
**Power Potential
Market Procedures**

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Website:

<https://www.nationalgrideso.com/innovation/projects/power-potential>

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IMPORTANT – PLEASE READ

Introduction

These Market Procedures are to be read with the Power Potential *DER Framework Agreement* – the contract between UK Power Networks and Power Potential market participants, which is available on National Grid ESO’s project website:

<https://www.nationalgrideso.com/innovation/projects/power-potential>

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Version control

Version	Date published	Comments
2.0	01/08/2018	
3.0	05/10/2018	Updated market calendar and testing milestones
4.0	04/12/2018	Clarified service window definition
5.0	29/03/2019	Updated indicative market calendar with revised trial start date, testing milestones and service window clarification allowing DERs to offer non-zero reactive range in a minimum of one settlement period within a service window.
6.0	27/04/2020	Updated market calendar with revised start date (reflecting COVID-19 impacts) and

Wave 1 availability thresholds. Clarifications on execution of active power service mandatory trials during commissioning.

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1 Background and high-level summary

This document provides current and future Power Potential service providers with clear, simple and transparent guidance on the services. It is a live document, which may change throughout the course of the Power Potential project. It is intended to help potential providers understand how the tendering process will work in practice.

Power Potential (originally named Transmission Distribution Interface 2.0) is a Network Innovation Competition project that represents a collaboration between National Grid Electricity System Operator (NGESO) and UK Power Networks (Distribution Network Operator). The trial, which is running in the South-East of England, is intended to explore the use of Distributed Energy Resources (DERs) to provide dynamic voltage support and constraint management services to the System Operator (SO), and to do so:

- ▶ **Efficiently** – identifying and dispatching DER able to deliver the service at the lowest cost to the SO, accounting for price and effectiveness,
- ▶ **Reliably** – ensuring that services produced by DER contribute to constraint resolution in a consistent and predictable manner, and
- ▶ **Securely** – ensuring that action to manage constraints on the transmission network do not create issues on the distribution network.

The trial is exploring the provision of reactive and active power services while investigating both the technical and commercial aspects of DERs' participation. It is designed to mimic the real-world situation in which a change in reactive and/or active power flows are required on the distribution network to manage voltage or thermal constraints on the transmission network.

A Distributed Energy Resources Management System (DERMS) is being developed as part of the project. The DERMS Web Interface will provide DER with a web portal to communicate its interest in participating. This system, which will be hosted and operated by UK Power Networks, acts as the intermediary between National Grid ESO and participating DER. At a high level, the process is as follows:

Reactive Power Service

1. Ahead of time UKPN enters in DERMS the PQ capability chart in the DER Framework Agreement (either upon commissioning or subsequently updated) indicating, for a given active power output (expressed in MW), the range of reactive power that is made available (expressed in Mvar) when the reactive power service is offered.
2. By 14:00 on the day ahead of the trading day, via the DERMS Web Interface, DERs provide:
 - i. expected operating level (expressed in MW) together with its reactive power range for each service window(s) for which they wish to bid,
 - ii. where relevant, the prices at which they wish to offer availability and utilisation.
3. The DERMS collates this information for each Grid Supply Point (GSP), considering the effectiveness of each DER at the GSP (see section 3.3.2 for more detail on 'effectiveness'), expected active and reactive power operating points and their bid, and passes this information to National Grid ESO as the total volume and the cost to procure this volume.
4. In the case of the reactive power service, National Grid ESO procures, through the DERMS, an availability volume in line with its requirement (where applicable, subject to prices), which will be confirmed to DER via their DERMS Web Interface and for which

DER will receive availability payments (subject to compliance). During settlement day, the DERMS can then dispatch DER in response to a request from National Grid ESO. DER must also respond automatically to network events, delivering dynamic voltage control when needed.

5. The DERMS monitors DER response to verify performance and records the necessary data for subsequent settlement and payment.

Active Power Service

1. By 14:00 on the day ahead of the trading day, via the DERMS Web Interface, DER provide:
 - i. maximum and minimum active power parameters and the expected operating levels (expressed in MW)
 - ii. the utilisation price at which they wish to offer the active power service.
2. The DERMS collates this information for each Grid Supply Point (GSP) and passes this information to National Grid ESO as the total volume and the cost to dispatch this volume.
3. The DERMS monitors DER response to verify performance and records the necessary data for subsequent settlement and payment.

The trial phase of the Power Potential project is planned to commence with Wave 1 Mandatory Technical Trials starting in May 2020 and run in accordance with the Market Trial Calendar provided in Appendix 1.

2 Structure of the trial

2.1 Introduction and overview

The project aims to trial both technical and commercial aspects of the Power Potential services. It is intended to ensure that trial participants receive adequate compensation for their involvement, whilst also encouraging market bidding that mimics real-world behaviour. DER have the option to participate in one or both services.

2.1.1 Reactive power service

To achieve these objectives, the reactive service component of the trial will be split into three 'waves'. Before participating in the waves, participants must complete a Mandatory Technical Trial (see section 3.3.1.1 Eligibility and timings).

- ▶ Wave 1 is predominantly aiming to trial the technical aspects of the Power Potential services and through the trial, allow participants to recover most of their upgrade costs. The wave 1 trial covers a range of network configurations and operating conditions. Before participating in the wave 1 trial, participants must complete a Mandatory Technical Trial.
- ▶ Wave 2 introduces competitive bidding between DERs, with the volumes accepted by National Grid ESO in line with actual system need. Volumes procured during this wave will not be used to secure the system.
- ▶ Subject to the project's Steering Committee decision to proceed with this wave, wave 3 brings DERs into competition with other market-based options available to National Grid ESO. Only DERs that are as cost-effective as other options will be accepted. DERs will be competing with transmission-connected assets where multiple parties at multiple connection levels can fulfil a requirement. National Grid ESO is entitled to secure the system using DERs' services during this wave.

Reactive service payments for DERs will include:

- ▶ Participation payments (linked to overall availability in wave 1 of the trials), and
- ▶ Market revenues (from payments for availability and utilisation during waves 2 and 3).

An overview of the key features of each reactive power trial wave is as follows:

Table 1: Reactive power trial structure

Wave	Funding from	Participation payment	Availability payment policy	Utilisation payment policy
1	Project budget	Up to £45,000 per site, linked to availability ¹	No payments	No payments
2	Project budget	N/A	Driven by market bids	Driven by market bids
3	National Grid ESO budget	N/A	Assessed in line with other market-based options	

¹ See section 3.3.1 for details of the availability assessment

2.1.2 Active power service

For any DER customer wishing to participate in the active power service, the DER must first complete an active power test in order to validate the DER's active power response to simulated active power signal requests in the DERMS. This covers the active power service mandatory technical trials specified in the DER contract. A fixed fee of £150/MWh will be paid for any MWh dispatched to validate the DER's response to an active power set-point instruction, before moving to competitive bidding. These tests will take place during the DER Commissioning process activities.

