NIA Project Registration and PEA Document

Date of Submission:

*Notes on Completion: Please refer to the NIA Governance Document to assist in the completion of this form. Please use the default font (Calibri font size 10) in your submission. Please ensure all content is contained within the boundaries of the text areas. The full-completed submission should not exceed 10/12 pages in total.*

1. Project Registration

|  |  |  |
| --- | --- | --- |
| Project Title (*This cannot be changed once registered*) |  | Project Reference |
| STARTZ (Stability Requirements Calculation Toward Net-Zero) |  | NIA2\_NGESO046 |
| Funding Licensee(s) |  | Project Start Date |
| NGESO |  | March 2023 |
| Nominated Project Contact(s) |  | Project Duration |
| Tatiana Assis (NGESO)Shurooque Baloch (NGESO) |  | 18 Months |
| Contact Email Address |  | Project Budget |
| innovation@nationalgrideso.com |  | £400,000 |

**Project Summary (125 words limit)**

This project will review the current methods of calculating system stability needs and implement automation and machine learning to calculate system stability needs for the GB network at a granular level. This project will:

* Review the current methods of calculating system stability needs and identify areas of improvement.
* Perform the analysis on a sufficiently granular representation of the active and passive network components in the GB system.
* Apply automation and other necessary methods (machine learning) to manage additional computational burden of using detailed network representation.

**Lead Sector**

|  |  |
| --- | --- |
| Electricity Distribution | Gas Distribution |
| Electricity Transmission | Gas Transmission |

**Other Sectors**

|  |  |
| --- | --- |
| Electricity Distribution | Gas Distribution |
| Electricity Transmission  | Gas Transmission |

**Research Area**

|  |  |
| --- | --- |
| Net zero and the energy system transition | Optimised assets and practices |
| Flexibility and Commercial Evolution | Whole Energy System |
| Consumer Vulnerability |  |

**Development steps**

|  |  |
| --- | --- |
| Technology Readiness Level (TRL) at Start 3 | TRL at Completion5 |

1. Project Details
	1. Problem(s)

This should outline the Problem(s) which is/are being addressed by the Project. This cannot be changed once registered.

The existing in-house developed tool to compute system stability needs (inertia, short circuit level) has limited interactions with detailed network models in the PowerFactory tool used widely in the Networks Options Assessment (NOA) and Electricity Ten Year Statement (ETYS) processes. The calculations are based on empirical formulas. For short circuit level, limited scenarios are studied in PowerFactory due to time and tools constraints. With the changing nature of the system, this approach may no longer be sufficient for future planning and more year-round analysis is required.

The current year-round analysis computes hourly generation and demand dispatches to identify the amount and the location of the stability services that need to be procured. These dispatches have a temporal variation which is captured through a time series analysis. The current tool is, however, unable to consider spatial uncertainty for inertia assessment, as the model is a lumped representation of the GB system.

* 1. Method(s)

This section should set out the Method or Methods that will be used in order to provide a Solution to the Problem. The type of Method should be identified where possible, eg technical or commercial.

For RIIO-2 projects, apart from projects involving specific novel commercial arrangement(s), this section should also include a Measurement Quality Statement and Data Quality Statement.

This project, seeks to achieve three main objectives –

* Review the current methods of calculating system stability needs and identify areas of improvement.
* Perform the analysis on a sufficiently granular representation of the active and passive network components in the GB system.
* Apply automation and other necessary methods (machine learning) to manage additional computational burden of using detailed network representation.

These objectives will be achieved by breaking down the problem into smaller tasks. As an example, the inertia requirement of the system will be treated as a sub-problem. Not only the total amount of system inertia is directly connected to the frequency stability and robustness of the grid, but also its specific location, especially in low inertia systems. Considering the possibility of procuring inertia as a service, the fundamental question would be ‘where to optimally place synthetic/rotational inertia in the system’. One approach to answer this question could be to calculate the electrical distance of all busbars from the Centre of Inertia (COI) of the system after a disturbance based on a Frequency Deviation Index (FDI). This would need to be repeated for every dispatch scenario. Based on the average improvement of the frequency nadir and RoCoF, a few locations can be identified where the system would benefit maximum from inertia services.

