SIF Round 3 Project Registration

Date of Submission

May 2024

Project Reference Number

10106177

Initial Project Details

Project Title

Fractal Flow

Project Contact

Chris Goodhand

Challenge Area

Whole system network planning and utilisation to facilitate faster and cheaper network transformation and asset rollout

Strategy Theme

Data and digitalisation

Lead Sector

Electricity Distribution

Other Related Sectors

Electricity Distribution

Electricity Transmission

Gas Distribution

Gas Transmission

Project Start Date

01/03/2024

Project Duration (Months)

3

Lead Funding Licensee

NPg - Northern Powergrid (Northeast) Limited

Funding Licensee(s)

NPg - Northern Powergrid (Northeast) Limited

Funding Mechanism

SIF Discovery - Round 3

Collaborating Networks

National Grid Electricity System Operator

Technology Areas

Active Network Management

Project Summary

DNOs require an innovative solution to accelerate net zero targets due to physical capacity constraints. A current solution to address this issue is via Active Network Management. However, information constraints and conflicting requirements can inhibit its adoption.

We will develop a tool which provides clear visibility of fractal network power flow, via a centralised vendor agnostic system to bind data-streams to a virtual network structure, while bridging various communication protocols.

This system will help unlock additional capacity by providing clearer status visibility and explore integration of powerful machine learning analysis and targeted data exchange across a Grid Supply Points (GSPs).

Add Third Party Collaborator(s)

Frazer-Nash Consultancy

Project Budget

£163,066.00

SIF Funding

£141,649.00

Project Approaches and Desired Outcomes

Problem statement

The capacity of electricity networks is restricted pending major reinforcement, limiting the integration of new Low Carbon Technologies (LCTs) onto the grid and constraining availability of renewable energy. As an interim solution, flexible connections are used to provide earlier and lower cost connections.

There is currently a blend of legacy (e.g. DNP3) and emergent (e.g IEC61850) protocols across the power network, necessitating a vendor-agnostic interface to unify this data.

Due to an increasing number of ANM, there also are emergent and conflicting system dynamics, for example, as the ESQ action balancing measures, ANM are operating to exploit resultant network headroom, negating the balancing measures.

Currently ANM systems don't provide the required cross network visibility of supply and demand behaviour, reducing effective usage of network capacity. The lack of standard data interfaces and conflicting requirements results in systemic inefficiencies and operational expenses that are absorbed by customers.

Data consolidation aids ONO controllers in optimizing LCTs and flexible users. An interoperable system offers sub-network visibility to DSOs and ESQ, shaping agreed interface requirements through stakeholder collaboration. Enhanced visibility enables in-depth analysis, leveraging Machine Learning, improving network operations and LCT deployment.

The solution addresses Challenge 1, Theme 2. We will develop a digital virtualisation tool to provide visibility and analytics of real-time power flow data across all network nodes. It will employ an intelligent data management system, bridging legacy and modern connections. The system will integrate machine learning for enhanced data value and include weather API calls to assist forecasting and support flexible procurement coordination.

Novel centralisation of whole system data also supports Challenge theme 2 by increasing equitability of net zero technologies and markets.

This tool targets DNO/DSOs as key users. It will gather requirements from ONO control operators and ONO data teams, addressing implementation constraints. NGESO will assess conflicting requirements to align the solution with broader market needs e.g. Read access to data.

Recent projects include:

- VirtualES - Open framework, with agreed access, operations and security protocols.
- Artificial Forecasting - Using AI to enhance load forecasting.
- Community DSO - Community Smart Local Energy Systems.
- Constellation - Contributing awareness of smart substations to enhance LCT generation.
- NG Weather Alerts - Deployment of weather APIs to assess Transmission asset risks.
- INCENTIVE - Evaluates network asset integration for cost-effective stability services.

Through this experience we are informed of data exchanges and understand how this can be integrated with the proposed tool.

Video Description

https://www.youtube.com/watch?v=nJj9rl8gwUE&list=PL-hp8OOckWOCesQpeW8ZytuHm478-oeqf&index=7

Innovation justification

No current system integrates, visualises, and aggregates power flow across ONO networks or facilitates data exchange between

ESQ and ONO layers. Existing products like Strata Grid might tie a network to a specific platform, risking obsolescence and single vendor dependency during for DSO transitions and future ESQ requirements.

A key challenge is diverse communication infrastructure and data formats between nodes and network layers, as seen in past innovation drives [ABCD, NG] and [ANM Good Practice Guide, ENA]. We will deliver a future-proof tool with supplier agnostic interfaces to unify previous innovation activities, to support the entire network.

