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NIA Project Registration and PEA Document

Date of Submission

Aug 2025

Project Reference Number

NIA_UKPN0111

Project Registration

Project Title

Python Power

Project Reference Number

NIA_UKPN0111

Project Licensee(s)

UK Power Networks

Project Start

August 2025

Project Duration

0 years and 8 months

Nominated Project Contact(s)

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Project Budget

£358,000.00

Summary

The project aims to enhance Distribution Network Operator (DNO) network modelling capabilities to make them scalable and future proof. This involves developing additional features and integrating the required datasets. If successful, the project will enable network modelling use cases including functionality to flexibly isolate sub-networks, state estimation, and integration of forecasts.

Once complete, this open-source tool will enable members of the public to run power flow simulations using published models. This project will offer accessibility to network modelling capabilities for customers supporting innovation across the sector. Python Power will support the transition to Net Zero through better use of data and open innovation.

Nominated Contact Email Address(es)

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Problem Being Solved

UK Power Networks currently faces challenges in accurately predicting when flexibility services will be needed and subsequently dispatched. Existing forecasting tools lack the ability to simulate power flows across the network, especially in areas without direct monitoring. This limits confidence in forecasts and makes it harder to decide when to dispatch flexibility. The Python Power project addresses this by enabling realistic, testable simulations using open-source tools, helping UK Power Networks improve forecast accuracy and make smarter, faster decisions for dispatching flexibility services.

The project will enhance short-term network forecasting methods deployed by UK Power Networks by enabling the ability to run power flow simulations in a flexible, programmatic way that is interoperable with data science software written in the programming language Python. The ability to run power flow analysis on forecasts will ensure that forecasts are internally consistent, enable forecasting of unmonitored sites, and improve the robustness of processes reliant on forecasts such as flexibility dispatch. Additionally, the project will develop tools to support other use cases, including functionality to flexibly isolate sub-networks, and state estimation.

Open-source tools offer a high degree of automation and flexibility for power system modelling, analysis, and optimisation. They allow for seamless integration with other Python-based tools and data science workflows, which is not possible with many closed-source tools. This integration is crucial for developing advanced forecasting and analysis capabilities that are essential for electricity network operators.

Method(s)

This project will support the development of the open-source Python based tool to be fully compatible with UK Power Networks' network models. Validating this open-source Python tool on GB DNO network models marks a step forward for the industry in power systems analysis.

In the first instance, the project will convert UK Power Networks' network models to be used within the tool. This requires the development of several features currently missing from the tool's existing converter and identifying/fixing issues. The project will ensure full compatibility with extensive and reproducible tests and demonstrate convergent power flow using the tool.

In addition, this project will develop tooling to support DNO use cases. This includes functionality to flexibly isolate sub-networks, for more computationally efficient constraint analysis, state estimation and bespoke tools for integration of forecasts and importing of near real time network configuration.

Scope

The project is comprised of the following work packages:

- Adjustments to enhance the existing software to successfully import network models
- Developing and testing a tool for the identification of sub-networks for constraint analysis
- Integration with forecasting methods
- State estimation based on partial measurements or forecasts for loads and generation which is not metered
- Interoperability with different network modelling exports to obtain near real time network configuration

Objective(s)

The project will set out to achieve the following objectives:

1. Enable UK Power Networks' network models to be compatible with the chosen software and demonstrate power flow convergence on these network models.
2. Ingestion of network models into the Python network model, and demonstration of convergent power flow.
3. Implementation and analysis of state estimation, enabling more complete coverage of the power flow model under incomplete/uncertain measurements or forecasts.
4. Implementation of functionality to easily segment the network into smaller sub-networks to reduce compute time for localised analysis.

Consumer Vulnerability Impact Assessment

It is not expected that the project will have a direct effect upon consumers in vulnerable situations. The project will indirectly benefit all consumers (including vulnerable consumers) by improving the efficiency and accuracy of flexibility dispatching, helping to lower overall system costs and, ultimately, contributing to more affordable bills for all consumers.

Success Criteria

The success of the project will be evaluated by reviewing progress against the following criteria:

1. The software has been updated to enable the import of a UK Power Networks' network model with the power flow analysis

converging to a satisfactory level

- 2. A state estimation solution is investigated based on partial measurements or forecasts.
- 3. The software can receive a full network model and selected nodes of interest from a user. The software can then return a sub section of the full network model to allow for improved computational performance when running analysis

Project Partners and External Funding

N/A

Potential for New Learning

During the Python Power project, the parties expect to learn how to integrate open-source power system modelling tools with UK Power Networks’ existing network models to improve forecasting, constraint analysis, and state estimation. Learnings will be disseminated through public tutorials and updates on the ENA Smarter Networks Portal, in line with Ofgem’s Network Innovation Allowance reporting requirements.