A similar approach can be adopted for short circuit level. Metrics like Weighted Short Circuit Ratio (WSCR), Composite Short Circuit Ratio (CSCR) and Equivalent Short Circuit Ratio (ESCR) with interaction Factors (SCRIF) can be used to identify the system strength at a particular location when there is a strong electrical coupling between nearby inverter-based resources. Repeating this process for several dispatch scenarios would provide a range of SCR and would provide an idea of the system needs.

The project will be delivered in three work packages:

* **WP1 - Review of current methods**
* **WP2 – Apply Alternate Methods**
* **WP3 – Comparison with Existing Tool**

In line with the ENA’s ENIP document, the risk rating is scored Low.

* TRL Steps = 1 (2 TRL steps)
* Cost = 1 (£400k)
* Suppliers = 1 (1 supplier)
* Data Assumptions = 2
* Total = 5 (Low)
	1. Scope

The scope and objectives of the Project should be clearly defined including the net benefits for consumers (eg financial, environmental, etc). This section should also detail the financial benefits which would directly accrue to the GB Gas Transportation System and/or electricity transmission or distribution.

Decarbonisation is bringing technical challenges that include the management of potential stability issues caused by the reduction in inertia and short circuit levels. In order to overcome potential stability problems while keeping economic and secure operation, NOA Stability Pathfinder projects have been looking to find and procure alternative sources of stability support.

One key aspect to the NOA Stability Pathfinder project or any other future stability services procurement process is the calculation of future system stability needs. Overestimation or underestimation of system needs potentially represents, respectively, unnecessary costs for consumers or system vulnerability with increased risk of blackouts.

The current methodology to calculate the system stability needs is based on several assumptions, criteria and simplifications that should be revised and improved following network evolving and energy landscape transition. Also, since a number of future generation and demand dispatches are considered, a higher level of automation in the calculation process is required.

This project will review the current methods of calculating system stability and identify areas of improvement, performing the analysis on a sufficiently granular representation of the active and passive network components in the GB system. Bases on this analysis, It will apply automation and other necessary methods (machine learning) to manage additional computational burden of using detailed network representation.

1. 1. Objectives

This cannot be changed once registered.

The existing tool to compute system needs is a standalone process and is not integrated with any of the NOA tools or ETYS models. The calculations are based on empirical formulas. At the same time, the year-round analysis computes hourly generation and demand dispatches to identify the amount and the location of the services that need to be procured. These dispatches have a temporal variation which is captured through a time series analysis. The current tool is, however, not able to consider spatial uncertainty for inertia assessment, as the model is a lumped representation of the GB system. This project, therefore, seeks to achieve three main objectives:

1. Review the current methods of calculating system stability needs and identify areas of improvement.
2. Perform the analysis on a sufficiently granular representation of the active and passive network components in the GB system.
3. Implement automation and other necessary methods (machine learning) to manage additional computational burden of using detailed network representation.
	1. Consumer Vulnerability Impact Assessment (RIIO-2 projects only)

Details of the expected effects of the Method(s) and Solution(s) upon consumers in vulnerable situations. This must include an assessment of distributional impacts (technical, financial and wellbeing-related). For RIIO-1 projects please add “Not Applicable”

The ESO does not have a direct connection to consumers, and therefore is unable to differentiate the impact on consumers and those in vulnerable situations. Benefits to all consumers are detailed below.

* 1. Success Criteria

Details of how the Funding Licensee will evaluate whether the Project has been successful. This cannot be changed once registered.

The project will be considered successful if the following criteria are met:

* Creation of an improved methodology and associated new tools which will interface with the detailed DIgSILENT Powerfactory model of the GB system to allow year-round calculating of system stability needs.
* Development of the ability to perform granular calculations of year-round system stability needs by implementing a set of automation and machine learning techniques.
* Validation of the new tool’s output against accurate outputs from DIgSILENT Powerfactory and the measured values from ESO operation.
* Dissemination and training for learnings and tools developed in the project.
	1. Project Partners and External Funding

Details of actual or potential Project Partners and external funding support as appropriate.

