Power Potential

Reactive Power Commercial Procedure Wave 2 and Wave 3

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Contents

Executive summary

The commercial reactive power service in the Power Potential trial consists of wave 2 and wave 3. In both waves, Distributed Energy Resources (DERs) provide their availability and utilisation price bids day-ahead to the Distributed Energy Resource Management System (DERMS), hosted by UK Power Networks. Then, the DERMS presents cost and Mvar volumes to National Grid ESO of the Virtual Power Plant (VPP) at each Grid Supply Point, for each service window day-ahead. This is the combination of the individual DER bids, reflecting DER's effectiveness, expected reactive range and forecast utilisation, while considering distribution network constraints to ensure security.

National Grid ESO will procure based on its technical requirement for reactive power service in each service window, and whether the cost of the VPP is below a counterfactual cost. In wave 2, the counterfactual is based on the long-run cost of investing in alternative transmission network infrastructure to address reactive power requirements. In wave 3, the counterfactual cost is based on the total cost of other system actions available immediately to National Grid ESO (not including alternative transmission network infrastructure).

The wave 2 market trial will run in the day and night for at least 1800 hours. Wave 2 has a minimum budget from the project of £358k that participants can bid for. If wave 3 proceeds, it would run for around 6 weeks and will be funded from National Grid ESO's balancing services budget.

Project ambition

The National Grid System ESO's Operability Framework Report highlights a need to access new sources of reactive power as GB transitions to a decentralised and decarbonised electricity system. It is expected that the requirements for reactive power will increase as network loading becomes more volatile and many conventional generators (which provide reactive power) run less predictably and less often.

Partnering with UK Power Networks the Power Potential project is supporting this ambition of identifying more new and flexible sources of dynamic reactive power to meet an increasing requirement. This is underpinned by the vision to create of a whole electricity system that procures more effectively, adapts to a changing environment and works together with other market participants to deliver value for the consumer.

Both National Grid Electricity System Operator (ESO) and UK Power Networks are committed to exploring how the results of a successful trial could translate to a business as usual approach aligned to how the reactive power markets develop within the transmission and distribution spaces.

1. Introduction

This document provides an overview of how wave 2 and wave 3 of the Power Potential trial of the commercial reactive power service will work. The document is intended to help potential trial participants understand their potential revenue from the trial. These waves follow the wave 1 technical trial, which offers up to £45k of participation payment based on a DER's availability during that period.

This document:

- Sets out the principles that National Grid Electricity System Operator utilises when assessing reactive capability delivered throughout the trial.
- Describes how the Distributed Energy Resources Management System (DERMS) calculation will work and the impact of effectiveness on a provider's cost to National Grid ESO.

- Provides information on the budget for waves 2 and 3 and how information will flow between the counter parties.

National Grid ESO's objective is to operate the system economically and consequently; the assessment principle reflects that view. National Grid ESO and UK Power Networks have worked together on the Power Potential trial to set up the DERMS so that a DER can be integrated to provide reactive power services to National Grid ESO during the trial.

2. Assessment methodology

The assessment methodology described in this document is in line with the Power Potential *DER Framework Agreement* and Market Procedures.

In deciding whether to accept or reject a bid for the reactive power service, National Grid ESO calculates the forecasted cost of the tender (combining availability and utilisation costs), and assesses it against the alternative cost to National Grid ESO of delivering the equivalent service. This document sets out the alternative cost in each wave. Reactive power that is assessed as being more expensive than the alternative cost is rejected, whereas those that are assessed as being cheaper are accepted.

There are two stages to assessment, the nomination process – ahead of real time; and the dispatch process – in real time. How these are accommodated is slightly different for the two different time periods and the two different waves.

3. Nominations

The nomination process occurs on the day-ahead between 14:00 and 17:00 for the next market day. This is the same for wave 2 and wave 3.

3.1 The DERMS

The DERMS is hosted by UK Power Networks. By 14.00 on the day ahead, all providers will enter the following data into the DERMS Web Interface:

- Whether they wish to participate in the service for the service window.
- Their expected active power operating level (MW) per settlement period.
- Their availability price (£/Mvar/h).
- Their utilisation price (£/Mvarh).

