Notes on Completion: Please refer to the appropriate NIA Governance Document to assist in the completion of this form. The full completed submission should not exceed 6 pages in total.

NIA Project Registration and PEA Document

Date of Submission

Oct 2025

Project Reference Number

NIA_SPEN_0123

Project Registration

Project Title

OPTIMA – Outage Planning Tool Integrating Machine learning and Analytics

Project Reference Number

NIA_SPEN_0123

Project Licensee(s)

SP Energy Networks Transmission

Project Start

October 2025

Project Duration

2 years and 0 months

Nominated Project Contact(s)

innovation@spenergynetworks.co.uk

Project Budget

£240,000.00

Summary

OPTIMA is a web-based, automated outage planning tool designed to enhance transmission outage planning. OPTIMA aims to use machine learning and AI to analyse historical outage data and current network conditions, helping planners identify optimal outage windows, reduce conflicts, and improve coordination while considering network impact. OPTIMA interfaces with various data sources such as NESO's eNAMS, SPEN databases, windfarm outputs, resource and vehicle availabilities and weather forecasts. The tool supports long-term, year-ahead, and in-year planning, reducing manual effort and improving reliability of the outages planned and submitted to NESO. In addition, OPTIMA aims to develop a solution that minimises renewable curtailment and enhances planning efficiency. OPTIMA delivers financial, operational, and environmental benefits while supporting vulnerable consumers and accelerating the transition to a low-carbon energy systems.

Nominated Contact Email Address(es)

innovate@spenergynetworks.co.uk

Problem Being Solved

Transmission outage planning is an essential task which covers all activities from maintenance, asset replacement to new installations. For outage-based work to take place, outage plans must first be agreed with the National Electricity System Operator (NESO). Outage planning is split into three functions: long term planning, year ahead planning and in-year planning. Each planning stage must follow criteria set by NESO and the Transmission Owner Code Procedure (STCP) 11-1.

Outage planning is a complex process where the planning engineer must consider network security and configuration, operational constraints, project programmes, customers and resource availability when building an outage plan. The increasing complexity of the transmission network, driven by the push towards Net Zero and the growing reliance on electricity alongside new requirements from NESO to improve the detail of long-term outage plans is placing significant pressure on traditional outage planning processes.

Currently, outage planning is a manual, time-consuming task that heavily depends on individual expertise and experience. With the volume of outage applications expected to rise, there is a clear need to modernise the way outages are planned and managed. An automated outage planning tool using analytics and machine learning will improve the efficiency of outage planning, reduce human error and will help capture technical knowledge of the network for new personnel.

Method(s)

The proposed method is to design and test a web-based, automated outage planning tool designed to enhance transmission outages planning practices. The method aims to use machine learning and AI to analyse historical outage data (successful and failed examples) and current network conditions, helping planners identify optimal outage windows, reduce conflicts, and improve coordination while technical network impact is also taken into consideration. OPTIMA interfaces with various data sources such as NESO's eNAMS, SPEN databases, windfarm outputs, resource and vehicle availabilities and weather forecasts etc.

Implementing this method includes developing data models, developing algorithms and analytics on historic outages, developing specifications of the tool, testing the algorithms offline, developing interactive web-based tool, demonstration and trial.

The project will use a series of **technical methods** to deliver a solution to the outage planning challenge:

1.Developing the data model

The first step involves identifying historic and new databases to form the overall OPTIMA data model. Also building a data based on historic outage plans against historic information fed to that historic plan.

2. Developing the engineering logics and algorithms

This will involve developing engineering logic, analytics criteria, and network conditions that directly lead to a specific real-life outage plan. The algorithm will be designed to support long-term, year-ahead, and in-year planning stages.

3. Trialling the Algorithm for Long-Term and Short-Term Planning

Once developed, the algorithm will be tested to validate its performance, accuracy and reliability in an offline environment. This includes simulating outage scenarios using current network data and assessing how well the tool supports planning decisions under different conditions.

4. Incorporating AI into the Outage Planner

Machine learning models will be integrated into the tool to analyse historical outage data and learn from past planning decisions. The AI component will identify patterns, predict potential conflicts, and recommend optimal outage windows based on multiple data sources including NESO's eNAMS, SPEN databases, windfarm outputs, and weather forecasts etc.

5. Testing and Validation with AI Integrated

The final method involves validating the AI-enhanced tool in a live planning environment. This will include comparing its recommendations with manual plans, assessing accuracy, and ensuring it meets NESO and STCP 11-1 criteria. Feedback from planning engineers will be used to refine the tool and ensure it is fit for operational use.