Scale of Project

The scale of the Python Power project is justified by the need to convert UK Power Networks’ network models into an open-source Python-based platform (PandaPower) and demonstrate power flow convergence across a real, complex distribution network. This project will address the required updates for each of UK Power Networks’ three licence areas as they each present unique challenges for example different load profiles and equipment such as station controllers. A smaller-scale project, such as one limited to synthetic or simplified models, would not expose the full range of operational edge cases, data inconsistencies, and integration challenges that are critical to developing a robust, scalable solution.

The level of investment proposed through this innovation project enables implementation of features relating to specialised components, the ingestion of real forecasts and measurements, state estimation under uncertainty, and sub-network segmentation. These capabilities will be essential for improving accuracy of flexibility dispatch and reducing system costs. Without this scale, the learning would be too narrow to inform business-as-usual adoption or deliver meaningful system-wide benefits.

Technology Readiness at Start

TRL5 Pilot Scale

Technology Readiness at End

TRL7 Inactive Commissioning

Geographical Area

This is a desktop-based project, which will cover network models across UK Power Networks’ three licence areas.

Revenue Allowed for the RIIO Settlement

No funding was provided within the current RIIO settlement that will become surplus to requirements as a result of this project.

Indicative Total NIA Project Expenditure

We estimate the project expenditure to be £358,000 of which £322,200 (90%) will be recovered from NIA as total NIA expenditure.

Project Eligibility Assessment Part 1

Requirement 1

Facilitate the energy system transition and/or benefit consumers in vulnerable situations

Please answer **at least one** of the following:

How the Project has the potential to facilitate the energy system transition:

The Python Power project supports the energy system transition by enabling UK Power Networks (and in due course facilitating other DNOs) to run flexible, scalable, and open-source power flow simulations using Python. This capability enhances forecasting accuracy, supports more efficient flexibility dispatch, and enables faster, data-driven decision making. By integrating real network models and measurements into the PandaPower platform, the project improves transparency and accessibility for both internal teams and external stakeholders. It also empowers technically capable customers to simulate their own network impacts, accelerating connections and reducing the volumes of customer network planning queries. These innovations will contribute to a more responsive, cost-effective, and decarbonised electricity system.

How the Project has potential to benefit consumer in vulnerable situations:

n/a

Requirement 2 / 2b

Has the potential to deliver net benefits to consumers

Project must have the potential to deliver a Solution that delivers a net benefit to consumers of the Gas Transporter and/or Electricity Transmission or Electricity Distribution licensee, as the context requires. This could include delivering a Solution at a lower cost than the most efficient Method currently in use on the GB Gas Transportation System, the Gas Transporter's and/or Electricity Transmission or Electricity Distribution licensee's network, or wider benefits, such as social or environmental.

Please provide an estimate of the saving if the Problem is solved

N/A

Please provide a calculation and/or description of the expected benefits of the solution

The Python Power project is forecast to deliver total net benefits of approximately £651,000 across ED2 and ED3.

We have assumed that flexibility utilisation will be increased through more accurate forecasting with PandaPower, and the ability to estimate the impact of flexibility dispatch on constraints more robustly. Furthermore, flexibility will be a more robust alternative to reinforcement as a result of running power flow analysis with PandaPower. The base case was established by taking the value of the total requested flexibility dispatch across the calendar year 2024/25. This value was used as a conservative assumption for the flexibility to be dispatched in future years as this amount is expected to increase in future with a consequential increase in benefits.

These benefits are derived from operational efficiencies through improved forecasting and flexibility dispatch. Unquantified benefits will also be delivered to members of the public who will be able to use the open-source PandaPower software to run network modelling without having to pay for software licencing.

Please provide an estimate of how replicable the Method is across GB

If successful, the network modelling enhancements made available through updates to the open source PandaPower software can be scaled in its approach with other distribution network operator licensees. As an open-source tool, PandaPower can be adopted by other DNOs and Transmission Operators (TOs) for a range of purposes. PandaPower is already used extensively by European DNOs and TOs. PandaPower model is already used in academia, this allows better alignment with industry use cases.

Please provide an outline of the costs of rolling out the Method across GB.

There will not be any cost associated with rolling out the Method across GB as the enhancements will be made publicly available

through the open-source tool. Any GB DNO licence holder will be able to adopt the Method free of charge once demonstrated through the course of this innovation project.