To aid the assessment of the service, the DERMS will then complete the following actions:

- Using a power system study, it will calculate an effectiveness score for each provider that is unique to that service window.
- Determine the **expected reactive power range**, using the expected active power output provided by the DER.
- The **expected reactive power range** for each settlement is then calculated into an average expected reactive power range for the service window.
- The DERMS collates this information for each Grid Supply Point (GSP) - the interface between the transmission network and the distribution network - considering the effectiveness and costs of each distributed energy resource at the GSP. It passes this information to National Grid ESO.

The ESO does not receive information on the provider's technical capabilities or individual prices. The cost of the service is calculated by the DERMS and displayed as Virtual Power Plants (VPP) for each GSP in the trials.

3.2 Effectiveness score

Providers with a low effectiveness score will appear more expensive than a unit with the exact same characteristics and tendered price, because more reactive power must be dispatched at the DER's point of connection to see an impact on the transmission system.

$$Effective\ Cost\ (£) = \frac{Submited\ Price\ (£/Mvarh)}{Effectiveness\ (\%)} * Forecast\ Utilisation\ (Mvarh)$$

The effectiveness is calculated for the service windows for nomination.

3.3 Counter-factual

The counter-factual is the significant difference for wave 2 and 3. The differences are outlined in the relevant sections on the individual waves.

4. Utilisation

When the service window, for which a provider is nominated occurs, the DERMS will send a signal to move providers to voltage control mode, arming them for the service window.

The ESO will then issue voltage set-point instructions at transmission. The DERMS will translate these into set-point instructions at the relevant connection voltage level. The DERMS optimises the utilisation of reactive capability on the nominated providers based on their effectiveness, utilisation price and available reactive range. The ESO cannot see which individual providers are being dispatched, only the net effect at the distribution – transmission interface.

Reactive power utilisation is across the nominated machines. It is expected to be in line with historic utilisation (see historic utilisation charts in DER Market Information folder on the Power Potential website). However, utilisation for individual providers will be price dependant.

5. An introduction to wave 2

Wave 2 is the first commercial trial in the Power Potential project. Wave 2 refers only to the reactive power service and is wholly funded from the project budget.

During these trials, DERs will be submitting availability and utilisation prices into the DERMS through a web interface at the day-ahead stage. The DERMS will provide costs of VPP to the ESO, who will make a procurement decision based on its requirements. The decision will be fed back to the DER via the DERMS Web Interface.

DERs who are procured are then committed to be available to provide reactive power services in its designated service window. On the following day, at the start of the relevant service window, the DERs will receive a signal to move to voltage control mode. Once armed, DERs will receive voltage set-points from the DERMS; these may require the injection or absorption of reactive power throughout the service window (for which utilisation payments are made, based on the accepted bid of the DER).

The purpose of wave 2 is to facilitate 'price discovery' from DER, i.e. allowing DERs to freely bid on both availability and utilisation under a competitive environment, allowing them to reflect any risk or cost associated with the provision of the service in the most efficient way. The original premise was for DER bids in wave 2 to be compared against the cost of network infrastructure. This principle is to be retained in the assessment of bids.

The resources procured during wave 2 will not be considered by National Grid ESO as system resource as per other balancing services, but will essentially be surplus to requirements to test the price discovery principle, given the unproven nature of the service.

5.1 Counter-factual

Costs received from the DERMS will be compared against the cost of network infrastructure (the counter-factual cost) and the technical requirement for reactive power in the service window. Comparable network infrastructure include STATCOM, Static VAR Compensator and reactive devices, depending on the nature of the reactive power requirement. The technical requirement is determined according to different factors (e.g. demand, weather forecast, outages, etc.) on a periodic basis.

The counter-factual cost will not be published as manufacturers of these devices do not allow sharing of agreed purchase prices of their assets. The counter-factual cost includes consideration of all infrastructure required to install the device, and the cost of maintenance.

The long-run marginal cost of the network infrastructure is used to calculate a comparable cost. This is adjusted for a combination of the following variables:

- Expected utilisation
- Required volume
- Service duration

The adjustment of these variables results in a counter-factual cost that varies, over the course of the day, with expected utilisation and required volume.

This counter-factual cost is compared with the forecast cost of achieving the same reactive power service from the DER's VPP by combining the availability and utilisation elements of a DER's price.

