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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

Sep 2021

Project Reference

NIA2_NGESO008

Project Registration

Project Title

Reactive Power Market Design

Project Reference

NIA2_NGESO008

Project Licensee(s)

National Grid Electricity System Operator

Project Start

September 2021

Project Duration

0 years and 11 months

Nominated Project Contact(s)

Yuting Dai

Project Budget

£600,000.00

Summary

Reactive Power is an essential service used by NGESO to control the system voltage level within the limits that are defined in the Grid Code and NETS SQSS.

Conventional transmission connected sources of reactive power are being replaced by renewable and decentralised units. This change to the generation base, along with a changing demand profile, makes controlling voltage on the NETS more challenging.

The project is to explore if a reactive power market could be developed to help ESO access more reactive power in the right location, create market access for more providers, incentivise more efficient new technologies and lower the overall spend on reactive power control. This will facilitate ESO's goals to deliver Competition Everywhere, Zero-Carbon System Operation, and Whole Systems Outcomes by 2025.

Nominated Contact Email Address(es)

box.so.innovation@nationalgrid.com

Problem Being Solved

This project is looking to explore the following challenges:

Challenge 1: As explained in Market Roadmap to 2025, along with the share of renewable generation in the energy mix rising, there is an increasing risk to ESO to manage voltage within the compliance limit in a secure and economic way.

Challenge 2: Spend on voltage services has increased over the past few years and is expected to continue to increase in the future. Monthly spend on voltage services can be found in the ESO's Monthly Balancing Services Summary (MBSS) reports.

Challenge 3: The ESO has ambitions to deliver Competition Everywhere, Zero-Carbon System Operation and Whole Systems Outcomes by 2025 (more details can be found in ESO RIIO-2 Business Plan), we need to keep developing reactive power service to better align with these ambitions.

Method(s)

The project will run a number of work streams exploring the elements of a future reactive market design. Work stream 1, the project will run a technical modelling exercise to define system needs and develop a methodology to identify the reactive market procurement requirements.

In parallel, work stream 2 will run an in-depth market analysis, exploring the blockers and enablers for reactive power market participation. Identifying a long list of potential market participants including traditional generators, DER, renewable generators, interconnectors and network assets. This workstream will also look to identify potential MVAr capability of these identified providers to participate in a market will be assessed both via exploring our existing data on reactive capability for providers who already provide some reactive power to the ESO as well as a series of stakeholder and market engagement activities (like forums with relevant associations, 121 interviews, etc.). This information will enable the project team to assess the levels of competition we might expect within a reactive power market in different locations. This will support the final feasibility study and recommendations for next steps.

These work streams will feed into a range of reactive market designs elements (i.e. building blocks). As part of a co-creation process, these building blocks will be chosen to form a range of potential market designs. ESO will collaborate with Afry and the industry, using a "strawman" approach, to develop these detailed end-to-end designs. Once several design options have been constructed, the project will test with market participants via the industry participated workshops. A commercial analysis will be run at this stage to make sure the final solution aligns with project objectives and success criteria.

Finally, a feasibility study will be run through an economic modelling assessment based on the outputs from above to simulate the market procurement. This will facilitate estimation of how much will be spent with the proposed market design arrangement until 2025, and to evaluate the feasibility of the options.

Scope

The proposed reactive power market is aiming to procure services to meet SQSS compliance including the steady state voltage requirements and to ensure that voltage step changes can be managed within limits. This project will include:

1. Technical analysis which will define service need and design a consistent, repeatable, and extendable methodology to set up the procurement requirement.
2. Market analysis to explore potential market size and recommend markets routes for different types of providers
3. Commercial analysis to design procurement strategy including frequency of procurement, assessment rules, and price setting methodology, etc.
4. Feasibility modelling and assessment based on the above analysis output to recommend the most suitable market design and next steps (trial, implement or not continue, etc.)

Objective(s)

The project will design a reactive power market and analyse whether it will be a feasible option that can be developed to meet the following goals:

- Access more reactive power (MVAr) in the right locations to maintain system voltage security
- Incentivise more cost-effective solutions
- Drive down the overall reactive cost to maximise consumer benefits

Develop routes to procure reactive power from more participants to stimulate greater competition

Consumer Vulnerability Impact Assessment (RIIO-2 Projects Only)

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

Success Criteria

The project will be a success if the following is achieved:

- A recommendation based on the feasibility of study to inform the future direction and next steps:

If a market-based solution would work, an implementable solution for an end-to-end reactive power market design will be created, backed up with an assessment of different options.

If the result shows the market is not ready to deliver the expected benefits yet, then the dependencies need to be analysed, i.e. under which conditions the procurement can be started.

- Positive feedback from stakeholders on our engagement throughout the project and that they recognise we have taken on board their feedback

Project Partners and External Funding

Project Partner: AFRY, no external funding contribution

Potential for New Learning

As a world first, the ESO expects all the information to come out of the project to be new learnings, but specifically of interest will be:

- A consistent, repeatable, and extendable methodology to define the procurement requirement or a reactive market
- Technical and commercial blockers and enablers of reactive market participation from different types of providers (including the ability for network assets to participate in a market for reactive power)
- Different options for a reactive power market design
- Optimisation of long term and short-term reactive power procurement
- Feasibility and readiness of a reactive market

Scale of Project

This project will span 6 months with AFRY delivering the work (as well as additional stakeholder engagement)

This is a project to explore the feasibility of using a market-based solution to reform reactive power services and so is small in scope.