Scope

The scope of the project is to develop, test, and deploy an automated outage planning tool – OPTIMA – that uses machine learning and AI to modernise outage planning tasks.

The scope of this project is explained in the work packages below:

1. Work Package 1 – Develop initial design, technical and functional requirements
    1. Identifying all the data sources needed by the outage planning tool. This will include data sources such as NESO's eNAMS, SPEN databases, windfarm outputs, resource and vehicle availabilities and weather forecasts.
    2. Developing data model stream considering all the databases and parameters that can affect an outage plan – focusing on long term planning data model
    3. Defining KPI indices for network impact assessment .
    4. Developing the engineering logic and the algorithm that can support long-term, year-ahead, and in-year outage planning.
    5. Develop a process to maintain and update the latest power system model of the network.
    6. Quantitative assessment of network impact and KPI calculations.
    7. Integration of the Powerfactory model with the offline outage planning tool.
    8. Testing the algorithm in an offline environment to validate its performance, accuracy and reliability. This includes simulating outage scenarios using current network data and assessing how well the tool supports planning decisions under different conditions.

2. Work Package 2 - Integration of AI and machine learning models
    1. Design of system architecture to integrate data sources into the outage planning tool.
    2. Integration of AI and machine learning models into the offline outage planning tool to analyse historical outage data and learn from past planning decisions.
    3. The AI component will identify patterns, predict potential conflicts, and recommend optimal outage windows based on multiple data sources including NESO's eNAMS, SPEN databases, windfarm outputs, and weather forecasts etc.
    4. Testing and validation of the offline outage planning tool with AI integrated.

3. Work Package 3 – Procurement
    1. Market research to shortlist capable vendors for partnership
    2. Preparation of tendering documents to select the suitable project partners.
    3. Technical and commercial interviews for competitive tendering.
    4. Partners appointment.

4. Work Package 4 – Designing and implementation the web-based tool, demonstration and trial
    1. Technical and functional specification developments, and establishing user stories.
    2. System architecture design for integration within IT/OT network
    3. Tool development and carrying out user acceptance tests
    4. Live trial of the web-based tool for different outage planning scenarios
    5. Feedback from planning engineers will be used to refine the tool and ensure it is fit for operational use.

5. Work Package 5 – Transition to BAU and handover of documentation.
    1. Preparation of procedures, manual documents
    2. Conduct trainings in collaboration with project partners

    1. Project governance documentation and dissemination

Objective(s)

The objectives of OPTIMA include

1. Develop the engineering logic behind outage planning and translate it into an outage planning algorithm.

2. Develop a data model on relevant historic and new databases for outage planning with separation on different horizon of the planning
3. Explore and develop machine learnings specifications which is fit for purpose for transmission outage planning
4. Test and validate the outage planner with long term, in-year and year ahead outage plans.
5. Dissemination of key findings and learnings

Consumer Vulnerability Impact Assessment (RIIO-2 Projects Only)

Consumers in vulnerable situations will benefit from the OPTIMA project as the project outcome will deliver a more reliable grid and reduce the chance of customers' supply interruption. By automating outage planning and integrating real-time data, the tool ensures outages are scheduled more efficiently, avoiding peak demand periods and adverse weather conditions that disproportionately affect vulnerable groups. Additionally, OPTIMA will help reduce curtailment of renewable energy sources by identifying optimal outage windows that minimise disruption to wind and solar generation. This not only supports environmental goals but also improves system efficiency, which can lead to lower operational costs and more stable energy pricing. For vulnerable consumers, this means greater reliability, reduced exposure to price volatility, and a more resilient energy system that better supports their needs.

Success Criteria

Key success criteria will include:

- Development of the algorithm to automate plan short, long and in-year outages as per requirements set by NESO and STCP 11-1.
- Successful validation of the outage planning tool's ability to generate reliable and accurate outage plans across long term, short term and in-year outage planning scenarios.
- Developing technical specifications of AI component in identifying outage conflicts, recommending optimal windows, and learning from historical data.
- Trial the tool, demonstrate the effectiveness and share the learnings with other Transmission companies

Project Partners and External Funding

n/a

Potential for New Learning

The learnings of the different parties will include:

- Understanding the Limitations of Current Outage Planning
- Development and Validation of an Automated Planning Algorithm
- Specifications of AI and Machine Learning in Outage Planning
- Operational Integration and User Feedback
- Method for integration of PowerFactory within OPTIMA tool

Dissemination of Learning

- Progress reports as per governance
- Webinar across ENA
- Energy Innovation Summit
- Specific project report including
  - Technical specification of the engineering logic processes and data model
  - Technical specification of machine learning tools
  - User story interface with outage planning tool
  - Learnings from tests and demonstration

Scale of Project

A smaller project would limit the different type of data which can restrict testing across planning horizons (long-term, year-ahead, in-year), and reduce insights into AI performance under real-world conditions. Outages affect the whole transmission network. If testing is carried out on a limited scale would not capture the full range of scenarios or risks.