5.2 Decision

If the expected cost of the VPP is less than the counter-factual cost of network infrastructure, a provider will be nominated up to the identified technical requirement. This decision is based on:

- Availability cost
- Forecast utilisation
- Utilisation cost

If more reactive capability is offered by a DER than the requirement, the cheapest option available to the ESO will be taken first. The DERMS determines the cost optimal way of achieving the required reactive capability and presents this as 10 separate VPPs per GSP. Therefore, sometimes the cheapest machines are not taken as it is not the cheapest overall solution. This optimisation is completed by the DERMS and is not something the ESO can influence. The ESO will take the cheapest VPP that meets the required volume.

The process is built to ensure a provider's entire machine capability will be nominated, in line with the commercial framework agreement.

If a DER is nominated by National Grid ESO as part of the VPP (based on its expected reactive power range at its expected operating level) it will receive an availability payment based on its maximum reactive power range.

The ESO may not procure any VPPs if these are all more expensive than the calculated counter-factual in a service window.

5.3 Budget in wave 2

Wave 2 is funded by the Power Potential project, therefore there is an explicit budget for this procurement period.

The minimum expected budget for wave 2 is £358,000. This budget is for all spend on availability and utilisation payments. The project is expected to have at least 5 DER participating in the trial.

In the event of an unspent budget from the wave 1 trials, this may be added to the wave 2 budget.

6. Market information in wave 2

6.1 Service windows

For the duration of the wave 2 trial, service windows are expected to remain as Electricity Forward Agreement (EFA) blocks. Complete information and definition of EFA blocks can be found in the Market Procedures (Appendix 3).

6.2 Requirement and intended procurement activity

The intention during the wave 2 trial period is to maximise the opportunity to learn about reactive power commercial procurement in different situations. It is expected to open and run the market for as many periods as possible within the Wave 2 calendar window, subject to budget and resource constraints.

The Power Potential trial has committed to running the market for a minimum of 1800 hours. Within this 1800 hours, some procurement is expected in all service windows. Current analysis of the requirement indicates, there is a reactive power need that the Power Potential region can influence throughout the day and night in a variety of network conditions.

7. An introduction to wave 3

Wave 3 is the second commercial trial in the Power Potential project. Wave 3 refers only to the reactive power service. Wave 3 is wholly funded from National Grid ESO's balancing services, as per other balancing services. Wave 3 will be included in the Balancing Services Use of System (BSUoS) charges and will impact customers' bills.

During these trials, DERs will participate in the same way as wave 2. The interface between the DERMS, DERs and the ESO also remains unchanged.

The purpose of wave 3 is to allow DERs to compete against other commercial options available to the ESO to meet the transmission system's reactive capability requirement. During this wave of the trial, any accepted bids will be selected so that the total costs of securing and operating the transmission system are minimised.

These other options to meet the ESO's reactive requirements are transmission network assets and providers of the reactive power through either 'mandatory' or 'enhanced' services. These are generally large transmission-connected power stations who have an obligation as part of their grid connection to provide reactive power services. These generators collect a mandated reactive power 'default' price for utilisation (the methodology for which is set out in the Connection and Use of System Code (CUSC), but may also need 'repositioning' in the balancing mechanism. The comparison will be against the full system cost of any solution i.e. considering both utilisation payments and, in the event where 'repositioning' of plant is required, the costs to do so.

The resources procured during wave 3 will be considered by National Grid ESO as a system resource as per other balancing services.

7.1 Counter-factual

The purpose of the wave 3 commercial trial is to allow DERs to compete against other providers of reactive power (but not the transmission network infrastructure alternative). Costs received from the DERMS will be compared against the cost of other system actions available to meet the requirement.

The cost of other system actions may include (but not be limited to):

- Net cost of any repositioning required to access reactive capability.
- Forecast utilisation costs.
- Firm or optional costs for any reactive services procured in contract mechanisms with providers not participating in the Power Potential trial.

Adjustments may be made to these costs to reflect the effectiveness of providers.

7.1.1 Repositioning cost

The cost associated with repositioning units and details of those providers which are able to meet the requirement is not currently available to the market. Also, over time, the machines, that can meet the requirement, change with network topology and wider network conditions. The effectiveness of these units is also under continuous review.

National Grid ESO's Forward Plan has committed to publishing historic spend by region by Q3 2019. This will allow greater visibility of the cost of managing reactive requirements and the spend on voltage constraints in all regions. The Power Potential project region will be included in this, but is not expected to be a distinct region.

7.1.2 Utilisation price

Utilisation costs are primarily composed of providers being paid reactive utilisation at the default price for utilisation (the methodology for which is set out in the Connection and Use of System Code (CUSC).

