Power Potential trials preparation: a new ESO reactive power service from DERs in DNO network

Presented by :

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4th of March 2020, Faraday House, National Grid ESO, Warwick UK

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Outline

1. Welcome and housekeeping
2. Project overview
3. Commissioning activities and DER preparation
4. Technical Trials Mandatory Trials
    - Mandatory Trials
    - Optional Trials
5. Commercial Trials

Project Overview

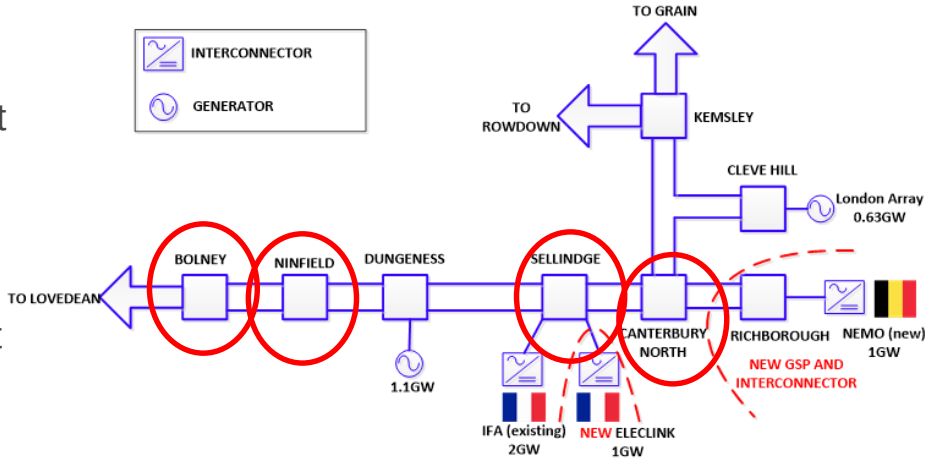
Charlie Grant

Power Systems Engineer,

National Grid ESO

Power Potential - Overview

- **Funding mechanism:**
  - Ofgem Network Innovation Competition (NIC)
  - Total budget £9.56m; contributions from National Grid ESO and UK Power Networks
- **Timescales**
  - Start Date – January 2017
  - End Date – December 2020
- **System Operator challenge:**
  - Potential voltage stability issues if a double circuit fault on the Canterbury – Kemsley route occurs
- **Project objective:**
  - To create a regional market for DER within the DNO network to provide dynamic voltage support for the transmission network
  - Develop an innovative solution to dispatch reactive power from DER to meet the challenge



Power Potential – The key benefits

- **Enable customers to connect in the South East region**
  - Defer costly transmission network reinforcements
- **New and existing customers could benefit from providing reactive power services to National Grid ESO**
- Additional revenue
- **Coordination of transmission and distribution services**
  - Procurement and dispatch of DER will not breach operational constraints or limits
- **Potential consumer savings of £400m by 2050**
  - Cost benefit analysis to be reviewed after the trials

Overview of reactive power trials

Objective: demonstrate proof of concept
- Providers paid availability

Current focus:

Interim DERMS solution

Objective: establish the commercial viability of this approach
- Providers paid availability and utilisation
- Commercial assessment required

Full DERMS solution

Objective: prepare DERs for a transition to current business as usual operations
- Providers paid availability and utilisation
- Commercial assessment required