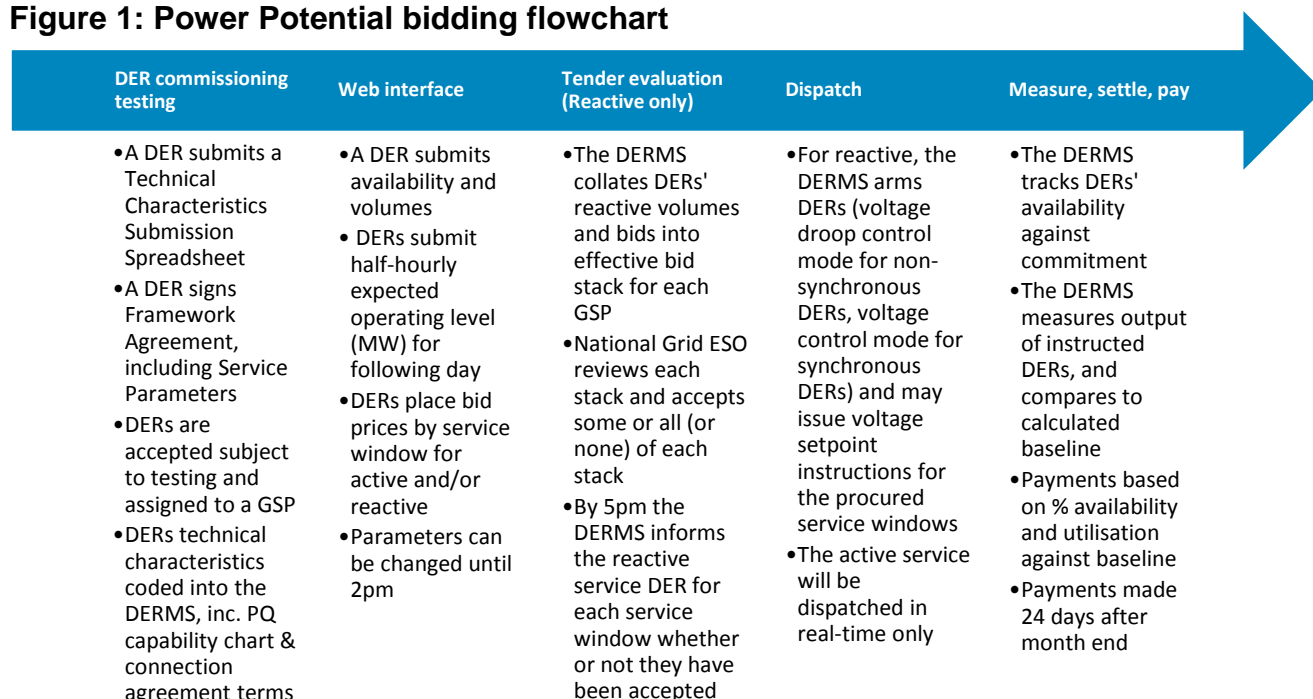
During competitive bidding, DER payments will be made at the level of DERs' bids ('pay-as-bid'), and there will be no availability payment for the active power service.

3 How to participate

3.1 Overview

The flowchart in Figure 1 outlines the process for competitive bidding (i.e. wave 2 and 3 for the reactive power service and competitive bidding following the Mandatory Technical Trials for the active power service). Note that wave 1 for the reactive power service differs for some of these steps.

Figure 1: Power Potential bidding flowchart



3.2 DER commissioning testing

All Power Potential providers will need to sign a Power Potential *DER Framework Agreement* and a *Variation Agreement to their Connection Agreement* with UK Power Networks. The agreements include technical characteristics of the provider, which the Power Potential team will confirm making the provider eligible to participate once they have completed the commissioning stage. The *DER Framework Agreement*, *DER Test Specification*, *DER Interface Schedule* and *DER Technical Requirements* can be found here:

<https://www.nationalgrideso.com/uk/investment-and-innovation/innovation/system-operator-innovation/power-potential>

At a high level, the requirements for potential providers are given in sections 3.2.1.1 and 3.2.1.2.

3.2.1.1 Active power service

The active power service relates to the active power generated from the participating DER's unit. After receiving an instruction, it will need to be capable of responding by automatically ramping the active power generated up and/or down according to the DERMS instruction and within the plant limitations. This service is expected to manage transmission constraints and to support technical and commercial optimisation and dispatch. It will be exercised on the day in real-time depending on the cost compared to other options available to the System Operator.

The provision of this service means that the plant should be ready to change its active power output on an instruction from DERMS. The plant's response should be automatic and within its pre-defined limits and ramp rates.

The testing of the active power service (i.e. active power service mandatory technical trials) will be scheduled with the DER during its commissioning activity (one-two days combined with the reactive power service). During the Commissioning, DER will receive an administered Utilisation Price set to £150/MWh for these active power service tests.

3.2.1.2 Reactive power service

The reactive power service relates to the reactive power generated or absorbed by the participating DER plant. This production/absorption of reactive power could allow more effective control of the voltage in the transmission system.

The reactive service is initiated by the DERMS issuing instructions to DER at the start of each service window for which the DER was contracted, to change its operating mode (where necessary):

- ▶ for a non-synchronous contracted DER unit, to operate in voltage droop control mode; or
- ▶ for a synchronous contracted DER unit, to operate in voltage control mode.

When in these control modes, DERs will automatically respond to voltage changes measured at the DER connection point. In addition to this, a National Grid ESO instruction via the DERMS would translate into a change of DER voltage set-point to achieve National Grid ESO's request. In either case, the response would be achieved within 2-5 seconds, as per service requirements. Otherwise, the DER would be kept operating at their default operating level and the DERMS would adjust DER voltage set-points if needed to keep a unit's reactive power output as close to its default value as possible.

3.3 Reactive power service

3.3.1 Wave 1 participation

3.3.1.1 Eligibility and timings

All participants who sign up to the *DER Framework Agreement* and *Variation to Connection Agreement* will be eligible to participate in wave 1 subject to passing the DER commissioning test.

Subject to COVID19 restrictions being lifted in time to complete preparatory works, Mandatory Trials can commence from May 2020, progressing as customers are commissioned (see the Indicative Market Trial Calendar in Appendix 1). Wave 1 includes Mandatory Technical Trials followed by Optional Technical Trials. The Optional Trials are expected to start on the 1st of September 2020. All dates are on reasonable-endeavours basis.