Technology Readiness at Start

TRL2 Invention and Research

Technology Readiness at End

TRL4 Bench Scale Research

Geographical Area

This project will cover the whole of the GB network. Aspects of the design are expected to, however, be location specific due to system needs and requirements

Revenue Allowed for the RIIO Settlement

None

Indicative Total NIA Project Expenditure

£600,000

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:

The energy system is going through rapid and extensive change, with changes in supply and demand. This project will facilitate the ESOs role though the energy system transition by:

System security

Accessing more reactive power capacity in the right location will provide the Electricity National Control Centre (ENCC) with more options in real-time thus enhance the security of the system.

Carbon/environmental

The project will assess the capability of renewables in the provision of reactive power services, explore their blockers and enablers to participate in the market from both technical and commercial perspectives, and provide recommendations on their specific routes to market

Customer/stakeholders

Market transparency will improve. Much clearer price signals and requirements will be sent to the market

It will create market access and an additional revenue stream for providers, especially the non-traditional ones

Increase customer satisfaction via positive engagement and co-creation with the market.

Financial

In theory, creating a short-term market will lower the barriers to entry, attract more efficient new technologies to join – particularly providing a route to market for potential sources of reactive power which are currently inaccessible to the ESO, and increase the market liquidity. All of these should lead to lower prices as well as a more transparent open process.

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

Not applicable

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)

Not applicable

Please provide a calculation of the expected benefits the Solution

Not required as this is a research project

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

This will be the output of the project. The scope of the project will cover the whole GB system.

The project scope covers a reactive market which could meet voltage needs at a transmission network level, so therefore covers all of GB. The scope will investigate the ability of distribution connected parties (DER) to contribute to solving these needs. However, not all Distributions Network Owners operate their networks in the same way and therefore the ability of DER to contribute may differ, resulting in different outcomes across the network.

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

The cost to rollout will be dependent on the final option chosen. The feasibility of the market-based solution is a core objective of this project, the estimated cost of a future rolls out cost will be determined at a later stage. If the solution is feasible, we then decide whether, and how, to do a small trial in some regions first or whether to implement it across GB directly.

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)

Not required.

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 project is a first and there should be no direct duplication of any existing activities/ projects.

NOA High Voltage Pathfinder project

NOA High Voltage Pathfinder project is currently procuring static reactive power service in some specific area via long-term contracts. The biggest difference between the pathfinder project and this market design project is: pathfinder project seeks services from new providers and only focus long-term market in specific areas, while this project is trying to assess the feasibility of establishing a reactive market covers whole GB networks (especially focus the short-term market) and the market will be open for all providers. The market design project will take pathfinder's lesson learned into consideration when design the long-term market principles. The learnings from this project will also help inform the next stage of the Pathfinders project.

Power Potential NIC project

The objectives of these 2 projects are completely different. Working with a DNO project partner, UKPN, the Power Potential project aims to explore how to implement an automated end-to end system approach to get reactive power services delivered from Distribution Energy Resources (DERs) in South East region. Whereas this market design project aims to explore how to establish an open, transparent and competitive market, thus it will focus on analysing ESO reactive power requirements, market liquidity and readiness, impact of different market design options on market participation level. These areas are not covered in Power Potential project.

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

Not applicable.

Additional Governance And Document Upload

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

In most countries, reactive power is still provided under a mandatory approach. Using market-based mechanisms to procure reactive power nation-wide (with clear volume, location, and price signal) is practically non-existent globally.

In GB, the current approach of defining a reactive power requirement is based on management of high voltages. This current approach only determines a number of balancing mechanism reactive power providers required in a zone instead a clear procurement volume. This project aims to deliver a consistent, repeatable, extendable method to define the requirements across various timescales.

Relevant Foreground IPR

The following Foreground IPR is expected to be generated from this project:

- A final report and recommendations for a reactive market

Data Access Details

If it is deemed necessary to have access to background IPR to utilise the results, a request may be submitted to the ESO and project partners, if this is a reasonable request then any relevant data may be anonymised and redacted where necessary to protect any sensitive information. We don't foresee any requests for background IPR access being necessary.

The terms on which such data will be made available by National Grid can be found in our publicly available "Data sharing policy related to NIC/NIA projects" and https://www.nationalgrideso.com/future-energy/innovation/get-involved. National Grid already publishes much of the data arising from our NIC/NIA projects at www.smarternetworks.org. You may wish to check this website before making an application under this policy, in case the data which you are seeking has already been published.

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

The NGESO currently procure reactive power via the mandatory service (ORPS) or bilateral contracts (TCM). No competitive market mechanism is in place for reactive power procurement. There is no guarantee that the market-based solution would work. Thus, before we implement this idea into business as usual, we need to prove:

1. a transparent, competitive and effective reactive power market can be established or developed
2. the market design is feasible to be implemented.

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 a similar market does not exist yet, there are a number of innovation risks associated with this project.

Firstly, there is a risk that the market is not ready yet (either there is no enough interest from market providers or there are technical or commercial blockers cannot be solved at this stage). Maybe the market-based solution is not the right direction to solve the challenges we are facing.

Secondly, the market design delivered at the end of the project could be either overly complex or not meet our requirements in some way (e.g. compared with other alternative actions, it may not be the most cost-effectiveness solution in the short-term).

Therefore, without an innovation project we would not know what the optimum solution for delivery is.

This project has been approved by a senior member of staff

☑ Yes