Full DERMS solution

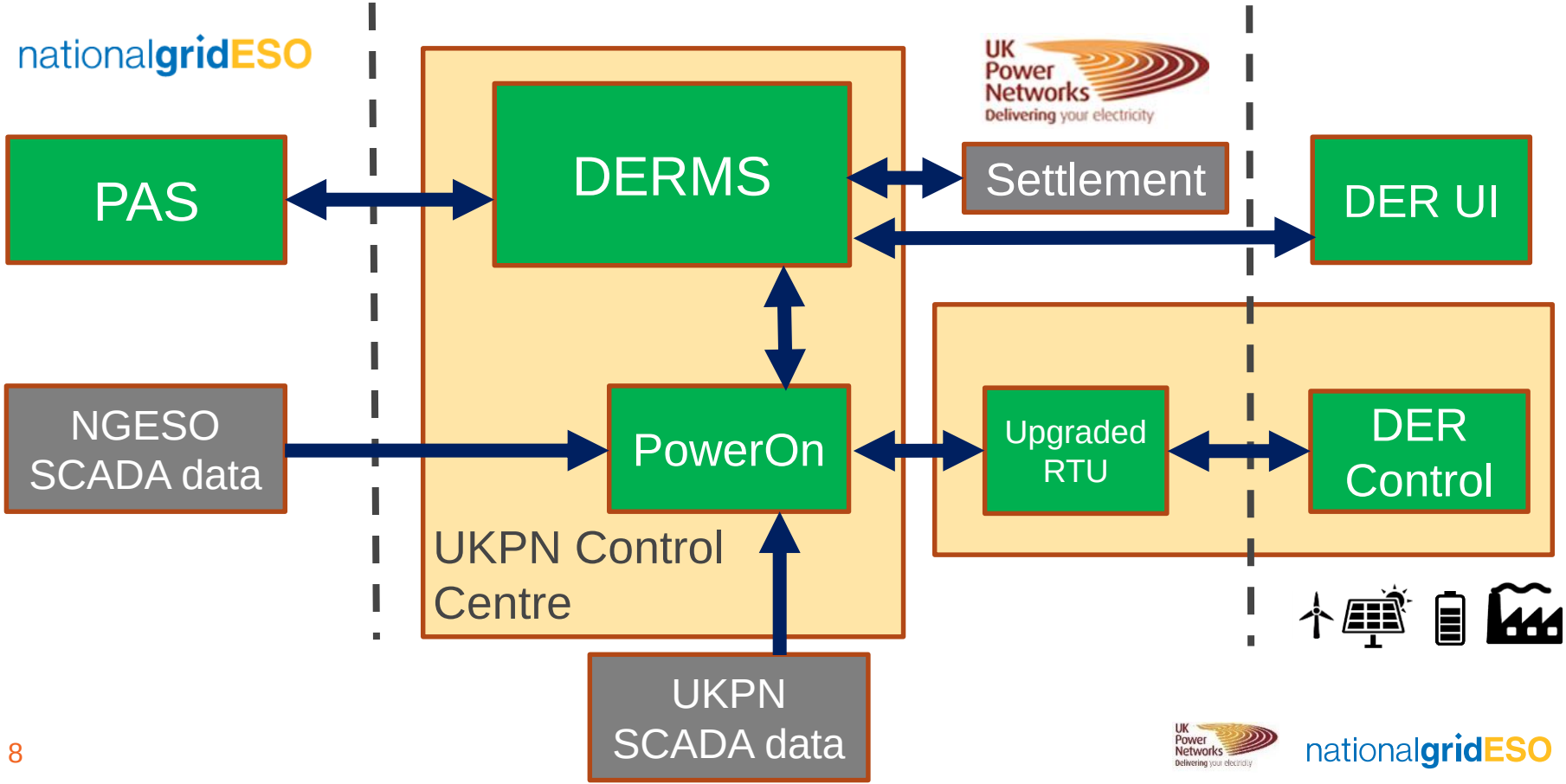
Commissioning and DER preparation

Richard Andrews

Innovation Workstream Lead,

UK Power Networks

Power Potential Technical Solution



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Test & Commissioning Strategy

UKPN have developed a structured approach to testing and commissioning as follows:

Pre-requisite tests – Laboratory test environment

- Laboratory Configuration Testing (Non-mandatory)
- Components Integration Testing
- All DER sites need to be upgraded with the appropriate hardware (where required) and the appropriate RTU logic