Technology Readiness at Start

TRL2 Invention and Research

Technology Readiness at End

TRL7 Inactive Commissioning

Geographical Area

The project will take place in the license area of SP Transmission Plc.

Revenue Allowed for the RIIO Settlement

NIL

Indicative Total NIA Project Expenditure

The funding licensee expects to reclaim £240,000 for the whole of the project (RIIO2)

Project Eligibility Assessment Part 1

There are slightly differing requirements for RIIO-1 and RIIO-2 NIA projects. This is noted in each case, with the requirement numbers listed for both where they differ (shown as RIIO-2 / RIIO-1).

Requirement 1

Facilitate the energy system transition and/or benefit consumers in vulnerable situations (Please complete sections 3.1.1 and 3.1.2 for RIIO-2 projects only)

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

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

The project has strong potential to support the energy system transition by modernising the way transmission outages are planned and managed. Outage planning is currently a manual, resource-intensive process that relies heavily on individual expertise. As the network evolves to meet Net Zero targets, with increasing renewable integration and electrification, the complexity of planning outages has grown significantly. This tool will automate and streamline outage planning using machine learning and analytics, helping planners identify optimal outage windows, reduce human error, and retain network knowledge. By integrating data from NESO, SPEN, windfarms and weather sources, the tool will improve coordination and decision-making across long-term, year-ahead and in-year planning. Ultimately, this will enable faster deployment of low-carbon infrastructure and improve system resilience, directly supporting the transition to a decarbonised energy 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 (RIIO-1 projects only)

n/a

Please provide a calculation of the expected benefits the Solution

The project is valued at £240,000 which encompasses developing the engineering logic and algorithm for various cases of outage planning which include long-term outage planning, year-ahead outage planning and in-year outage planning. The next step will include incorporating AI and machine learning into the outage planner followed by testing and verification. Once proven successful, this innovation will help in improving network resilience. The outage planner will also improve the efficiency of resource allocation and streamline planning processes to support network outages, maintenance activities, and network modernisation. Whereas with the current process, outages are planned manually which take a lot of time and can lead to inaccuracies or errors. The manual process also means it takes longer to train new planning engineers due to the steep learning curve. OPTIMA aims to address these issues by being a more efficient tool to plan outages and help planning engineers with planning outages.

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

OPTIMA can be replicated across all the Transmission license areas in the UK with suitable modifications to the power system model and outage planning guidelines.

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

The costs of rolling out OPTIMA across GB will include the cost of modifying the power system model to suit that of the local transmission operator and any costs associated with modifying the outage planning algorithm to suit the policies of the transmission operator in terms of outage planning and resource allocation.

Requirement 3 / 1

Involve Research, Development or Demonstration

A RIIO-1 NIA Project 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

RIIO-2 Projects

☐ 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 OPTIMA will be highly valuable to other Network Licensees as it introduces a new approach to outage planning using machine learning and AI. By analysing historical outage data and integrating real-time inputs from NESO, SPEN, windfarm and weather sources, the tool will generate insights into optimal outage windows, conflict prediction, and resource coordination. These learnings can be shared across the industry to improve planning accuracy, reduce manual effort, and enhance network resilience. Unlike previous projects that used idealised models, OPTIMA will rely on current and accurate power system models, making its outputs more applicable to real-world scenarios. The methodology and outcomes can be adopted or adapted by other licensees to modernise their own planning processes, helping to standardise best practices and support the wider energy transition.

Or, please describe what specific challenge identified in the Network Licensee's innovation strategy that is being addressed by the project (RIIO-1 only)

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.

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

While outage planning projects have previously been undertaken by other DNOs, this project – OPTIMA – will not result in unnecessary duplication. Unlike earlier initiatives that relied on idealised models and manual planning processes, OPTIMA will utilise current and accurate power system models to reflect real network conditions. The tool will apply machine learning and AI to study historical outage data, enabling it to identify patterns, predict conflicts, and suggest optimal outage windows. This approach goes beyond traditional

methods by automating decision-making and improving the quality and reliability of outage plans. OPTIMA's integration of live data sources such as NESO's eNAMS, SPEN databases, windfarm and weather data ensures that planning is both dynamic and responsive to system needs. As such, the project represents a significant advancement in outage planning and avoids repeating previous work by introducing a data-driven, intelligent solution tailored to the evolving demands of the energy transition.

