

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. Network Licensees must publish the required Project Progress information on the Smart Grids Portal by 31st July 2014 and each year thereafter. The Network Licensee(s) must publish Project Progress information for each NIA Project that has developed new learning in the preceding relevant year.

NIA Project Close Down Report Document

Date of Submission

Jul 2024

Project Reference Number

NIA2_NGESO008

Project Progress

Project Title

Reactive Power Market Design

Project Reference Number

NIA2_NGESO008

Project Start Date

September 2021

Project Duration

2 years and 7 months

Nominated Project Contact(s)

Yuting Dai

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.)

Objectives

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

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

Performance Compared to the Original Project Aims, Objectives and Success Criteria

National Grid Electricity System Operator (“NGESO”) has endeavoured to prepare the published report (“Report”) in respect of Reactive Power Market Design, NIA2_NGESO008 (“Project”) in a manner which is, as far as possible, objective, using information collected and compiled by NGESO and its Project partners (“Publishers”). Any intellectual property rights developed in the course of the Project and used in the Report shall be owned by the Publishers (as agreed between NGESO and the Project partners).

The Report provided is for information only and viewers of the Report should not place any reliance on any of the contents of this Report including (without limitation) any data, recommendations or conclusions and should take all appropriate steps to verify this information before acting upon it and rely on their own information. None of the Publishers nor its affiliated companies make any representations nor give any warranties or undertakings in relation to the content of the Report in relation to the quality, accuracy, completeness or fitness for purpose of such content. To the fullest extent permitted by law, the Publishers shall not be liable howsoever arising (including negligence) in respect of or in relation to any reliance on information contained in the Report

Copyright © National Grid Electricity System Operator 2024

Project Overview and Activities

Voltage management is very local as reactive power does not travel great distances.

The issue of high voltages on the system has been seen in the last decade and is increasing, limited options are available in real time which could put system security at risk, hence there is need to access more reactive power capacity to keep system voltage within limit;

Spend on voltage services has increased over the past few years and there is a risk it continues to increase in the future, the cost is mainly made up from the ORPS payment and the cost of buying additional generation on in the Balancing Mechanism or via Trading arrangements when there is not enough reactive power provision in a region, hence there is need to procure reactive power service in a more economic and competitive way. The project will design a reactive 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
- 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

The project produced several reports aligned with the original objectives of this project:

[Project summary report](#)

[Market analysis report](#)

[DER blockers and routes to market report](#)

[Commercial analysis report](#)

The reports cover the recommendations for the market design including market analysis, assessment of options and a description of the recommended market design; DER blockers and routes to market; drivers for change; recent history; future trends and commercial analysis.

Outputs from the project include a Provider heat map of expected MVar capability by Grid Supply Point (GSP) using the Electricity Ten Year Statement (ETYS) data, as well as details of the opportunities and challenges for Providers along with case studies. The case studies detail the characteristics and capabilities of different Provider types, along with their barriers and enablers to reactive power provision.

Project Deliverables

1. Technical workstream: Reactive power product and service design, requirement analysis methodology design (locational and effectiveness impact) – Completed. Details can be found in the [project summary report](#).
2. Market workstream: Market size and competition analysis in locations; market route design from transmission connected providers covering different technologies – Completed. Details can be found in the [market analysis report](#).
3. Commercial workstream: Procurement strategy, assessment methodology, price setting and payment methodology design – Completed. Details can be found in the [commercial analysis report](#).
4. Recommendation on the specific routes to market from Distributed Energy Resource (DER) units through a whole system approach with DNOs – Completed in the [DER, blockers and routes to market report](#).
5. Simulate and model the market design and evaluate the feasibility for recommendation – Completed details in project summary report (link above).

Stakeholder engagement was carried out throughout the project (summarised below), enabling the ESO to share project progress and findings, and gather information and feedback from industry to help shape further work and future market design:

- [Project update webinar](#) – October 2021
- [Market analysis case studies workshop](#) – November 2021
- [Strawman option design workshop](#) – December 2021
- [Project update](#) – December 2021
- [Project update](#) – February 2022
- [ESO thought piece](#) – reactive power market design innovation project – March 2022

Following the completion of Phase 1, the project was paused, and resource diverted to deliver the new Balancing Reserve service which was identified as a higher priority to deliver savings for consumers by addressing soaring balancing costs during 2022.

Although the project was accepted to restart in Spring 2023, it has remained on hold and a decision to close the project has now been made.

Required Modifications to the Planned Approach During the Course of the Project

The Reactive Power Market Design project was extended by one month to investigate a number of areas which arose in the course of the project:

- Investigating options for the next phase of Reactive Power (a future development/demonstration project), including integrating all key ESO stakeholders into the future of reactive work, and understanding the scale and complexity of implementation challenges.
- Developing the functional requirements for the auction clearing algorithm for the reactive power market.

The additional work carried out is detailed below:

- Eligibility criteria refinement - we have identified three sets of eligibility 'groups' including incremental investment, incremental capability, and existing providers. For this stage we will need to agree the criteria to be applied which qualifies these groups for eligibility under these three buckets of eligibility.
- Formula for penalties and late start fees for long-term market. We propose to review current arrangements in relation to the pathfinder projects and propose any changes if necessary.
- Communication of requirement, release of nodal effectiveness, release of requirements, timing of release.
- Communication of market outcomes, including calculation of and reporting of prices for transparency purposes, release of bid data, timing of communication.
- Feasibility study to map existing processes, identify gaps, analyse system and resource requirements and optimise the design
- Development of nodal clearing algorithm
- Regulatory issues including treatment of TO assets in competitive reactive process for long term markets
- Competition and potential price caps to review the competitive landscape building on previous work to help determine the level of competition before go live; potential price cap and design of price cap
- Alternative costs forecasting methodology

The additional costs incurred for the above additional work were a total of c£160k

Lessons Learnt for Future Projects

The project provides insight into the expected market size, location of reactive power providers and capabilities of different technologies. This insight has supported the work to design the proposed market and should continue to inform and support decision making in the next phase of refining and implementing the market.