TNEI will be carrying out the work. No external funding required*.*

* 1. Potential for New Learning

Details of what the parties expect to learn and how the learning will be disseminated.

The project will generate a significant understanding of the energy transition impact one stability-related requirements under different future energy scenarios (FES). The application of automation and machine learning techniques will enable the extension of the analysis considering different generation and demand conditions with a feasible computational process time. A significant impediment to an exhaustive search of potential scenarios of concern regarding the system stability is the inherent quantity of possible conditions and the associated computation required.

This project will also build on the learnings that have been gathered from other innovation projects in the area of stability, probabilistic modelling, forecasting and machine learning techniques. These projects have dealt with analysing a large number of scenarios and the methods adopted will provide a springboard to explore further scenario clustering and reduction techniques, which can be extremely relevant in this new development.

* 1. Scale of Project

The Funding Licensee should justify the scale of the Project – including the scale of the investment relative to the potential benefits. In particular, it should explain why there would be less potential for new learning if the Project were of a smaller scale.

The project spans 18 months with one project partner. The project consists of desk-based research and workshops with the relevant ESO teams (including network and wider teams).

* 1. Geographical Area

Details of where the Project will take place. If the Project is a collaboration, the Funding Licensee area(s) in which the Project will take place should be identified.

This project will be based upon the GB ESO area of operations.

* 1. Revenue allowed for in the current RIIO settlement

An indication of the funding provided to the network licensee within the current RIIO settlement that is likely to be surplus to requirements as a result of the Project.

None

* 1. Indicative Total NIA Project Expenditure

An indication of the total Allowable NIA Expenditure that the Funding Licensee expects to reclaim for the whole of the Project (RIIO1).

An indication of the Total NIA Expenditure that the Funding Licensee expects to reclaim for the whole of the Project (RIIO2).

£400,000

1. Project Eligibility Assessment

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).

* 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:

* + 1. How the Project has the potential to facilitate the energy system transition:

The project will directly facilitate the energy transition as it will improve the calculation of system requirements in terms of stability; this an essential parameter to allow the integration of renewable generation onto the GB network. By understanding more accurately stability needs, it is possible to anticipate the technical solutions that will guarantee the system operates in a reliable and safe way, facilitating the transition to a zero carbon energy system while keeping the lights on.

* + 1. How the Project has potential to benefit consumer in vulnerable situations:

* 1. 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.

* + 1. Please provide an estimate of the saving if the Problem is solved (RIIO-1 projects only

N/A

* + 1. Please provide a calculation of the expected benefits the Solution

 This is for Development or Demonstration Projects, not required for Research Projects. It should be (Base Cost – Method Cost, Against Agreed Baseline) and include a description of the recipients of the benefits.

* + 1. Please provide an estimate of how replicable the Method is across GB

This must be in terms of the number of sites, the sort of site the Method could be applied to, or the percentage of the Network Licensees system where it could be rolled-out.

The project will aim to study the entire GB transmission system and the tools developed can be used across individual regions when relevant.

* + 1. Please provide an outline of the costs of rolling out the Method across GB.

The cost of rolling out the method consists of the software license and the required hardware upgrades only, this is estimated to be £100k.

* 1. Requirement 3 / 1 – involve Research, Development or Demonstration
		1. RIIO-1 Projects

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):

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| --- | --- |
| 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 systems and 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 GB electricity transmission or distribution systems |  |
| A specific novel commercial arrangement |  |

* + 1. RIIO-2 Projects

A RIIO-2 Project must involve the Research, Development or Demonstration of at least one of the following:

|  |  |
| --- | --- |
| 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 |  |

* 1. Requirement 4 / 2a – develop new learning

A Project must develop new learning that can be applied by Gas Transporter and/or Electricity Transmission or Electricity Distribution licensees. For RIIO-1 Network Licensees may wish to address challenges specific to their network.

Please answer one of the following:

* + 1. Please explain how the learning that will be generated could be used by relevant Network Licenses

The learnings from this project can also be beneficial to Transmission Owners (TOs) concerning sub synchronous oscillation (SSO) identification in future connections and network development studies. The TOs use the same EMT software package, and the developed tool should integrate with their models seamlessly.

