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

Dec 2020

Project Reference Number

NIA_NGSO0037

Project Registration

Project Title

Optimal Outage Planning System

Project Reference Number

NIA_NGSO0037

Project Licensee(s)

National Energy System Operator

Project Start

December 2020

Project Duration

2 years and 1 month

Nominated Project Contact(s)

Jonathan Barcroft

Project Budget

£385,000.00

Summary

Outage planning is currently based on a worst-case scenario for each outage. There is limited accounting for the potential impact of increasingly changing system conditions (generation, weather, etc.) or of changes to one outage as a result of other outages. This has historically been done using “rules of thumb”.
With the rapid pace of change, the current planning methods are starting to show their limitations. In particular, a lot of work is devoted to reacting and re-planning.
This project will provide added value by providing a solution to the imperative need for better integration of risk estimation into the planning optimization so that the amount of work remains manageable for the NAP process.

Third Party Collaborators

University of Edinburgh

Nominated Contact Email Address(es)

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Problem Being Solved

Outages on the GB electricity transmission network are proposed by network operators and coordinated by the Electricity System Operator (ESO). The ESO will secure agreement with other stakeholders such as generating plant, bordering networks and plan actions on the system to facilitate the outage (where possible). These actions include outage scheduling/alignment, running arrangements and pre- and/or post-fault actions to secure the system. This relationship is governed by the System Operator

Transmission Owner Code and the Grid Code. An outage plan is agreed at year ahead. This plan is modified to account for outage changes within the year where required.

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With the rapid pace of change, the current planning methods are starting to show their limitations. In particular, a lot of work is devoted to reacting and re-planning.

Method(s)

The project is structured in two phases split over 22 months. The first phase of work lasts 12 months and will focus on building the first version of the outage planning tool. This tool consists of four optimization models: a model of the underlying electricity network, a decision model to integrate outages in the plan, a recovery model to handle disruptions, and a risk-to-the-system model to assess the impact of outages on security and stability. The second phase of work uses the remaining 10 months to focus on refining each of the models to better support the Network Access Planning (NAP) operations.

WP 0: Developing a first version of the network model
In this WP, a first version of the underlying network model is developed. It will be able to perform simplified optimal power flow computations on the chosen network model. At the end of this WP, the code will be set up in such a way that we are able to adjust the level of detail of the model in the later phase of the project.

WP 1: Developing a first version of the decision model
Deliverable: Prototype for testing by NAP staff
In parallel with the first version of the network model, the decision model will be developed. At the end of this WP, the decision model can propose whether and when to add a single outage to the current plan and is ready to be tested by NAP.The decision model can propose whether and when to add a single outage to the current plan and is ready to be tested by NAP.

WP 2: Developing a first version of the recovery model
Deliverable: Prototype for testing by NAP staff
Network Access Planning (NAP) and the University of Edinburgh (UoE) will explore and agree upon the possible recovery actions that the tool can propose, and the decision criteria by which the tool values different options (such as cost).
At the end of this work package, the recovery model can propose a recovery action taken from an agreed upon set of actions for a single given delayed outage.

WP 3: Developing a first version of the risk-to-the-system model
Deliverable: Prototype for testing by NAP staff
NAP and UoE will explore and agree upon the criteria that are used to determine the risk of the system. At the end of the work package, the risk-to-the-system model can output performance criteria that allow to quantify the risk to the system for one single outage. It is ready to be tested by NAP.

WP 4: Developing a refined cost estimation and duration estimation model
Deliverable: Prototypes of the models that can be used by the main models
We will refine the cost estimation model used in the decision model and the recovery model. We will also work on the duration estimation model to later consider predicted delays in outages.

At the end of the work package, prototypes of these models can be integrated into the other models.

WP 5: Refining the decision model
Deliverable: Refined prototype
We will refine the decision model after testing by NAP. After a meeting to discuss the test results and to agree on the changes and improvements that are necessary and realistic, we will implement them. This WP also contains the work of integrating the results of WP 4.

At the end of this work package NAP can work with a refined prototype.

WP 6: Refining the recovery model
Deliverable: Refined prototype
Building on WP 2 we will refine the recovery model after testing by NAP.This work package also contains the work of integrating the results of WP 4.

At the end of this work package NAP can work with a refined prototype.

WP 7: Refining the risk-to-the-system model
Deliverable: Refined prototype
We will refine the risk-to-the-system model after testing by NAP.This work package also contains the work of integrating the results of WP 4.

At the end of this work package NAP can work with a refined prototype.

Scope

The outage planning process at National Grid ESO involves collecting information from multiple systems and using it to make decisions on system access (who can do what, where and when). These planning decisions balance costs and system risks which are affected by unexpected changes due to various factors, both internal (e.g. conflicting or changing operational requirements) and external (e.g. changes to work specifications, faults).

