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 2024

Project Reference Number

NIA2_NGESO091

Project Registration

Project Title

Quantitative assessment of self and central scheduling

Project Reference Number

NIA2_NGESO091

Project Licensee(s)

National Energy System Operator

Project Start

July 2024

Project Duration

0 years and 4 months

Nominated Project Contact(s)

innovation@nationalenergyso.com

Project Budget

£690,000.00

Summary

The previous project **NIA2_NGESO053** assessed the pros and cons of more coordinated procurement of energy, response and reserve under different market designs. The results suggest there are significant potential benefits from co-optimisation in the context of GB's future net zero system. Realising these benefits would require implementation of Central Dispatch. Separately, ESO has identified significant issues in current scheduling arrangements, which we believe Central Dispatch could mitigate.
This project will provide a qualitative overview of different scheduling approaches and quantitatively estimate the impact of self vs central scheduling under national and zonal pricing. The project will also test whether improvements to the BM or strengthening balancing incentives market participants face may impact the case to move to central scheduling.

Nominated Contact Email Address(es)

box.so.innovation@nationalgrid.com

Problem Being Solved

The choice of 'Dispatch mechanism' describes how market participants and the System Operator share responsibility for keeping the electricity system in balance close to real-time. Since electricity cannot easily be stored, price signals close to real-time delivery (the 'spot price') are critical for incentivising efficient market behaviour. Since market players' expectations of spot prices underpin all forward trading and investment decisions, any dispatch mechanism distortions will impact long-term system efficiency.
The current GB market framework was intended to be highly decentralised: Trading of wholesale energy occurs Over the Counter (OTC) and on power exchanges, outside of system operator view. An hour before delivery, participants in the Balancing Mechanism

(BM) finalise how each unit intends to run for the next 30 minutes and send this plan to the System Operator (SO). To resolve energy imbalances and system constraints, the SO 'redispatches' via bids and offers in the BM, using information provided by units and its own forecasts. The intention was that removing system operator interference until the last possible moment would best facilitate free price formation and would provide the right environment for innovation.
The REMA Programme has identified several issues affecting current dispatch. ESO has provided additional analysis that has formed the 'Problem Statement' being addressed in this body of work. In summary:
Incentives: The energy markets do not provide scheduling incentives in line with system needs and operational requirements.
Visibility and Access: ESO's incomplete visibility of market outcomes and limited access to some resources can make system operation challenging and impact wider coherence between wholesale market (WM) and balancing.
Intertemporal Issues: The current dispatch mechanism does not facilitate effective optimisation of costs and unit constraints over time, leading to inefficient dispatch.
To address these issues, and since other REMA reforms will impact dispatch design, REMA is exploring the merits of retaining the current 'self-dispatch' design against moving to 'central dispatch'.
Assessment of Central Dispatch commissioned by DESNZ' in REMA's first phase concluded that central dispatch could bring benefits for GB but that it would be challenging to implement. For REMA Phase 2, ESO has identified several possible dispatch models. It believes that 'gross pool' central dispatch could lead to significant consumer savings and operational efficiency; however, there are major uncertainties as to how it could coordinate with effective cross-border trading.
The overall objective of this project is to quantitatively and qualitatively evaluate the impacts of self vs central scheduling on consumer costs; and how potential changes to the design of the Balancing Mechanism (BM) and/or the potential introduction of zonal wholesale electricity pricing impact this evaluation.
This enables robust understanding of potential consumer and system benefits from significant reform in REMA

Method(s)