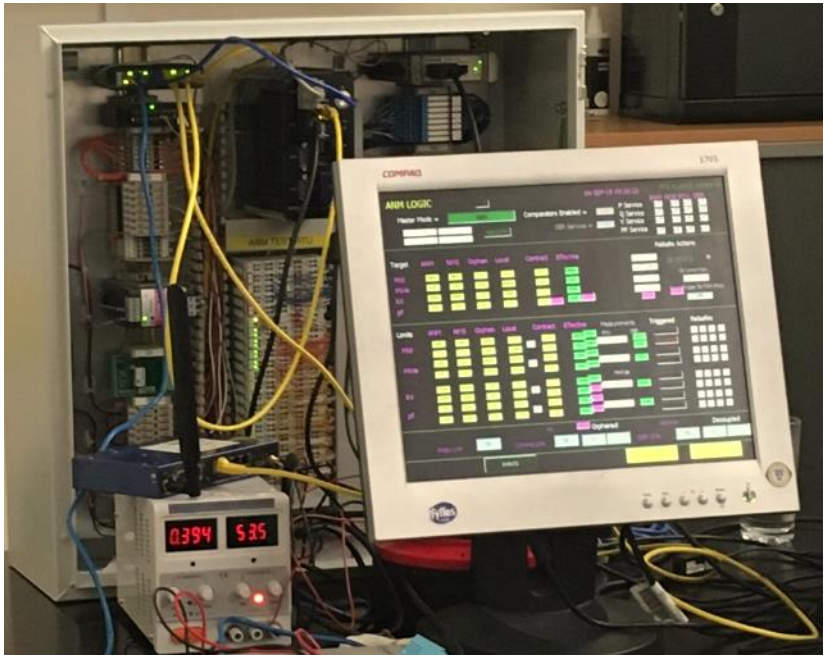
Commissioning

- PowerOn to Customer Integration (not including DERMS)
- DERMS to Customer full commissioning

Laboratory Test Environment

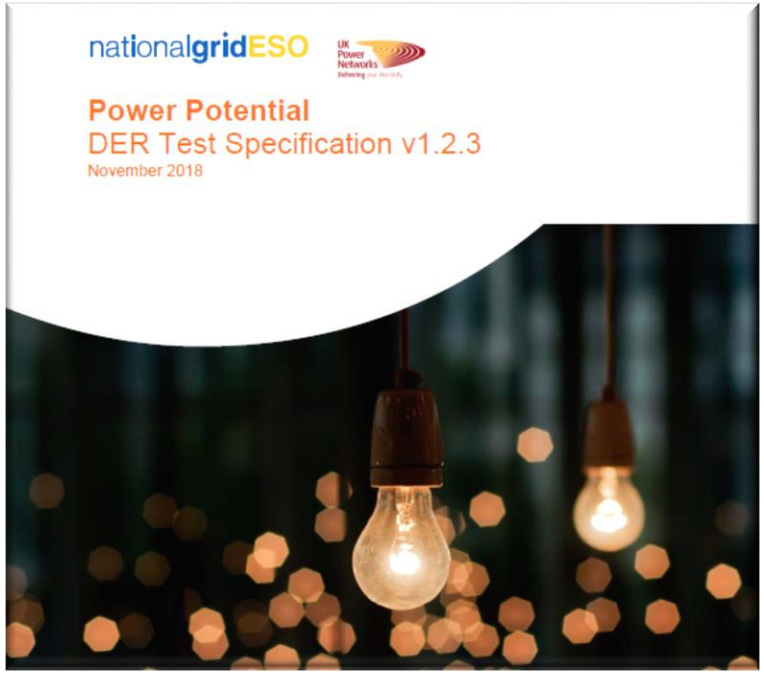
Laboratory Configuration Testing is carried out to standardise the configuration between the UKPN RTU and the DER control system

Components Integration testing is carried from end to end, to validate the signals integration between the major components in the Power Potential solution.