* + 1. Or, please describe what specific challenge identified in the Network Licensee’s innovation strategy is being addressed by the Project (RIIO-1 only)
		2. Is the default intellectual Property Rights (IPR) position being applied?

This cannot be changed once registered.

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| --- | --- |
| Yes  | No |

If “no”, the following questions must be answered:

* + - 1. Demonstrate how the learning from the Project can be successfully disseminated to Network Licensees and other interested parties:

* + - 1. Describe how any potential constraints or costs caused, or resulting from, the imposed IPR arrangements:

* + - 1. Justify why the proposed IPR arrangements provide value for money for customers:

* 1. Requirement 5 / 2c – be innovative

A Project must be innovative (ie not a business as usual activity) and have an unproven business case entailing a degree of risk warranting a limited Research, Development or Demonstration Project to demonstrate its effectiveness. This could include Projects which are untested at scale, or in relation to which there are risks, which might prevent the widespread deployment of the equipment, technology or methodology.

* + 1. Why is the project innovative?

RIIO-1 projects must include description of why they have not been tried before.

The project will integrate automation and machine learning in calculation of system stability requirements and allow granular analysis of more scenarios in DigSILENT Powerfactory. It will be the first time that the GB system stability needs could be calculated at a granular level considering the existing and potential network changes and different year-round conditions.

In addition, the proposed approach is a collection of several advanced techniques. The individual techniques have been researched in academia for different applications and this project will look to utilise a combination of these techniques/methods for a particular application, i.e., system stability needs assessment. This has not been tried before in the GB system.

* + 1. Why is the Network Licensee not funding the Project as part of its business as usual activities?

Due to the nature of the project and that it is researching potential future impacts to the grid based largely on assumptions, this does not fall into current business as usual (BAU).

* + 1. Why can the Project can only be undertaken with the support of NIA?

This must include a description of the specific risks (e.g. commercial, technical, operational or regulatory) associated with the Project.

* The project is in a complex area of power systems, and the TRL of the overall framework is low. Therefore, innovation funding is more suitable for exploring the project's potential and increasing the TRL before transferring into BAU activities.
* The methods are novel and have not yet been trialled on real networks.
* There are potential risks associated with the availability of required data and the acceptable performance of the methods.
* Standard procedures may also need to change to integrate the developed tool.
* Consideration of the practicality of the runtime and the need for high computational resources.
* There are risks associated with acceptable performance of the methods when applied to the detailed GB network model.
	1. Requirement 6 / 2d – 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.

* + 1. Please demonstrate below that no unnecessary duplication will occur as a result of the Project.

We are aware of several other innovation projects that are now in delivery or recently completed, that will complement the work proposed here. Some of the projects are –

* **Applications of convex optimisation to enhance National Grid’s NOA process**: the project developed an optimisation tool (based on OATS – Optimisation and Analysis Toolbox for Power Systems) using new advancements in mathematical and computational techniques to enable year-round assessment of reactive power requirements in the GB system to comply with planning voltage standards for a given future network.
* **Study of Advanced Modelling for Network Planning Under Uncertainty**: the project identified potential alternatives for new planning methodologies and developed a tool to perform Least Worst Weighted Regret analysis for the NOA process.
* **Reactive Power Market Design**: The project delivered a reactive power market framework to lay the foundation for ESO to procure market-based solutions for voltage management in future networks.
* **Probabilistic planning for stability constraints**: TNEI has recently delivered this innovation project and has worked extensively with the ETYS model. Several automation features were developed to interface with the DIgSILENT model and a machine learning tool was developed to reduce computational time for year-round analysis. We have engaged with the various project teams and will continue to have regular catchups to share learnings throughout the project's progression.
	+ 1. If applicable, justify why you are undertaking a Project similar to those being carried out by any other Network Licensees.

1. PEA approval

The senior person (RIIO-1) or senior network manager (RIIO-2) responsible for implementing RIIO-2 NIA Projects must approve the PEA. It must then be published on the Project Registration page of the Smarter Networks Portal.

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| --- | --- |
| **Please confirm this project has been approved by a senior member of staff** |  |