Synchronizing communication protocols is also challenging, especially for legacy assets, underscoring the need for a vendor and protocol-agnostic approach.

Based on market trajectory, local flexibility markets are anticipated. We will develop a future-proof tool to centralise understanding of sub-network power generation characteristics and help unlock these new market services, while providing powerful data analytics to support customers and new connections.

Our creative Graph Networks usage establishes a robust data infrastructure, binding data-streams to a virtualized network structure. This novel data science application offers a fractal-level view of power and network control parameters, featuring data aggregation and a platform for innovative Machine Learning Functionality. This includes projected reliability of generation asset clusters through weather API calls, explored in later project phases. The new data structure facilitates GSP data-exchange between DNOs and ESO.

Adoption of a Graph Network will allow for the integration of innovative features supported by Machine Learning such as:

- Node prediction - optimizes network planning and informs generators and customers about nodal trends.
- Missing Link -- derives performance from associated network connections in case of communication loss.
- Similarity Analysis -- groups similar subgraphs, assessing sub-system performance, identifying systematic issues, and suggesting performance improvements.
- Risk Monitoring -- uses tailored KPIs to evaluate network risks in specific areas.

Moving from Technology Readiness Level 2 to 4 is estimated for Discovery.

Moving from Integration Readiness Level 1 to 2 is estimated as required data relationships between GSP and networks nodes are identified

Determining Commercial Readiness Level forms a key objective for the project, as the tool could benefit power networks worldwide.

Provision of a future-proofed tool with supplier-agnostic interfaces represents a major step change in the operational and control capability of the whole network.

Impacts and benefits selection (not scored)

Financial - future reductions in the cost of operating the network

Financial - cost savings per annum for users of network services

Environmental - carbon reduction – indirect CO2 savings per annum

Revenues - creation of new revenue streams

Impacts and benefits description

Electricity network limits hinder the integration of Low Carbon Technology (LCT) , constraining renewable energy availability for customers. Restricted operational information leads to conservative decision-making

These conservatisms and existing ANM control dynamics result in systemic inefficiencies and operational expenses that are absorbed by customers; e.g. ESQ action balancing measures and an ANM operates to exploit network headroom, negating the said measures.

The following metrics shall be used within the CBA to report on this position:

- Headroom (MW)
- Generation that can be installed (MW)
- Additional Energy of enabled low carbon generation (MWhr)

Teams and resources

Northern Powergrid has identified two Partners -- Frazer-Nash Consultancy (FNC) and National Grid Electricity System Operator (ESO).

NPG has a pre-existing relationship with FNC from an innovation project and NPG's role as a key stakeholder in a Tees Valley Decarbonisation Study led by FNC. NPG acknowledges FNC's expertise in digital systems, tool development, energy systems, and a strong delivery record on network innovation projects.

FNC's deep insight into the UK electricity network positions them well to assess risks, opportunities, and barriers to the implementation and viability of wide-scale solutions.

FNC's role is to lead on all three FractalFlow work packages and provide a Project Manager to oversee the co-ordination of tasks and stakeholders on the project.

FNC excels in digital asset management, employing modelling and simulation for a deeper understanding of the customers systems and optimising performance.

The Techno-Economic Assessment team has conducted 10 cost-benefit assessments for SIF discovery phase projects, demonstrating expertise in technology road mapping across various industries.

NPG's role will be as technical advisor across all WPs. NPG bring extensive knowledge of their network and control procedures, including legacy challenges with collating data and managing data boundaries - linking with NPG's 2023-2028 Data & Digitalisation strategic theme.

ESQ have been identified as a key customer for the FractalFlow data outputs and are therefore an important stakeholder. Their role in this phase is to provide input on their requirements for the GSP interfaces, as well as any future operation proposals that may impact these requirements, and provide their perspective on the characterisation of the challenges and development of an implementation strategy. It is recognised that both the control operators and data experts within ESQ will have valuable inputs on this topic and engagement with a range of stakeholders is planned.

No equipment or facilities are needed in this project phase, and resources for delivering outputs by the Lead Network and Partners are identified. Preliminary resources for skill/knowledge areas were identified during the application phase, and specific resources will be confirmed upon successful application notification. Workshops with key stakeholders will be scheduled to gather specialist inputs from Partner organisations.

NPG hold a representative view of other DNQs so no other DNQs are to be engaged formally during Discovery. Engagement with other DNQs will be explored for broader stakeholder alignment during Alpha. It is also considered that no engagement with connections customers would be needed until after Discovery.