Detailed modelling will be undertaken based on the ESO's Future Energy Scenarios (FES) 2022 Leading the Way scenario. The project consists of a number of core workstreams each with defined objectives.
Overview of core workstreams:
Core 1 – Qualitative overview of scheduling approaches: Description of the pros and cons of the two types of regimes depending on their key implementation parameters and the interaction with zonal pricing. Description of potential implementations of central scheduling: hybrid (Irish-style) and fully integrated (US-style), and introduction of balancing incentive issues to contextualise the quantitative workstreams. Numerical examples to illustrate the key differences.
Core 2 – Quantitative estimate of the impact of central vs self-scheduling under national wholesale pricing:
This assessment would be comparing two model setups:
N1C: National | Central scheduling (fully integrated) | Interconnectors scheduled based on the same prices as all other resources, i.e. nodal shadow prices | Imbalance resolved by ESO through BM (assuming market participants do not resolve them) | Thermal constraints resolved (implicitly) through the central scheduling at DA stage (and residual thermal constraints, arising from real-time energy imbalances resolved by ESO through BM).
N1S: National | Self-scheduling | Interconnectors scheduled based on the same prices as all other resources, i.e. national price | Imbalance resolved by market participants through national "intraday" wholesale markets | Thermal constraints resolved by ESO through BM.
Core 3 – Development of an appropriate (self-scheduling) counterfactual for the analysis: status quo BM with appropriate augmentations:
Qualitative discussion of the potential augmentations (e.g. intraday balancing reserve, improving access to a wider range of resources, reducing skip rates, improved arrangements for NIV chasing and extending gate closure time).
Quantitative evaluation of the volume and price effects of augmenting the status quo BM: impact of expanding volume of participants and/or reducing the bid/offer prices (e.g. reducing the uplifts assumed in the bids/offers), as a proxy for the qualitative factors above
Core 4 – National vs zonal:
These model setups would be:
Z1C: Zonal – 12 zones | Central scheduling (fully integrated) | Interconnectors scheduled based on the same prices as all other resources, i.e. nodal shadow prices | Cross-zonal capacity allocated in an 'optimal' manner | Imbalance (alongside residual thermal constraints) resolved by ESO through BM.
Z1S: Zonal – 12 zones | Self-scheduling | Interconnectors scheduled based on the same prices as all other resources, i.e. zonal prices | Cross-zonal capacity allocated in an 'optimal' manner | Imbalance resolved by market participants through zonal "intraday" wholesale markets | Thermal constraints resolved by ESO through BM.
This would compare the key modelling outputs in Core 2 above to evaluate how a zonal design changes the merits of central vs self-scheduling.
There are also a number of optional workstreams which may be undertaken. The decision to go forward with these will be taken as a result of the outputs from the core workstreams to identify where there is clear added value of the optional workstreams.
Overview of optional workstreams:

Optional 1 – National vs zonal sensitivity:
This workstream would add two additional model setups: Z2C and Z2S, both featuring zonal design with 4 zones.
Compare the outcomes relative to Z1C and Z1S described above (and relative to N1C and N1S) to identify key differences in the merits of central vs self-scheduling and how this is affected by the number of zones (and relative to national design).
Optional 2 – Cross-border transmission sensitivity
N3C: National | Central scheduling | Interconnectors scheduled based on national prices (while all other resources are scheduled based on shadow nodal prices) | Imbalance (alongside residual thermal constraints) resolved by ESO through BM.
Z3C: Zonal | Central scheduling | Interconnectors scheduled based on zonal prices (while all other resources are scheduled based on shadow nodal prices) | Imbalance (alongside residual thermal constraints) resolved by market participants through BM
Qualitative commentary on regulatory implications for existing and new ICs, e.g., if congestion rents are substantially affected.
Optional 3 – Impact of strengthened balancing incentives (Dual cash-out price, stronger reserve scarcity pricing, shorter SPs)
Build upon N1S (National self-scheduling) and alter the level of net GB imbalance introduced after the DA scheduling is completed, under the self-scheduling model only. In effect, proxy the impact of strengthened balancing incentives by reducing the magnitude of the introduced real-time imbalances.
In this approach, the day-ahead run would be the same day-ahead schedule as the N1S in Phase 2a. Using that day-ahead run as a basis, run two BM runs with decreasing proportion of the hourly nodal real-time energy imbalances solved by market participants (giving an end range of 100%, 80%, 60% - tbd exact percentages), while the remainder of the imbalances would be resolved by the ESO in the BM.