The Market Trial Calendar in Appendix 1 is published, with a nominal 'actual trial commencement date' of 1st May 2020. Mandatory Technical trials may then be arranged from this date onwards (though not necessary starting on 1st May). The Market Trial Calendar will be updated and shared with participating DER *as required during the trials*.

Before a DER can participate in the Optional Technical Trial (which participation payments are linked to, see below) it must first complete a period of Mandatory Technical Trials (for which no payments are made to a DERs). Mandatory Technical Trials will be carried out during the first months of the trial (now expected to be May-August 2020), with trial windows between two and ten hours in length across up to two days, the timing of which will be agreed with a DER².

There are some steps to participate in the Mandatory Technical Trials:

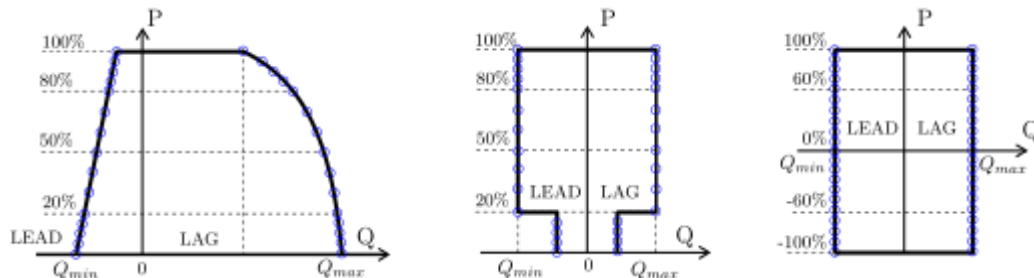
1. As part of submission of their *Technical Characteristics Submission Spreadsheet*, DERs will have submitted their PQ capability chart (see Figure 2), and UK Power Networks will discuss with the DERs any limitations on this related to the Connection Agreement for the site. The combined PQ capability chart forms Schedule 3 of the *DER Framework Agreement* and will have been verified through commissioning testing at the active power level at the time of the commissioning test.
2. Agree with the project team the times to conduct the Mandatory Technical Trial, during two days, following the final Market Trial Calendar.

Before Optional Technical Trials, DERs will be required to submit their hours of availability (at settlement period granularity) for reactive power for the whole of that period. These availabilities could be amended³ if the DER's expectations change during this time.

² DERs that cannot carry out Mandatory Technical Trial in the first weeks of the trial dedicated to this activity will not be able to offer availability for Optional Technical Trial until they have completed their Mandatory Technical Trial. We will work with DERs to schedule these as soon as possible to maximise a DERs chances of maximising their participation payments during Optional Technical Trial.

³ Meaning that the DERs could opt out/in of the reactive power service. Availability definition is covered in the Settlement and Payment section of this document and refers to the DER's capability to provide the service not to the reactive range available.

Figure 2: Illustration of reactive and active service availability via PQ capability chart⁴



Submission of availability for the reactive power Optional Technical Trials will be done through the DERMS Web Interface.

For each trial day, by 2pm the day before, DERs will be required to provide a half-hourly forecast of their active power expected operating levels. This information will not be acted on in wave 1 but will be used as a learning, both for the DER and the Power Potential project, to prepare for wave 2.

Wave 1 Optional Technical Trials are expected to cover 1,680 hours (i.e. 10 weeks).

DERs will not receive an availability or utilisation payment during Wave 1. Instead, they will receive a participation payment based on the duration of their availability.

During Wave 1 Optional Trials, there can be utilisation of the DER while they are armed to provide the service, due to changing network conditions and National Grid ESO instructions. The DER utilisation during Wave 1 is not expected to be significant and it will be reviewed by the project on a weekly basis, so that the project can assess whether actions need to be taken to control the utilisation levels. Monitoring of utilisation will include assessing total Mvarh utilisation per DER, utilisation as a % of a customer's reactive range, and utilisation occurring as a % of their available hours. Given the reduction in the duration of Wave 1 Optional Trials from 15 to 10 weeks, we are no longer setting an explicit limit or target on the % utilisation level, but will monitor, communicate and manage this as set out above. This analysis will be set in the context of the Mvar output of the DER when it not being instructed by DERMS.

DERs must be available for a minimum of 467 hours to recover the minimum payment. Participation payments will be made based on the number of hours DERs are available during the 1,680 hours, as per Table 2 in section 3.3.1.3.

For a DER to be deemed available during wave 1 (mandatory and optional), it must:

1. Indicate whether it is available for each settlement period via the DERMS Web Interface.
2. Offer the full Q range that it can do for a given MW output level (in accordance with their submitted PQ capability chart and network connection agreement limits), and
3. Can provide a non-zero volume of reactive power, as indicated by the PQ capability chart and the DERMS measurement of active power output.

⁴ Note that in the adopted convention, $Q > 0$ refers to export/inject conditions (lag) while $Q < 0$ refers to import/absorb conditions (lead).

3.3.1.2 Participation process

For the reactive power service, wave 1 Optional Technical Trials will take place after the Mandatory Technical Trials and will gather data from a range of operating conditions and network configurations. The Optional Technical Trials will run on a 24-hour basis for 10 weeks. DERs who are not fully available during this period will be paid based on the hours which they are available (see section 3.3.1.3 for details), with the minimum number of hours being 467 to receive payment.

3.3.1.3 Settlement and payment

Wave 1 Optional Technical Trials will provide 1,680 hours of opportunity for DERs to be available. Every hour they are available will contribute towards their participation payment. Participation Payments will be made in line with the monthly settlement process where the cumulative number of hours a DER was available will be calculated and settled accordingly, in line with Table 2 below.

Where a DER has already received payment in a previous month, additional payments will only be made to reflect the additional hours the DER was available for, but have not yet been compensated. For example, if a DER achieves 467 hours of availability over month 1 and 2, they will receive £36,000 through the month 2 payment process. If by the end of month 3 they have cumulatively been available for 667 hours (including month 1-2 availability) they will receive an additional £2,000 (£38,000 minus £36,000) through the month 3 payment process.

Table 2: Optional Technical Trials Availability Thresholds

Amount recoverable	Availability hours
£36,000	$\geq 467, < 667$
£38,000	$\geq 667 < 867$
£41,000	$\geq 867 < 1,000$
£43,000	$\geq 1,000 < 1,233$
£45,000	$\geq 1,233$

To determine hours achieved, a DER Unit will be deemed to have been available for each settlement period:

- ▶ If non-synchronous, when it is online with an active communications link as indicated by the DERMS Monitoring, in voltage droop control mode, and has submitted to the DERMS Web Interface an Expected Operating Level for active power (which could be zero, but for which the associated reactive power volume available would be non-zero).
- ▶ If synchronous, when it is online with an active communications link as indicated by the DERMS monitoring, in voltage control mode, and has submitted to the DERMS Web Interface an expected operating level for active power (which could be zero, but for which the associated reactive power volume available would be non-zero).