Requirement 3 / 1

Involve Research, Development or Demonstration

Projects must have the potential to have a Direct Impact on a Network Licensee's network or the operations of the System Operator and involve the Research, Development, or Demonstration of at least one of the following (please tick which applies):

- ☐ A specific piece of new (i.e. unproven in GB, or where a method has been trialled outside GB the Network Licensee must justify repeating it as part of a project) equipment (including control and communications system software).
- ☐ A specific novel arrangement or application of existing licensee equipment (including control and/or communications systems and/or software)
- ☐ A specific novel operational practice directly related to the operation of the Network Licensees system
- ☐ A specific novel commercial arrangement

Involve Research, Development or Demonstration - Please select all that apply

- ☐ A specific piece of new equipment (including monitoring, control and communications systems and software)
- ☒ A specific piece of new technology (including analysis and modelling systems or software), in relation to which the Method is unproven
- ☒ A new methodology (including the identification of specific new procedures or techniques used to identify, select, process, and analyse information)
- ☐ A specific novel arrangement or application of existing gas transportation, electricity transmission or electricity distribution equipment, technology or methodology
- ☐ A specific novel operational practice directly related to the operation of the GB Gas Transportation System, electricity transmission or electricity distribution
- ☐ A specific novel commercial arrangement

Specific Requirements 4 / 2a

Please explain how the learning that will be generated could be used by the relevant Network Licensees

The learning generated from this project can significantly benefit network licensees by demonstrating that open-source tools can be demonstrated to be interoperable with existing network models. This project will demonstrate how to develop and implement a flexible, programmatic approach to power flow simulations using Python. The open-source nature of this software will allow for continuous improvement and customisation, enabling network operators to adapt the tool to their specific needs.

n/a

Is the default IPR position being applied?

- ☒ Yes

Project Eligibility Assessment Part 2

Not lead to unnecessary duplication

A Project must not lead to unnecessary duplication of any other Project, including but not limited to IFI, LCNF, NIA, NIC or SIF projects already registered, being carried out or completed. Networks must explicitly mention similar projects that they have considered and how these differ.

Please demonstrate below that no unnecessary duplication will occur as a result of the Project.

This is the first project to integrate open-source Python-based modelling (PandaPower) with a GB DNO's distribution network model, enabling programmatic power flow simulations, state estimation, and sub-network analysis. No other project has addressed this specific combination of open-source tooling, real network data, and automation at this scale. As such, there is no risk of unnecessary duplication. This project fills a unique innovation gap and sets a foundation for future open-source modelling across the sector.

If applicable, justify why you are undertaking a Project similar to those being carried out by any other

Network Licensees.

N/A

Additional Governance And Document Upload

Please identify why the project is innovative and has not been tried before

This project is innovative because it integrates open source software with DNO network models, enabling the running of programmatic analysis and simulations. It enhances data sharing, improves forecasting accuracy, and automates network analysis, setting a new standard for transparency and efficiency.

Relevant Foreground IPR

The data created, outputs, and deliverables produced as part of the project will conform to the default treatment of IPR.

The outputs and deliverables produced as part of the project will conform to the default treatment of IPR. The foreground IPR will be comprised of the following:

- The learnings from updating the software features that enable UK Power Networks' network models to be imported and simulated within the open-source PandaPower platform
- The learnings from the development of the tooling for sub-network segmentation, allowing users to isolate and analyse specific parts of the network for constraint analysis and computational efficiency
- The learnings from the development of the state estimation functionality, enabling the estimation of network conditions using partial or forecasted data

Data Access Details

To view the full Innovation Data-Sharing Policy, please visit UK Power Networks' website here:

<https://d1oyzg0jo3ox9g.cloudfront.net/app/uploads/2023/10/UKPN-InnovationDataSharingPolicy-Nov-23-v1.0.pdf>

UK Power Networks recognises that Innovation projects may produce network and consumption data, and that this data may be useful to others. This data may be shared with interested parties, whenever it is practicable and legal to do so, and it is in the interest of GB electricity customers. In accordance with the Innovation Data-Sharing Policy, UK Power Networks aim to make available all non-personal, non-confidential/ non-sensitive data on request, so that interested parties can benefit from this data.

Please identify why the Network Licensees will not fund the project as a part of it's business and usual activities

The network licensee is not funding the project as part of its business as usual activities because it involves significant innovation and development beyond routine operations.

Please identify why the project can only be undertaken with the support of the NIA, including reference to the specific risks (e.g. commercial, technical, operational or regulatory) associated with the project

As noted in the NIA guidance, certain projects are speculative in nature and yield uncertain commercial returns. This is the case for this project. There is a technical risk that the solution developed as part of the project is not adopted by stakeholders within the business. This technical risk could be due to the fact that the solution requires additional testing to evidence its applicability for GB DNO network models. This risk is being mitigated against through early engagement with stakeholders and ensuring requirements are clearly defined and documented.

This project has been approved by a senior member of staff

☒ Yes