, the existing system allows for modifications via established processes (e.g., Code Modification Proposals for changes to the Connections and Use of Systems Code). The risks identified in this phase are rather related to the potential responses of stakeholders in the queue, and can be managed via consultations and stakeholder engagement. National Grid ESO, Northern Powergrid and key stakeholders will be engaged in the Alpha phase to understand the existing grid code and procedures for connection queue management and identify risks for code and procedure changes.

Value for money

The total project cost will be £301,768, with a total of £56,567 contribution from the partners with a request for funding from SIF of £245,411. The detailed cost below for each work package:-

WP1. Connect Quicker: Solutions to Accelerate Distribution Connections
Total cost: £115,470 (38.26%) NPg: £6,000

NGESO: £5,220 WSP: £100,000 EOS: £4,250

WP2. Cost Benefit Analysis: Establishing Customer and Network Benefits
Total cost: £65,690 (21.77%) NPg: £1,600

NGESO: £4,176 WSP: £54,914

EOS: £5,000

WP3. Delivery Plan for Conversion to Business as Usual
Total cost: £82,276 (27.26%) NPg: £7,200

NGESO: £4,176 WSP: £67,900

EOS: £3,000

WP4. Communication and Dissemination
Total cost: £38,332 (12.70%) NPg: £7,000

NGESO: £3,132

WSP: £26,700 EOS: £1,500

Contribution and SIF funding requested:
NPg will contribute all of their costs as an in-kind contribution of £21,800 and therefore 100% of their project costs.

NGESO will contribute £3,340 (20% of their project cost of £16,704). They will request a total of £13,363 from SIF.

WSP will contribute £17,466 (7% of their project cost of £249,514). They will

request a total of £232,048 from SIF.

EOS will contribute all of their costs as an in-kind contribution of £13,750 and therefore 100% of their project costs.

Associated Innovation Projects

- ○ Yes (Please remember to upload all required documentation)
- ◉ No

Supporting documents

File Upload

SIF Inform Mid-Term Update - Alpha.pdf - 689.7 KB
Mid-Point Review Meeting.pdf - 620.5 KB
DFQM - Technical Review v3.pdf - 1.2 MB
Artificial Forecasting Alpha (SIF) - WP2-D3 - Proof of Concept model and Technical summary report.pdf - 3.8 MB
SIF Alpha Round 2 Project Registration 2024-01-18 8_47 - 66.8 KB

Documents uploaded where applicable?

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