The DER report identifies key technical, commercial, and regulatory barriers for DER to be considered and several possible ways forward on how to overcome these. The critical next steps involve changes impacting distribution network owners and will require a coordinated approach to implementation.

The economic modelling gives insight into the potential costs, actions, and associated carbon emissions for managing the system under ESO's Leading the Way FES 2021 scenario for 2025. This provided the ESO with views on the potential benefits of a competitive approach to reactive power.

The requirement setting defines nodal MVAR requirements; node-to-node effectiveness; and specific provider-to-node effectiveness which enables a consistent and repeatable way to produce market signals. Results can be sensitive to inputs (e.g. changes in network topology) and will need to be carefully calibrated based on ESO system operational views.

The market design delivers the market framework appropriate to meet the challenges faced by both the ESO and providers. It forms the foundation for the way forward, towards the implementation of a desired end-state market solution. The design gives a detailed overview of procurement considerations and prototype mathematical formulation of clearing algorithm objectives, which form the basis for development of a clearing algorithm.

There are a number of areas that need further analysis and consideration, including:

- Implementation readiness and cost, gap analysis and cost-benefit analysis
- Further design refinement with internal and external stakeholders
- Provider readiness
- Refine TO participation approach
- Further explore residual value of TO assets and expired RAB assets
- Service stacking
- DER participation through a coordinated approach to implementation with the DNO's

Note: The following sections are only required for those projects which have been completed since 1st April 2013, or since the previous Project Progress information was reported.

The Outcomes of the Project

The project has delivered a market framework designed to meet the challenges faced by both the ESO and providers. It forms the foundation for the way forward, towards the implementation of a desired end-state market solution.

The market should enable all commercial providers to be eligible to participate, though to only be selected if they bring a benefit to the system in terms of incremental capability ('additionality') and/or cost efficiency.

A coordinated approach to implementation needs to be taken as DSO's will need to re-run network studies to understand limitations and potentially modify connection agreements to allow providers on the distribution network to provide reactive power services.

A methodology has been developed to define nodal MVAR requirements, node-to-node effectiveness, and specific provider-to-node effectiveness. This enables a consistent, transparent and repeatable way to produce market signals.

Based on the technical analysis a nodal market is recommended, where reactive power requirements are identified and stated per node and effectiveness factors are calculated per node for the different products.

The market design is recommended to run over two timeframes:

- Long-term annual markets operating in investment timeframes which offer multi-year contracts to underpin investment in assets, complemented by annual year-ahead contract rounds to finesse procurement
- Short-term market operating at the day ahead stage to enable participation of assets unable to make long-term commitments

Further engagement with Ofgem and TO's to settle on framework for TO assets' indirect participation.

Consultation with stakeholders ahead of market launch to understand residual challenges for some provider types and to conclude on specific design features.

Through the additional work undertaken, a number of internal reports were produced: a report on the existing implementation gaps and a report on the Functional Requirements for the short term market including the Reactive Power Clearing Algorithm.

Building on the outcomes of Phase 1, we have initiated additional BAU funded work to progress the project towards implementation and explore long term procurement, the design of a D-1 market, and broader analysis of the impacts of procuring across three timescales. Further work may be undertaken through a future innovation project and is under consideration.

Data Access

Details on how network or consumption data arising in the course of NIA funded projects can be requested by interested parties, and 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 www.nationalgrideso.com/innovation.

Foreground IPR

All publicly shareable reports produced in the course of the project are published on the Smarter Networks portal ([Reactive Power Market Design](#) | [ENA Innovation Portal \(energynetworks.org\)](#)).

Planned Implementation

We have completed our work on the long-term market and plan to launch the first tender when the right opportunity presents itself. Implementing the long-term market will drive locational investment and enable greater competition in the delivery of reactive power service provision. 2029 is the earliest year for which there may be a requirement to be covered by the long-term market, subject to a firm requirement being identified and the long-term market being selected by ESO as the preferred delivery route.

We are continuing to assess the consumer benefit impact that a mid-term reactive market would provide by procuring reactive power closer to the delivery year. There are some design questions to be further analysed before progressing with a mid-term market, so we will continue to review the value and impact of a mid-term market and will update the latest progress through newsletter and webpage.

On the short-term market, further analysis is required to determine the value of a day ahead service. This work will also consider the output from the review of the Obligatory Reactive Payment Service (ORPS). Prior to the introduction of a short-term market, we are continuing the roll out of Commercial Services Agreements (CSAs), providing an option via which generators can receive payment for their additional reactive power capability beyond their mandatory obligations.

In summary, the next steps would be:

1. Assess system need and decide whether to launch the long term market starting from 2029 onwards or later
2. Review business cases for mid and short term market including benefit cases, market design and implementation effort in order to decide whether to launch those two markets in the future.

Other Comments

The Project outcomes and results contain confidential information and intellectual property rights that cannot be disclosed in this Report due to their proprietary nature. Should the viewer of this Report ("Viewer") require further details this may be provided on a case by case basis following consultation of all Publishers. In the event such further information is provided each and any Publisher that owns such confidential information or intellectual property rights shall be entitled to request the Viewer enter into terms that govern the sharing of such confidential information and/ or intellectual property rights including where appropriate formal licence terms or confidentiality provisions. Dependent upon the nature of such request the Publishers may be entitled to request a fee from the Viewer in respect of such confidential information or intellectual property rights.