To determine reactive power availability in wave 1 Optional Technical Trials, a provider is expected to offer its full range of reactive power availability for each active power operating level, consistent with the performance test at site commissioning.

3.3.1.4 Trial GO / NO GO decision

Whilst it is expected that the Power Potential trial will proceed as planned, the project's Steering Committee has set out clear expectations of the projects' core objectives to be satisfied to ensure that sufficient learning can be demonstrated. With respect to DERs' participation, this objective focuses on two indicators:

1. **Sufficient participation**, defined as having at least 5 participants signed up to the project with at least 1 DER commissioned prior to the Mandatory Technical Trial (this milestone was met on 16 March 2020) and a total of 4 having completed these Mandatory Technical Trials before the start of Optional Trial.
2. **Sufficient effect**, defined as expecting to see at least 40 Mvar of reactive power availability across the GSPs.

The project will also consider business readiness to deliver the trial and readiness of the technical solution.

From a technical perspective, we track detailed progress of the overall build and test of the DERMS solution and its system integration, and we will use our mailing list to inform our stakeholders, including participating DERs, of the technical progress.

In October 2018, the project decided to adopt a staged approach to delivery of the DERMS solution – starting with an Interim Solution followed by the DERMS Full Solution. The Interim Solution is sufficient to start wave 1, while wave 2 and 3 would be run on the Full Solution.

The DERMS Interim Solution provides a technical demonstration of key aspects of the infrastructure. This includes communication from NGENSO's systems to the DERMS to UK Power Networks' network management system to Remote Terminal Units (RTUs) and DER controllers and in reverse. DERs will still use the web interface to enter their availability data.

We have committed to inform DERs of the project's progress, including development of the DERMS and as a minimum, reporting on the development milestones:

1. The 'Factory/System Acceptance Test' (FAT/SAT) for the DERMS solution
2. The 'Site Integration Test' (SIT) for the solution, covering end-end system integration and also user acceptance testing (UAT) on our pre-production system.
3. The Operational Acceptance Test (OAT) for the solution is complete on our live production systems.

The FAT for the DERMS interim solution was completed in March 2019, which confirmed that the system passed functional tests in UK Power Networks' cloud-based test environment, with remaining defects carried over to the pre-production system. A partial OAT for the solution was completed in December 2019, confirming the DERMS software installation and support as part of a live production system.

The further stages of SIT/UAT/OAT have then been split for according to the systems required to deliver commissioning, Mandatory Technical Trials, Optional Trials and the Wave 2/3 trials.

For commissioning, SIT/ UAT was completed on 25th Feb 2020 and OAT on 28th Feb 2020.

The remaining dates are on a reasonable endeavours basis subject to COVID-19 restrictions.

For Mandatory trials, SIT/ UAT / OAT is due to complete by May 2020.

For Wave 1 Optional trials, SIT/ UAT is due to complete by the end of May 2020.

For Wave 2/3, SIT/ UAT is due to complete by the end of July 2020

For the system for the Optional and Market Trials is due to complete by the end of August 2020.

The project's formal 'go / no go' decision, to start or delay the trial, has been made, with reference to the DERs' participation, development criteria set out above (alongside business readiness). This was our 'go' decision to confirm the indicative trial start date as detailed in Appendix 1.

If the Power Potential trial does not go ahead and providers have successfully commissioned, they will be eligible for compensation for direct costs incurred up to 100% of the total participation payment. The project has agreed discretion to pay these costs even if commissioning is not completed. Compensation will be calculated on an open book basis, and providers will be asked to produce evidence of costs incurred for upgrades required as a direct result of intending to participate in the Power Potential trial. Once the level of compensation has been agreed, DERs will need to invoice UK Power Networks to receive payment.

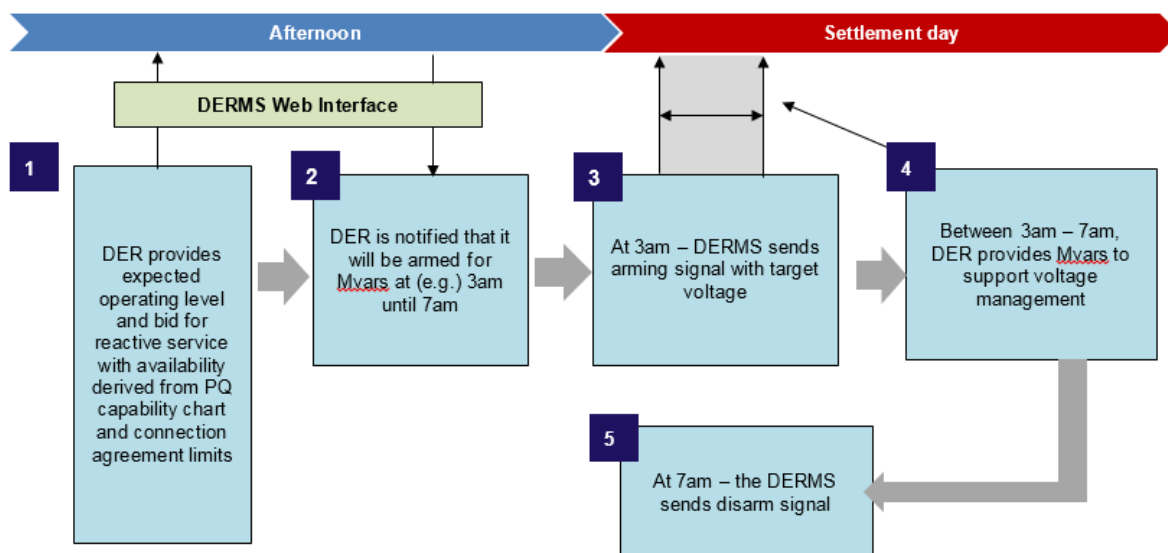
3.3.2 Wave 2

3.3.2.1 Participation process

DERs must have completed their Mandatory Technical Trial to participate in wave 2. The process for participation in wave 2 is similar to that for wave 1. The key difference is that this wave introduces competition among participants, with each specifying both an availability price and a utilisation price. Therefore, the situation may arise where DERs might have made themselves available but, depending on the combination of bid prices and effectiveness, would not be selected by the DERMS when it receives service procurement request from National Grid ESO.

The process for tendering of reactive power service is summarised in Figure 3.