Historic prices can be found here.

The average utilisation price between November 2007 and February 2019 was £2.89/Mvarh. This is the average price paid for 'obligatory reactive power services' nationally and is only an indication of the historic price of reactive power.

7.1.3 Utilisation of DER

During wave 3, DERs will only be dispatched if they are the cheapest option available (considering both the repositioning and utilisation cost of the transmission alternative option).

7.1.4 Utilisation costs

Reactive power utilisation data is available for each machine in receipt of the 'obligatory reactive power service' payment.

This lists each individual machine, and the lead and lag reactive capability metered for each month since October 2000. This information can be found here.

Reactive power utilisation spend for providers in this region in recent months is summarised below:

			Apr-18		May-18		Jun-18		Jul-18	
Default Price (£/Mvarh)			3.089897		3.143368		3.143368		3.239749	
Company	**Unit**	**Default/Market**	*TOTAL (MVARH)*	*COST (£)*	*TOTAL (MVARH)*	*COST (£)*	*TOTAL (MVARH)*	*COST (£)*	*TOTAL (MVARH)*	*COST (£)*
NELC	**DNGB_21Z**	D	17,162	53,028	9,986	31,388	13,146	41,322	15,801	51,191
NELC	**DNGB_22Z**	D	30,681	94,800	22,869	71,884	16,206	50,942	25,091	81,288
SCPL	**SHOS_01Z**	D	5,695	17,598	1,122	3,528	731	2,297	332	1,077

			Aug-18		Sep-18		Oct-18		Nov-18		Dec-18	
Default Price (£/Mvarh)			3.272756		3.429979		3.692605		3.870293		3.815611	
Company	**Unit**	**Default/Market**	*TOTAL (MVARH)*	*COST (£)*	*TOTAL (MVARH)*	*COST (£)*	*TOTAL (MVARH)*	*COST (£)*	*TOTAL (MVARH)*	*COST (£)*	*TOTAL (MVARH)*	*COST (£)*
NELC	**DNGB_21Z**	D	19,896	65,116	16,356	56,100	0	0	0	0	0	0
NELC	**DNGB_22Z**	D	33,202	108,662	0	0	0	0	0	0	0	0
SCPL	**SHOS_01Z**	D	1,129	3,694	1,486	5,096	1,945	7,183	13,551	52,447	2,138	8,156

7.2 Decision

If the expected cost of the VPP is less than other commercial options available (such as transmission connected machines), a provider will be nominated up to the identified technical requirement. This decision is based on:

- Availability cost.
- Forecast utilisation.
- Utilisation cost.

The process is built to ensure a provider's entire machine will be nominated. In line with the commercial framework agreement, it is not possible to nominate to hold available only part of a machine's reactive power range.

The ESO may not procure any VPPs if these are all more expensive than the calculated counter-factual.

7.3 Budget in wave 3

Wave 3 is funded from National Grid ESO's balancing services budget. There is no explicit budget for reactive procurement through Power Potential in this procurement period.

However, all procurement in this period will be in line with the ESO's objective to operate the system economically and consequently, any accepted bids will be selected so that the total costs of securing and operating the system are minimised.

8. Market information in wave 3

8.1 Service windows

Service windows for wave 3 will be reviewed to ensure these are in line with National Grid ESO requirements. The Market Procedures outlines the indicative service windows (in Appendix 3).

8.2 Requirement and intended procurement activity

During wave 3, it is expected that the market will run daily. However, procurement will only take place if providers are competitive with the other options available in the market.

8.3 Market expectations

The reactive capability market nationally is a significant part of balancing services spend, in the 2017/2018 financial year, £78.49 million was spent on reactive power utilisation costs nationally. Additional expenditure also incurred from 'repositioning' of machines to access the reactive capability.

The transmission voltage constraints in the South-East region covered by Power Potential are already preventing new generation connections, so cost-effective reactive power services are important in this area.

Information on National Grid ESO's expenditure on balancing services can be found here.

Historically for the Power Potential area, the average cost of a transmission solution was around £4.34/Mvarh (combining repositioning and utilisation costs). This is the average price paid for this service between January and July 2017 and is only an indication of the historic price of reactive power in the project area (excluding transmission network infrastructure). This figure should not be interpreted as a guaranteed price for the Power Potential trials, or possible maximum or minimum payments.

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