An outage is considered as a period of time when a piece (or group) of equipment is offline for access for maintenance or construction work. Outage characteristics to be considered include:

- start/end dates
- equipment affected
- emergency return to service times
- indication of Transmission Operator significance of the outage

Outages must be planned in accordance with the SQSS (Security and Quality of Supply Standards) which sets a limit for compliance. Beyond this the ESO considers system risks and consumer benefit. Initially outages on the National Electricity Transmission System up to the distribution boundary (LV substation of interface sites) will be considered. The outages will be on transmission circuits, supergrid transformers and busbars. Some consideration may be required to related outages within the Distribution Network.

This project will provide added value by providing a solution to the imperative need for better integration of risk estimation into the planning optimization so that the amount of work remains manageable for the NAP team. In doing so, our Optimal Outage Planning System will also bring increased benefits for National Grid as a whole, for the DSOs, and for all the stakeholders.

Objective(s)

The ultimate objective of this project is to develop a tool that

1. facilitates the most efficient economic decision-making from the year-ahead plan to three-weeks ahead, and
2. identifies and tracks risks from year-ahead to day-ahead.

Consumer Vulnerability Impact Assessment (RIIO-2 Projects Only)

n/a

Success Criteria

The following success criteria apply to this project:

- A tool based on new mathematical optimization models designed to address the various needs of the planning process. It will have a modular structure that can be incrementally and independently improved as the different models are developed, tested, and validated for deployment.
- A report summarizing the tool development, benefits delivered and any next steps

Project Partners and External Funding

Project Partner – University of Edinburgh
No External Funding

Potential for New Learning

The project will be a success if the following learning can be achieved:

- A decision model to look at ways to integrate additional outages into the plan, taking the additional risk into account.
- A recovery model to determine the optimal recovery plan when a disruption happens, and to estimate the cost.
- A risk-to-the-system model to estimate the effects of an outage on the overall system security and stability.

Scale of Project

This project will be a desk based research activity, followed by a trial in a working environment of the tools developed

Technology Readiness at Start

TRL3 Proof of Concept

Technology Readiness at End

TRL5 Pilot Scale

Geographical Area

The project will be undertaken using teams based within University of Edinburgh and National Grid ESO.

Revenue Allowed for the RIIO Settlement

None

Indicative Total NIA Project Expenditure

Network Innovation Allowance expenditure is: £385,000

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:

n/a

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)

The project will deliver several benefits if successful:

Financial:

- At the moment, a delay in maintenance work costs on average GBP 5000 per day and for capital works it costs GBP 15000 if decided on day ahead. Improved planning will allow us to reduce the number of such delays.
- A substantial amount of work of NAP is planning for outages. Allowing NAP to reallocate work from repeated re-planning of outages that are unlikely to happen would increase the efficiency of the outage planning process, and allowing more complex planning decisions to be undertaken faster, We would also reduce the cost of the recovery actions needed to take, due to more advanced notice for outages and a more complete understanding of the possible impacts which could affect the cost of an outage.

System security:

- Improved estimates for the risk of maintenance measures will allow for more maintenance work to take place, thus improving system security

Reputational:

- Reduced impact of outage measures on consumers will allow NGESO to maintain system access transparency with TOs when planning outages.

Environmental:

- Will allow more rapid replacement of aging equipment through improved network access planning.

Please provide a calculation of the expected benefits the Solution

Not required for research projects.

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

The optimisation tool created will potentially be modular, allowing the solution to be extended to cover a greater part of the GB electricity network and for increasing complexity.

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

As it is planned for the prototype tool to be modular in design, the costs to expand usage across the GB network should be minimal, with the majority of costs required in futher testing and data collection to populate the models. If other network operators have specific requirements that need to be accommodated, then this would incur extra cost.

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

n/a

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

This project fits against the following strategic priority areas as defined by the ESO in its Innovation Strategy published in March 2020:

- Whole Energy System
- Digital transformation

☑ Has the Potential to Develop Learning That Can be Applied by all Relevant Network Licensees

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.

This is a solution specific to the outage planning process undertaken by the ESO, as such no other solutions have been found commercially which can add the additional capabilities necessary to consider the growing complexity for cost and risk considerations, and an awareness of the outage interaction in a way that can potentially be extended modularly.

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 will provide a solution to the imperative need for better integration of risk estimation into the planning optimization, so that NAP team can continue to manage outage planning effectively into the future. No solution currently exists for improving this specialised ESO process, so by working with an academic partner now, we can address this challenge and find an innovative solution before this issue becomes unmanageable.

Relevant Foreground IPR

n/a

Data Access Details

n/a

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

This project involves research and early stage development activities which are inherently risky (i.e. may not produce a viable business solution that can be implemented by the NAP team), therefore this type of innovation is unable to be funded as business-as-usual.

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

NIA is necessary to fund this partnership with academia to improve the Outage Planning process, which will deliver benefits for the wider system and ultimately consumers. There is significant technical risk inherent in developing a new tool to optimise the Outage Planning process. While commercial products for optimisation at a lower level do exist, these are not suited for the developing complexity of the power system of the future. The approach being proposed by University of Edinburgh offers opportunities to grow this as the complexity becomes more understood. This also explores new ground in presenting the recommendations/assessments in a way that Power System Engineers can interpret and make decisions on.

This project has been approved by a senior member of staff

- [x] Yes