Scope

Core 1 – Qualitative overview of scheduling approaches:
To provide a conceptual understanding of the differences between self-scheduling and central scheduling.
This includes the pros and cons of the two regimes, interactions with zonal pricing, and numerical examples of each approach
Core 2 – Quantitative estimate of the impact of central vs self-scheduling under national wholesale pricing:
Total consumer costs including: wholesale costs and CfD payments under both scheduling approaches; BM costs to resolve thermal constraints under self-scheduling; compensation payments and BM costs to solve energy imbalances under central scheduling
Forecasted DA wholesale electricity prices
Total system costs
Total volumes activated in the BM and revenues, by technology and year
Direction and volume of IC flows
A key insight from this assessment will be the relative quantum of the BM costs under self-scheduling and the (much lower) BM costs under central scheduling, and how this difference compares to the compensation payments required under central scheduling.
Core 3 – Development of an appropriate (self-scheduling) counterfactual for the analysis: status quo BM with appropriate augmentations:
Key outputs would be the same as in Core 2 above with a focus on constraint costs and redispatching volumes and revenue, by technology and year.
Core 4 – National vs zonal:
Compare the key modelling outputs (listed in Core 2 above) to evaluate how a zonal design changes the merits of central vs self-scheduling. Note that under zonal pricing also inter-zonal congestion rent is created that can be redistributed to consumers. In addition, for the zonal model setups, to comment on:
Differences in zonal wholesale price patterns
BM volumes by zone
Utilisation of inter-zonal (within GB) transmission capacity and the impact on wholesale costs and inter-zonal congestion rent
The potential impact of uncertainty in inter-zonal transmission capacity that can be made available in the wholesale market under self-scheduling, relative to central, on the quantum (qualitative only).
Optional 1 – national vs zonal sensitivity
Key outputs the same as Core 2 and Core 4
Does the case for central scheduling vary depending on the number of zones?
To what extent does self-scheduling become less/more attractive option with a lower number of zones?
Optional 2 – cross-border transmission sensitivity
Key outputs would be the same as in Core 2 with an additional analysis of congestion rent earned by ICs under the four different model setups (N1C, Z1C, N3C and Z3C).
Optional 3 – impact of strengthened balancing incentives
The outcome of this analysis will be a mapping of BM costs on the proportions of the hourly nodal real-time energy imbalances resolved by market participants vs those resolved by ESO. This mapping will give an indication of the extent to which the reforms to balancing incentives (represented by the magnitudes of imbalances) can impact overall BM costs.

Objective(s)

The overall objective of this project is to
Quantitatively and qualitatively evaluate the impacts of self vs central scheduling on consumer costs; and
Establish how potential changes to the design of the Balancing Mechanism (BM) and/or the potential introduction of zonal wholesale electricity pricing impact this evaluation

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 and those in vulnerable situations.

Success Criteria

This project should enable robust understanding of potential consumer and system benefits and trade-offs from significant reform in REMA (self vs central scheduling) and in turn, support key decision making within the REMA programme. This involves the delivery of:

- A qualitative assessment of central vs self-scheduling approaches with the relative pros and cons
- A robust quantitative assessment of central vs self-scheduling and the estimated consumer and system benefits
- The development of a robust counterfactual to understand the impacts on the quantitative evaluation above
- A robust quantitative assessment of the impact of zonal wholesale pricing on scheduling approaches (under both a low zone scenario and a high zone scenario)
- A robust quantitative assessment of the impact of cross-border transmission scheduling on the benefits case for central scheduling

Project Partners and External Funding

Project partner: FTI Consulting. No external funding.

Potential for New Learning

The project will provide a quantitative estimate of the impact of central vs self-scheduling under both national and zonal wholesale pricing
Quantitative evaluation of the expected improvement of improving the status quo BM design
More informed understanding of scheduling approaches and their interactions with wholesale market design (national vs zonal)
The key learnings of the project will directly feed-in to the REMA decision making process to enable better consideration of different dispatch design options

Scale of Project

This a research and analysis project that includes modelling different scheduling approaches that requires a tailored and very detailed model of the GB power system which has been built up throughout the co-optimisation project by FTI consulting.
The project will span 4 months with FTI delivering the work. It is therefore small in scope.

Technology Readiness at Start

TRL1 Basic Principles

Technology Readiness at End

TRL3 Proof of Concept

Geographical Area

Whole of the GB network

Revenue Allowed for the RIIO Settlement

None

Indicative Total NIA Project Expenditure

£670k

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 REMA programme aims to identify reforms to the electricity market required to enable a decarbonised, secure, and affordable electricity system. One of the key options for reform within REMA is whether to move from the current self-scheduling arrangements to central scheduling.
- ESO's Case for Change work identified that ESO is increasingly acting as a central scheduler in a market environment designed for a residual balancer due to changes in the power system – more RES, more storage, more DER and more interconnection.
- While the need for balancing actions grows, ESO faces an increasing level of uncertainty and variability, compounding the difficulty and the potential for inefficient decisions
- The issues with the current scheduling and dispatch regime have significant impacts on the market, and consequentially, the energy system transition:
Market participants are impacted by the conflicting incentives due to ESO activity overlapping with the wholesale market – the overall affect is reduced market transparency and investor confidence
Flexibility providers – a crucial element to the energy transition – are negatively impacted by the inability of ESO to effectively optimise beyond gate closure. In some circumstances, this leads to under-utilisation of energy-limited assets, negatively impacting their investment case and leading to unnecessary system cost
The ESO operates under more uncertainty than necessary, which requires more proactive decision making. This leads to higher than necessary balancing costs, which negatively impacts consumer bills
- It was concluded that there is a clear need for a Case to Change as the system has and will continue to transform as the system decarbonises. What is less clear is what to change to
- The objective of this study is to quantitatively and qualitatively evaluate the impacts of self vs central scheduling on consumer costs; and how potential changes to the design of the Balancing Mechanism (BM) and/or the potential introduction of zonal wholesale electricity pricing impact this evaluation.
- This will deepen understanding within the REMA programme of the relative consumer and system benefits of self- vs central scheduling and the key trade-offs to inform decision making which will have significant impacts on the energy system transition.