Figure 3: Reactive power service tendering process



As with wave 1, DERs will indicate their availability for the reactive service in three steps:

1. Using the DER PQ capability chart and Connection Agreement limits. If the DER wishes to offer less than the full reactive range of their asset they can do so via the DERMS Web Interface. The Q offering implied by the expected operating level must be non-zero for the bid to be valid for at least one of the half-hour periods in a Service Window.
2. By submitting a forecast of the MW expected operating level for each half-hour period in Service Windows (of the following day) into which the DER wishes to bid.
3. By indicating their willingness to offer Reactive Power services to the DERMS for the duration of a Service Window (e.g. via a 'tick box').

By default, the DERMS will assume that DERs are not available unless specified by the provider. This can come via the DERMS Web Interface single-day input or a bulk upload mechanism that allows DERs to offer availability over several days. When the DERMS collates offers, the last indication from the DER (whether via single-day input or bulk upload) will be deemed the actual availability offer of the DER⁵.

In wave 2 there is an additional step. For each service window, DERs need to indicate an availability price (£/Mvar/hr) and a utilisation price (£/Mvarh) for reactive power. If successful, DERs will receive payment on a pay-as-bid basis. A zero price would be a valid input.

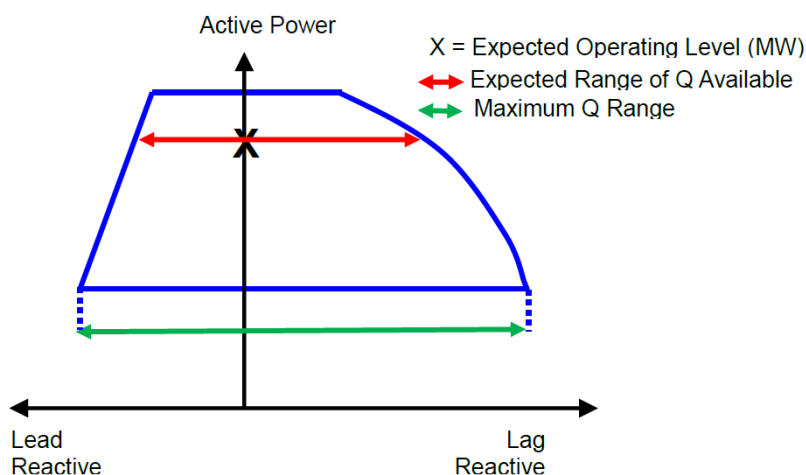
In choosing to offer the reactive service, a participant, if successful, is committing to allow the DERMS to control the DER unit on instruction from National Grid ESO within the operating range defined by the PQ capability chart (whether that is the original technical PQ capability or the updated chart to reflect a more limited range, if applicable). If successful in the tender, the

⁵ In the absence of a bulk upload submission for a given day, the DERMS software assumes that the DER's last submitted availability rolls over to apply in the following day.

availability payment received by the DER will be based on the maximum reactive range. The maximum reactive range is determined as the point where the reactive range is greatest on the PQ capability curve. This is independent of the operating point. The availability payment calculations associated with each service window are given in schedule 2 of the Power Potential *DER Framework Agreement*.

The actual reactive service availability will be a function of the outturn MW operating level (see Figure 4). The expected MW operating level submitted by DERs will be used to calculate their nominal reactive output and hence the reactive range expected to be available for reactive power dispatch. This expected reactive range will be used to build the availability stack and hence by National Grid ESO to assess availability and effective price. The expected MW operating level, provided by the DER should represent an honest and accurate forecast, but the intention is not to apply any performance factor adjustment tied to MW inaccuracies occurring during the trial (although performance factor adjustments linked to absolute availability can be incurred). Any difference between the active power operating level forecast and outturn will be reviewed as part of the trial and learning and will inform the development of future reactive power services.

Figure 4: Illustrative PQ capability chart



If a DER becomes unavailable within one or more settlement periods, the DERMS will detect this through the 'heartbeat' monitoring. There is no contractual need for the DER to notify UK Power Networks that it is unavailable, although the project team can be notified via powerpotential@ukpowernetworks.co.uk. It is expected that the DER will endeavour to restore availability as quickly as possible.

The market will be run for a minimum of 1800 hours, with the intention of running more if the trial budget allows. Indicative dates can be found in APPENDIX 1 – Market Trial Calendar.

3.3.2.2 Acceptance criteria⁶

At a high level, Power Potential is designed to mimic the situation in which National Grid ESO procures the Power Potential services directly from providers, but does so via the DERMS.

⁶ Note that whilst the Power Potential team wishes to be fair and transparent about the acceptance criteria, it should be recognised that this is a trial and, as such, any of the decision-making criteria are subject to change.

The DERMS collects availability and utilisation bids by each provider, carries out distribution network analysis, and presents an adjusted stack to National Grid ESO (where the 'adjustment' is described in more detail below).

Each DER will have been assigned to a GSP stack, representing the GSP to which they are most effective. National Grid ESO will meet its requirement from some combination of volumes from each of these stacks (i.e. some stacks may have higher volumes accepted than others). Whilst DERs will be initially assigned at the commissioning stage, they could be reassigned for a number of reasons during the trial, including:

1. Network changes, load flow changes, or improved calculations reveal that a DER is more effective at a different GSP from the one they were initially assigned.
2. One or more GSP has insufficient participation to ensure a functioning market, so two or more GSP stacks are combined and assessed collectively. Note that in this case, no change would be made to the total volume that National Grid ESO intends to procure.

National Grid ESO determines what proportion of each stack to accept. In making this determination, National Grid ESO will assess the cost of DER bids against the cost of installing or upgrading network assets to manage voltage constraints. A bid may be accepted if it is higher than the cost of dispatching flexible assets on the transmission network, but not if it would have been more cost-effective to resolve the constraint through network reinforcement. This is on the basis that the cost benefit analysis for Power Potential is to be assessed against the transmission asset counterfactual. A bid may also be rejected if, although cheaper than dispatching flexible assets available on the transmission network, it would have been more cost effective to resolve a constraint through network reinforcement.

Once National Grid ESO has made its determination, the DERMS then indicates to the corresponding providers that they have been successful at their tendered price.

From a provider's perspective, assuming they can deliver what they commit to, they will receive payment in line with their bid price and the maximum reactive range implied by their PQ capability chart. For example, if a provider has a maximum 1Mvar reactive range, offers the Reactive Service for a 4-hour service window at a price of £5/Mvar/hr with a utilisation bid of £10/Mvarh, and is accepted on that basis they will receive £20 for that window plus any utilisation paid at the bid price. However, providers should be aware that the acceptance of a provider's bid will depend on other factors.