Project Plans and Milestones

Project management and delivery

Several key meetings (Kick-Off, Mid-Project Review, Close-Out) have been scheduled to bring all partners together, to ensure a common understanding of scope, progress against the plan, review risks and manage dependencies. These will be supported by weekly meetings between NPG, ESQ and FNC to discuss day-to-day management of the project, and a regular touchpoint to monitor project risks and identify early implementation of mitigations.

FNC's Power Transmission and Distribution Business Manager, who is accountable for our work with energy networks, will provide oversight of performance or delivery beyond the direct project team. Further to this, as part of the FNC Quality Management System, an independent project auditor will be appointed to oversee the project delivery to the requisite quality standards.

To ensure that innovation is encouraged, control operators within ESQ and ONO will be asked to outline the 'ideal' view of tool capability to ensure that the solution isn't constrained at the concept phase and that all opportunities are sought to embed useful capability and use the collected data in novel ways. A staged process will be taken to evaluate the effort required, technology maturity and benefits delivered for different aspects of the technology to down-select the functionality to be incorporated in the FractalFlow tool. Optimisation of delivery schedule shall also be considered.

Work packages WP1 - Feasibility Assessment, WP2 - CBA, WP3 - Technology Roadmap will all hold a dependency with the Project KO meeting to ensure that points of contact are established early in the project. This is also a key mitigation within the risk management strategy to ensure that communication channels for technical disciplines are clear throughout the project. WPs will then progress in parallel, until their conclusions are consolidated into the WP findings which is a critical project milestone for presenting the conclusions of the work. To mitigate risk of KO meeting availability, an advanced placeholder will be reserved in diaries for week 1.

Each WP has an associated milestone for its completion.

There are no known policy/regulatory challenges, but the feasibility assessment will look to characterise these constraints in further detail. The project aims to deliver outputs within existing policy and regulatory environment as opposed to trying to influence/change them, while also remaining cognisant of the potential future changes in this domain.

This project will not result in any supply interruptions, nor will energy consumers need to be engaged.

Key outputs and dissemination

1. The Discovery Phase will define the requirements, barriers and roadmap for the core aspects of the digital platform capability for the FractalFlow tool (power flow visualisation at all nodes, either within ONO networks, or at a level which facilitates data exchange between ESQ and ONO network layers). This includes not only technical aspects of the software tool, but also considers aspects such as regulatory constraints, cyber security requirements, hardware interfaces and communication protocols. These outputs will be combined with cost estimates for development of vendor-agnostic tool, along with evaluation of the benefits provided to establish the feasibility and value of further pursuing this project.

2. The feasibility will be evaluated for the inclusion of enhanced functionality such as weather API calls, allowing DNOs to determine the reliability of generation within actively constrained sites. This includes a review of reliable weather data sources, data formats and any associated costs. Additionally, the Discovery Phase will identify opportunities to use the data collected by this flexible platform to further optimise network performance through techniques such as machine learning.

3. A high-level strategy for expanding the availability of the FractalFlow tool to all regional DNOs will be outlined.

Responsibility for Outputs
We have assigned ownership of each WP to the most appropriate partner, as captured in the points below:

- WP1 - Feasibility Assessment (NG)
- WP2 - CBA (NPG)

- WP3 - Technology Roadmap (FNC)

As overall project manager and Technical Lead, FNC will be responsible for driving overall delivery of the project and producing the deliverables, with other partners contributing and approving.

NG and NPG will own the deliverables that define the FractalFlow's capability and interface requirements from the respective system operator and ONO perspectives.

Project Dissemination
It is anticipated that NPG and FNC will collaborate on the dissemination of the project outputs. The outputs will be shared through the project webinar and through posts on forums such as LinkedIn. A decision will be taken towards the end of the Discovery Phase to determine if it is appropriate to share any of the findings of this project at the 2024 Energy Innovation Summit.

Commercials

Intellectual Property Rights (IPR) (not scored)

The default IPR arrangements will be used for this project.

Value for money

Total Costs = £171,066 Funding Requested: £147,649

All partners will deliver their work at reduced costs to provide their financial contribution towards the project.

Supporting documents

File Upload

Project Management Book R3D Final.xlsx - 149.7 KB
FNC 023283-145816V Fractal Flow_Show & Tell.pdf - 1.5 MB
FNC 023283-144763V_SIF CBA_Fractal Flow_Discovery.xlsx - 966.2 KB
FNC 023283-144388V - Fractal Flow WP Deliverables - FINAL.pdf - 2.4 MB
SIF Round 3 Project Registration 2024-05-15 10_29 - 56.6 KB

Documents uploaded where applicable?

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