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## NIA Project Annual Progress Report Document

### Date of Submission

Jul 2023

### 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 4 months

### Nominated Project Contact(s)

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## 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).*

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## Project Overview and Activities

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 MVA 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. The reactive project is now being restarted from Spring 2023.

## 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

## 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 MVA 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 MVA 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 this 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](http://www.nationalgrideso.com/innovation).

National Grid Electricity System Operator already publishes much of the data arising from our NIC/NIA/SIF projects on the Smarter Networks Portal ([www.smarternetworks.org](http://www.smarternetworks.org)) and National Grid ESO Data Portal ([data.nationalgrideso.com](http://data.nationalgrideso.com)). You may wish to check these websites before making an application under this policy, in case the data which you are seeking has already been published.

## Foreground IPR

All publicly shareable reports produced in the course of the project are published on the [Smarter Networks portal](http://www.smarternetworks.org).