Assessment factor 1: Expected Reactive Power range

The first factor is the expected range of reactive power available, as implied by the DER's active power expected operating level. If the DER's active power forecast implies a relatively low reactive power range the DERMS will use that reduced volume when building the availability stack for presentation to National Grid ESO. The effective price of that volume would therefore be higher than if more reactive power was expected to be available. For example, using the same 1 Mvar provider described above, if its expected reactive power range is 0.5 Mvar this would cost National Grid ESO £10/Mvar (£5 for 0.5 Mvar), before accounting for the effectiveness of the DER with respect to the GSP.

Assessment factor 2: Effectiveness with respect to GSP

The second factor that will be considered is the 'sensitivity' of a provider to a GSP. The sensitivity value is defined as follows:

Sensitivity value is an indicator of the effectiveness of a DER's reactive power injection in a particular GSP. Allocation of a DER to a GSP is done according to where this value is shown to be maximum (GSP reactive power variation Q_{GSP} divided by a DER reactive power variation of Q_{DER}).

This is the key adjustment made by the DERMS. A GSP (or any point on the network) will be more sensitive to the injection or absorption of reactive power at some network locations than others. Some DERs' sites can help to resolve network issues more effectively than others. Therefore, two providers with identical bids could be seen differently by the DERMS, and hence by UK Power Networks. It may be that a provider with a low bid, but low sensitivity value, is rejected in favour of a provider with a higher bid but high sensitivity value. See Table 4 below for an example. DER 1 would be higher in the stack than DER 2 as a result of its higher effectiveness despite its bid prices being higher than DER 2.

Table 3: Example of sensitivity factor impacting the DER stack

	DER1	DER2
Volume	5 Mvar	5 Mvar
Availability price	£1.50/Mvar/hr	£1/Mvar/hr
Utilisation price	£10/Mvarh	£5/Mvarh
Sensitivity value	80%	40%
Volume expected at GSP	4 Mvar	2 Mvar
Effective price in stack (Availability)	£1.88/Mvar/hr	£2.50/Mvar/hr
Effective price in stack (Utilisation)	£12.50/Mvarh	£12.50/Mvarh ⁷

Providers should be aware that their sensitivity relative to other providers could be a key determinant of the frequency with which their bids are accepted. A provider with low sensitivity might need to lower their bid to increase that frequency.

Both the availability and utilisation price will be factored into the adjusted stack presented to National Grid ESO, considering a forecasted utilisation of each DER calculated by the DERMS. This forecast utilisation is based on average historic utilisation values and the DERMS will update its algorithm during the project lifetime to improve its accuracy of the likely utilisation calculation.

3.3.2.3 Measuring, settlement and payment

Response will be measured at the DER's connection point of the provider's site. The Power Potential project may make separate measurement of the service at different points on the network (e.g. GSP) but this will not be used for settlement purposes. This is a key learning outcome for the project and the project bears this risk. Providers should be aware that this would be reviewed should a Power Potential service be rolled out as business as usual.

⁷ NB: prices used in this example are arbitrary and not intended to be illustrative of anticipated bid prices during the trial

DER reactive service providers will receive:

- ▶ Availability payments for reactive power availability accepted in the Power Potential tender and
- ▶ Utilisation payments for reactive power response.

Availability prices (£/Mvar/hr) and Utilisation prices (£/Mvarh) will be the prices submitted by providers as bids for Service Windows at the day-ahead stage and will be paid on a pay-as-bid basis.

The total availability payments received will be adjusted for the DER's performance. This means that at the end of each month, the aggregate number of Settlements Periods in which the DER was accepted and deemed to have been available (as measured under the logic specified for wave 1) is compared to the total number of Settlement Periods that the DER service was accepted for, to calculate a Relevant Proportion of availability achieved.

A detailed description of the basis for DERs' payments for each service is given in Schedule 2 of the *Power Potential DER Framework Agreement*.

At the start of the service window for which a DER was contracted, the DERMS will put the DER into voltage control / voltage droop control mode ('arm') and adjust their voltage set point to keep the Mvar output as close as possible to the output prior to the change in operating mode. Initially, the voltage set-point will match the measure voltage at the DER Connection Point at the time of arming. This has the effect of maintaining the Mvar produced by the DER as close to their default operating level as possible.

3.3.3 Wave 3

From the DER's perspective, wave 3 will operate in a similar manner to wave 2. There are key features that should be noted:

- ▶ Wave 3 will only commence if project's Steering Committee determines that the service is competitive with options already available to it on the transmission system. This decision will be made available to providers and the wider market.
- ▶ Power Potential services, if accepted, will be used to help secure the system.
- ▶ Wave 3 bids will be met from National Grid ESO's business as usual budget rather than the Power Potential trial budget.
- ▶ Availability and utilisation bids will be assessed in line with the cost of alternative actions by National Grid ESO to secure the system.
- ▶ National Grid ESO will only accept the DERMS's volumes where the price is as cost effective as alternatives available to it. This means that some (or all) DERs may not be accepted if they cannot reduce their bids to a competitive level.
- ▶ National Grid ESO reserves the right to change procurement windows in this period to aid assessment or to clearly highlight requirements with at least 5 days' notice. However, it is expected that procurement will remain in EFA blocks.

3.4 Active power service

3.4.1 Active power - Mandatory Technical Trials

DERs will need to complete an active power service test during DER commissioning before being able to participate in the Active Power Service. This will be scheduled with the DER who is expected to be available for one day. During the Commissioning active power service test, DER will receive an administered Utilisation Price set to £150/MWh.

There will be no Optional Technical Trial for the Active Power Service in wave 1.

3.4.2 Active power – competitive bidding

3.4.2.1 Participation process

DERs must have completed the active power service tests during DER commissioning (i.e. active power mandatory trials) to participate in the competitive bidding wave.

DERs will be in competition with traditional options available to National Grid ESO and only be dispatched if economic to do so. The process for tendering of the active power service is summarised in Figure 5.

- ▶ Power Potential services, if accepted, will be used to help secure the system.
- ▶ Utilisation bids will be assessed in line with the cost of alternative actions.
- ▶ National Grid ESO will only accept the DERMS's volumes where the price is as cost effective as alternatives available to it, meaning that some (or all) DER may not be accepted if they cannot reduce their bids to a competitive level. The details of the active power competitive bidding calendar will be confirmed following further consideration and confirmation from our Steering Committee of the form of the active power trials.

3.4.2.2 Measurement, settlement and payment

There is no availability payment for the active power service.

Active power utilisation is measured in terms of the deviation from a baseline level of active power output. The calculation of this baseline is detailed in Schedule 2 of the *DER Framework Agreement*.