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

- We expect that the implementation of central scheduling would reduce consumer costs due to the scheduling of assets in line with transmission network constraints. This benefit would be derived largely from lower balancing costs (through more efficient constraint management), but in addition a reduction in wholesale costs due to efficient allocation of resources between wholesale and ancillary services markets.
- Central scheduling coupled zonal pricing would provide additional consumer benefits through the reduction in transfer payments required relative to under central scheduling with national pricing
- Our innovation project on co-optimisation suggests there are significant benefits (£4.9bn consumer savings 2025 - 2035) from co-optimisation in GB, in particular due to better utilisation of storage for energy and reservebn consumer savings 2025 - 2035) from co-optimisation in GB, in particular due to better utilisation of storage for energy and reserve

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)

N/A

Please provide a calculation of the expected benefits the Solution

N/A as this is a research project

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

This research project will evaluate the potential consumer and system benefits for GB from significant reform in REMA.

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

N/A as this is a research project

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

This project will provide a quantitative estimate of the impact of self vs central scheduling under national and zonal pricing. The results will be shared with key stakeholders, including DESNZ, Ofgem and industry.

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

N/A

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.

There are three projects which are similar, they are mostly qualitative, and the quantitative work is very limited in terms of ability to capture the complexities of scheduling and so there will be no duplication
ESO assessment of scheduling & Dispatch for REMA. This has involved:
Scheduling & Dispatch 'Case for Change'
Investigation into the economic benefits of co-optimisation
Analysis of storage utilisation in the current Balancing Mechanism
ESO Innovation project: NIA2_NGESO053
Assessed the pros and cons of more coordinated procurement of energy, response and reserve under different market designs. The results suggest there are significant potential benefits from co-optimisation in the context of GB's future net zero system. Realising these benefits would require implementation of Central Dispatch.
DESNZ' REMA Programme analysis:
DESNZ has already undertaken some research into Central Dispatch. It is aiming to model some benefits of central scheduling in this current phase of REMA, but its Bid 3 Model cannot capture all the nuances of different scheduling approaches
External industry:
An AFRY 'multi-client' study has qualitatively assessed different dispatch options in REMA and found that central dispatch is unlikely to realise significant system benefits

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

The quantitative analysis of different scheduling approaches is, as far as we are aware, the first of its kind in GB policy context.
So far, the performed analysis, commissioned by ESO and other stakeholders, has been qualitative.
Modelling different scheduling approaches requires a tailored and very detailed model of the GB power system which has been built up throughout the co-optimisation project Exploring the Economic Benefits of Co-optimising Procurement of Energy, Response and Reserve

Relevant Foreground IPR

An interim and final report will be produced

Data Access Details

Data for this project and all other projects funded under the Network Innovation Allowance (NIA), Network Innovation Competition (NIC) or the new Strategic Innovation Fund (SIF) can be found or requested in a number of ways:
A request for information via the Smarter Networks Portal at https://smarter.energynetworks.org, to contact select a project and click 'Contact Lead Network'. National Grid ESO already publishes much of the data arising from our innovation projects here so you may wish to check this website before making an application.
Via our Innovation website at https://www.nationalgrideso.com/future-energy/innovation
Via our managed mailbox innovation@nationalgrideso.com
Details on the terms on which such data will be made available by National Grid ESO can be found in our publicly available "Data sharing policy relating to NIC/NIA projects" at https://www.nationalgrideso.com/document/168191/download.

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

This project will be NIA funded due to the uncertainty of future market arrangements being developed through the Government's REMA Programme.

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

- There are several options on the table for solving the issues that we have identified in GB dispatch. None of these options are proven internationally in an environment that resembles GB
- We need to understand the implications of these different models through modelling (which the ESO does not have the internal capabilities for).
- It would be far too risky to progress with any model now without this work. This innovation study will derisk the options so we can

progress with a preferred model.

- If this is not done via innovation funding, but through a separate project, it will be difficult to link the benefits of co-optimisation to other reforms being considered in REMA

This project has been approved by a senior member of staff

☑ Yes