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

OPTIMA is innovative because it introduces a data-driven, intelligent approach to outage planning that goes beyond traditional manual methods. While previous projects have explored outage scheduling, they relied on idealised models and static planning processes. OPTIMA will use accurate, real-time power system models and apply machine learning to study historical outage data, enabling the tool to learn, adapt, and improve over time. The integration of AI allows for predictive planning, conflict detection, and optimal outage window recommendations—capabilities not present in existing tools. By automating long-term, year-ahead, and in-year planning and incorporating live data from NESO, SPEN, windfarms, and weather sources, OPTIMA represents a step-change in how outages are managed, supporting a smarter, more resilient energy system.

Relevant Foreground IPR

Any new intellectual property which are completed as part of the NIA project will be made available to other relevant networks licensees. No background IPR is required.

Data Access Details

The provision of data is subject to anonymisation and/or redaction for reasons of commercial confidentiality or other sensitivity.

Access to this data must be requested by contacting SPInnovation@spenergynetworks.co.uk. Please provide the following information in your request:

- Affiliation, position and contact details of requesting party
- Relevant project and type of data required
- Reasons for requesting this data and evidence that this data will be used in the interest of the UK network electricity customers
- How data will be shared internally and externally by the requesting party

Any data request deemed unsuitable for sharing will be highlighted to the appropriate requesting party. After receiving the request we will provide the estimated date for completing the data provision based on other requests and our team workload at that time. All requested data remains the property of SP Energy Networks.

https://www.spenergynetworks.co.uk/pages/data_sharing_policy.aspx

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

SPEN is not funding OPTIMA as part of its business-as-usual activities due to the significant risks associated with automating transmission outage planning, a highly complex and critical operation. Outage planning directly affects the security and reliability of the electricity transmission network, and any errors or misjudgements can lead to severe repercussions such as system instability, voltage violations, equipment overloading, or blackouts. Poorly coordinated outages can disrupt supply to essential services and vulnerable consumers, especially during peak demand or adverse weather conditions. Additionally, inadequate planning may result in the curtailment of renewable energy sources, undermining Net Zero targets and increasing reliance on fossil fuels, which carries both environmental and financial consequences. Regulatory compliance is another major concern; failure to meet NESO's criteria or the Transmission Owner Code Procedure (STCP) 11-1 can lead to fines, reputational damage, and increased scrutiny. The manual nature of current planning processes also introduces risks related to human error and knowledge dependency, making it difficult to maintain consistency and continuity, especially when experienced personnel leave. Furthermore, poor outage coordination can delay critical maintenance, asset replacement, and infrastructure projects, affecting broader investment programmes and operational efficiency. Given these high stakes, SPEN considers OPTIMA a strategic innovation initiative that requires careful development, testing, and

validation outside of routine operations to ensure it meets the necessary standards for safety, reliability, and regulatory compliance.

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

The OPTIMA project can only be undertaken with the support of the Network Innovation Allowance (NIA) due to the significant commercial, technical, operational, and regulatory risks involved in automating transmission outage planning. Outage planning is a critical and complex function that directly impacts the security and reliability of the transmission network. Any errors or misjudgements in this process can lead to serious consequences such as system instability, voltage violations, equipment overloading, or blackouts. Poorly coordinated outages may disrupt supply to essential services and vulnerable consumers, particularly during peak demand or adverse weather conditions. From an environmental and financial perspective, inadequate planning can result in the curtailment of renewable energy sources, undermining Net Zero targets and increasing reliance on fossil fuels. Regulatory compliance is also a major concern; failure to meet the criteria set by the National Electricity System Operator (NESO) or the Transmission Owner Code Procedure (STCP) 11-1 can lead to fines, reputational damage, and increased scrutiny. The current manual planning process is highly dependent on individual expertise, which introduces risks related to human error and knowledge retention, especially when experienced personnel leave. Additionally, poor outage coordination can delay critical maintenance, asset replacement, and infrastructure projects, affecting broader investment programmes and operational efficiency. Given these high stakes, SPEN has determined that OPTIMA cannot be funded as part of its business-as-usual activities. Instead, NIA support is essential to allow for the development, testing, and validation of this innovative solution in a controlled environment, ensuring it meets the necessary standards for safety, reliability, and regulatory compliance before any operational deployment.

This project has been approved by a senior member of staff

☑ Yes