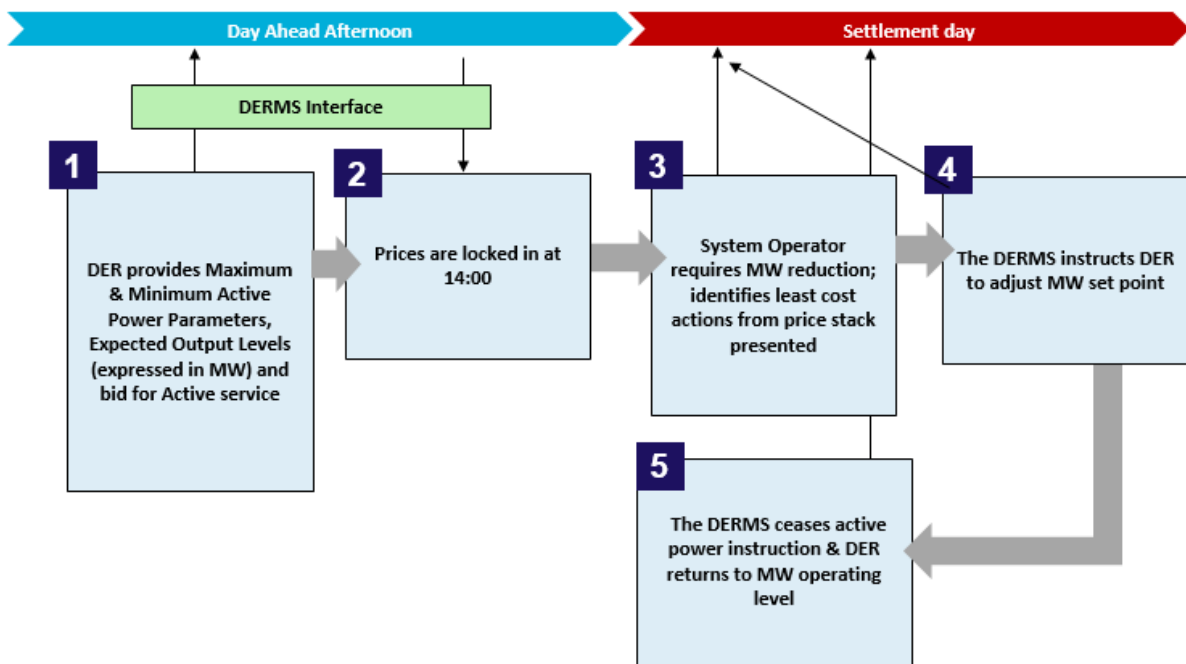
Where Power Potential active power trials have been initiated, DER providers will receive utilisation prices for active power response volumes accepted based on the prices submitted into the Power Potential tender, as per the *DER Framework Agreement*.

The DERMS will instruct DERs for utilisation based on its own measurement of real-time availability and will be entitled to use the full range of flexibility technically afforded to it (as per the *DER Framework Agreement*). This may exceed the availability implied by the DER's expected operating level submitted at the day ahead Power Potential tender.

One additional constraint applies; the baseline must be within the maximum and minimum operating level of the plant (i.e. if the application of the scaling factor implies a baseline outside of the DER’s capability, the capability limit becomes the baseline).

Payments will be made by UK Power Networks to the DER provider within 24 business days following the relevant month using the bank details given in the provider’s *DER Framework Agreement*.

Figure 5: Active power service tendering process



4 Market reporting

The Power Potential Project may use all technical and market data for the purposes of assessing the progress of the trial. The intention is to provide some level of market reporting on the outcomes of the tendering process. This should help to inform DERs' bidding activities. The level of detail is yet to be determined, and will need to consider:

- ▶ The need to anonymise commercially sensitive data.
- ▶ The desire to be transparent about the procurement of system services.
- ▶ The need to avoid facilitating anti-competitive bidding practices.

The form of market reporting will be discussed with market participants before reporting commences. However, DERs should be aware that the project team is minded towards full disclosure of bids and acceptances, along with the effectiveness estimates used in the assessment process. This reflects the direction of travel for existing System Operator services.

5 APPENDIX 1 – Market Trial Calendar

		17.4	10.0	15.0	0.0		
		Reactive Power Service			Active Power Service		
Week Commencing	Week number	Commissioning and Mandatory trial	Wave 1	Wave 2	Wave 3	Mandatory trial	Competitive bidding
		specific times to be agreed with DER	24/7 hours of opportunity across 1,680 hours	commit to run market for a minimum of 1800 hours	pending decision to run wave 3	specific times to be agreed with DER	pending decision how to run active power trial
27/04/2020	18	No trial occurring	No trial occurring	No trial occurring	No trial occurring	No trial occurring	No trial occurring
04/05/2020	19						
11/05/2020	20						
18/05/2020	21						
25/05/2020	22						
01/06/2020	23						
08/06/2020	24						
15/06/2020	25						
22/06/2020	26						
29/06/2020	27						
06/07/2020	28						
13/07/2020	29						
20/07/2020	30						
27/07/2020	31						
03/08/2020	32						
10/08/2020	33						
17/08/2020	34						
24/08/2020	35						
31/08/2020	36	No trial occurring	Reactive Power Service	No trial occurring	No trial occurring	Active Power Service	No trial occurring
07/09/2020	37						
14/09/2020	38						
21/09/2020	39						
28/09/2020	40						
05/10/2020	41						
12/10/2020	42						
19/10/2020	43						
26/10/2020	44						
02/11/2020	45						
09/11/2020	46						
16/11/2020	47						
23/11/2020	48						
30/11/2020	49						
07/12/2020	50						
14/12/2020	51						
21/12/2020	52						
28/12/2020	1	Christmas break				Christmas break	
04/01/2021	2	No trial occurring	No trial occurring	Reactive Power Service	No trial occurring	Active Power Service	No trial occurring
11/01/2021	3						
18/01/2021	4						
25/01/2021	5						
01/02/2021	6						
08/02/2021	7						
15/02/2021	8						
22/02/2021	9						
01/03/2021	10						
08/03/2021	11						
15/03/2021	12						
22/03/2021	13						
29/03/2021	14						

Key	
	No trial occurring
	Reactive Power Service
	Active Power Service

Subject to the lifting of COVID-19 restrictions on site commissioning and testing activities, the project team expects commissioning and Mandatory Technical Trials to proceed June- August 2020, new trial start dates are:

- Wave 1 Mandatory Technical Trials: starting May 2020 (individual Mandatory Technical Trials to be scheduled as customers commissioned after COVID-19 restrictions lifted)
- Wave 1 Optional Technical trials: reasonable endeavours to begin 1st September 2020 (duration 10 weeks).
- Wave 2 Market Trials: 12th November 2020, and until 16 March 2021, with a break 17th December – 5th January
- Active power trials and wave 3 are subject to further planning and Steering Committee recommendation.

For the avoidance of doubt the Wave 1 trials will continue to run at the weekends. Availability and expected operating level for the start of the optional trial must be submitted by 2pm on the day-ahead. The optional trial is expected to start 11am on 1st September 2020, so DERs would need to submit their availability and expected operating level by 2pm on 31st August. These are currently reasonable endeavours dates, subject to public health guidance allowing the lifting of COVID-19 activity restrictions to enable all preparatory works to complete.

6 APPENDIX 2 – DUoS charges related to Power Potential

All users of the distribution network are subject to Distribution Use of System Charges (DUoS reference below). These charges are governed by DCUSA (DCUSA reference below). Charges identified as related to providing service through Power Potential include reactive power charges, excess capacity charges and normal charges for import / export from the network and associated distribution losses.

We confirm that reactive power and excess capacity charges will not be applied to DERs when they are providing service under Power Potential. Within the existing methodology for Distribution Use of System Charges, if the Distributed Network Operator (DNO) requests a change in how a generator operates, then charges will not apply. An instruction from the DERMS to operate with a power factor less than 0.95 or to exceed a maximum import capacity would be an example of such an instruction.

No change to the existing charging methodology or contractual arrangements are required to implement this, so this has not been included as an additional clause in the DER Provider Agreement. Any excursions will be logged as trial learning.

For the specific example of reactive power charges, these charges are not currently levied for EHV connections (customers charged under the EHV Distribution Charging Methodology), so Power Potential could not lead to a change. For HV and LV connections, there are reactive power charges for operating in a power factor range outside 0.95, but DCUSA Schedule 16, table 7 note 7 states these not apply when the DNO requests the change in power factor.

Loss adjustment factors in the DUoS charging methodologies are the assumed losses in MWh relative to a customer's energy consumption in MWh. Loss adjustment factors for each type of HV and LV customer are derived annually for the whole network based on actual historic MW data and notional power factor, so losses for any specific customer would not be altered by participation in the trial. Loss adjustment factors for EHV customers are modelled annually based on half-hourly historic site-specific power flows, including the normal power factor of operation rather than any temporary change to that power factor, so the site-specific loss adjustment factors would also not be altered by participation in the trial, either in the year of trial or the following year. However, if a DER alters its total MWh consumption or export during the Trial period, whether due to the Trial or not, this would lead to change in the MWh consumption and export charges, and via the loss adjustment factor a change in the cost of losses for the site.

Distribution Use of System Charges (reference)

- ▶ <https://www.ukpowernetworks.co.uk/internet/en/about-us/duos/operatingin.html>

DCUSA reference

- ▶ <https://www.dcusa.co.uk/SitePages/Documents/DCUSA-Document.aspx>
- ▶ <https://www.dcusa.co.uk/DCUSA%20Document%20Public%20Version/DCUSA%20v10.2%20Public.pdf>

7 APPENDIX 3 – Service windows by wave

Both active power and reactive power services will be contracted by service window. Where a provider chooses to offer an active and/or reactive service in any service window, to be accepted, the DER will be required to be available for a minimum of one 30-minute settlement period within the service window. For the reactive power Service, the expected reactive power range for each Settlement Period offered is converted into an average expected reactive power range for the service window. To be available, this means that a provider must expect to have non-zero expected reactive power range in at least one Settlement Period in the Service Window. For a solar provider only offering reactive power service during the day or during the night, this means they can offer availability during the Service Window including their transition between day and night.

Availability will be submitted alongside the DER's availability price and utilisation price for the reactive power service, and their utilisation price only for the active power service per service window.

The service windows for the Power Potential trial are defined below.

7.1 Wave 1 reactive power service window definition

In wave 1, service windows will be aligned to settlement periods (i.e. 48 service windows in a day) to maximise the flexibility to providers and their ability to access the full participation payment. If wave 1 covers a period of clock change the number of service windows in a day will be adjusted to suit.

Service window	Time on	Time off	Settlement Period	Service window	Time on	Time off	Settlement Period
1	23:00	23:30	47	25	11:00	11:30	23
2	23:30	00:00	48	26	11:30	12:00	24
3	00:00	00:30	1	27	12:00	12:30	25
4	00:30	01:00	2	28	12:30	13:00	26
5	01:00	01:30	3	29	13:00	13:30	27
6	01:30	02:00	4	30	13:30	14:00	28
7	02:00	02:30	5	31	14:00	14:30	29
8	02:30	03:00	6	32	14:30	15:00	30
9	03:00	03:30	7	33	15:00	15:30	31
10	03:30	04:00	8	34	15:30	16:00	32
11	04:00	04:30	9	35	16:00	16:30	33
12	04:30	05:00	10	36	16:30	17:00	34
13	05:00	05:30	11	37	17:00	17:30	35
14	05:30	06:00	12	38	17:30	18:00	36
15	06:00	06:30	13	39	18:00	18:30	37
16	06:30	07:00	14	40	18:30	19:00	38
17	07:00	07:30	15	41	19:00	19:30	39
18	07:30	08:00	16	42	19:30	20:00	40
19	08:00	08:30	17	43	20:00	20:30	41
20	08:30	09:00	18	44	20:30	21:00	42
21	09:00	09:30	19	45	21:00	21:30	43
22	09:30	10:00	20	46	21:30	22:00	44
23	10:00	10:30	21	47	22:00	22:30	45
24	10:30	11:00	22	48	22:30	23:00	46

7.2 Wave 2 reactive power service window definition

Based on feedback from DERs, the reactive service will be procured in wave 2 in Service Windows of 4 hourly EFA (Electricity Forward Agreement) blocks, as indicated in the table below. The ability to submit bids in EFA blocks aligns with other ancillary services and gives providers the ability to stack services while participating in other markets.

The standard definition of EFA blocks will be used, in the event of wave 2 occurring during clock change, EFA block 1 will commence and end at the same time but will be an hour longer or shorter in duration.

Service window	Time on	Time off
1	23:00	03:00
2	03:00	07:00
3	07:00	11:00
4	11:00	15:00
5	15:00	19:00
6	19:00	23:00

7.3 Wave 3 reactive power service window definition

Service windows for wave 3 will be defined in line with our requirements following the decision to proceed to wave 3. These will be confirmed with at least 5 days' notice prior to the start of wave 3.

7.4 Active Power Competitive Bidding Service Window Definition

Based on feedback from DERs, competitive bidding for the active service will be procured in Service Windows of 4 hourly EFA (Electricity Forward Agreement) blocks, as indicated in the table below. The ability to submit bids in EFA blocks aligns with other ancillary services and gives providers the ability to stack services while participating in other markets.

Service window	Time on	Time off
1	23:00	03:00
2	03:00	07:00
3	07:00	11:00
4	11:00	15:00
5	15:00	19:00
6	19:00	23:00