Commissioning Tests

- DER capability as per tech req.
- Hardware/Software initialisation
- Data Transfers
- DER Measurements
- Logic Control Mode Tests
- DER Operational Modes
- Communications
- Failsafes



Further information including the DER Technical Requirements and DER Interface Schedule is on the Power Potential website
https://www.nationalgrideso.com/innovation/projects/power-potential

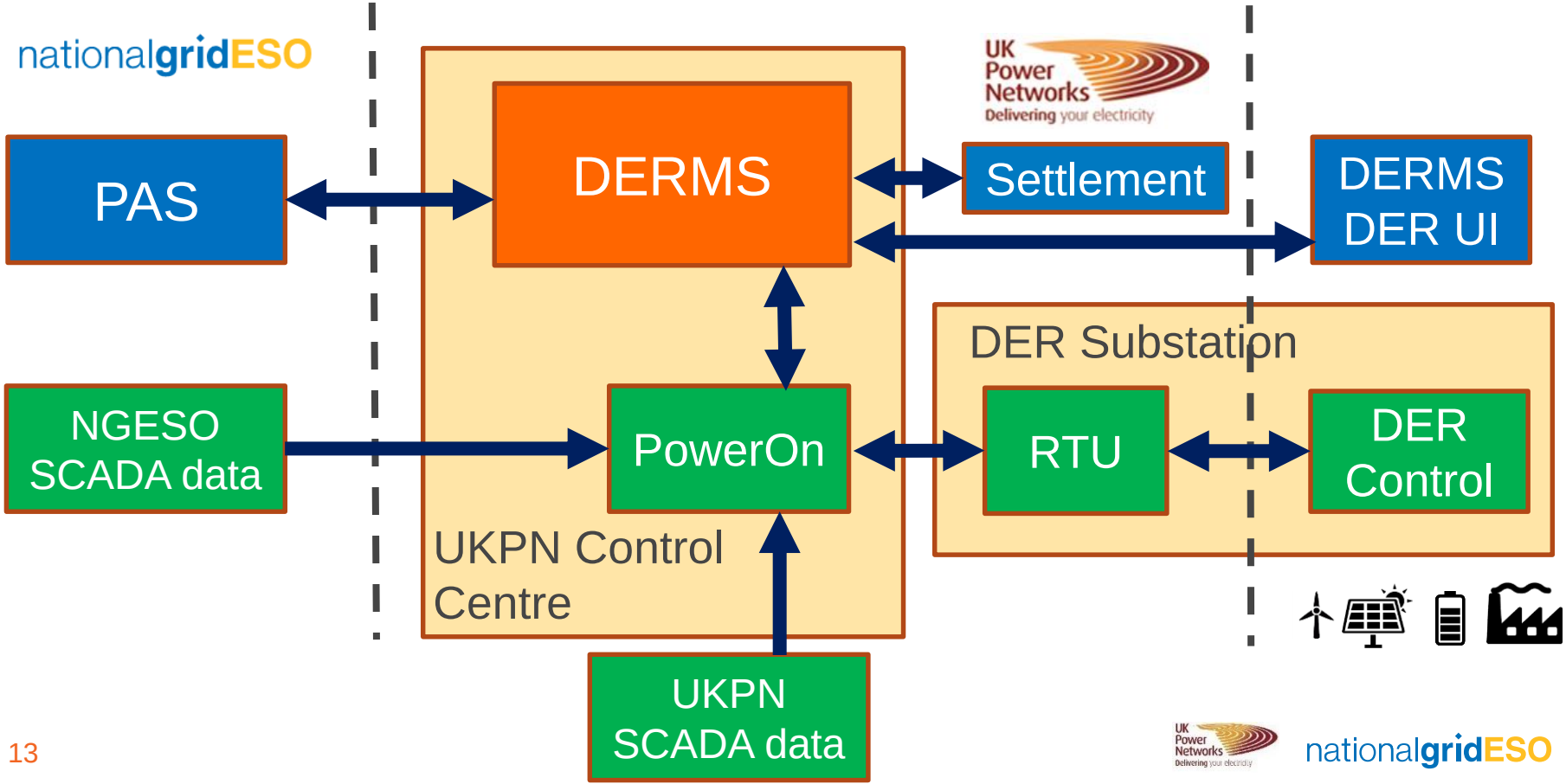
Technical Trials

Inma Martinez

Power Systems Engineer,

National Grid ESO

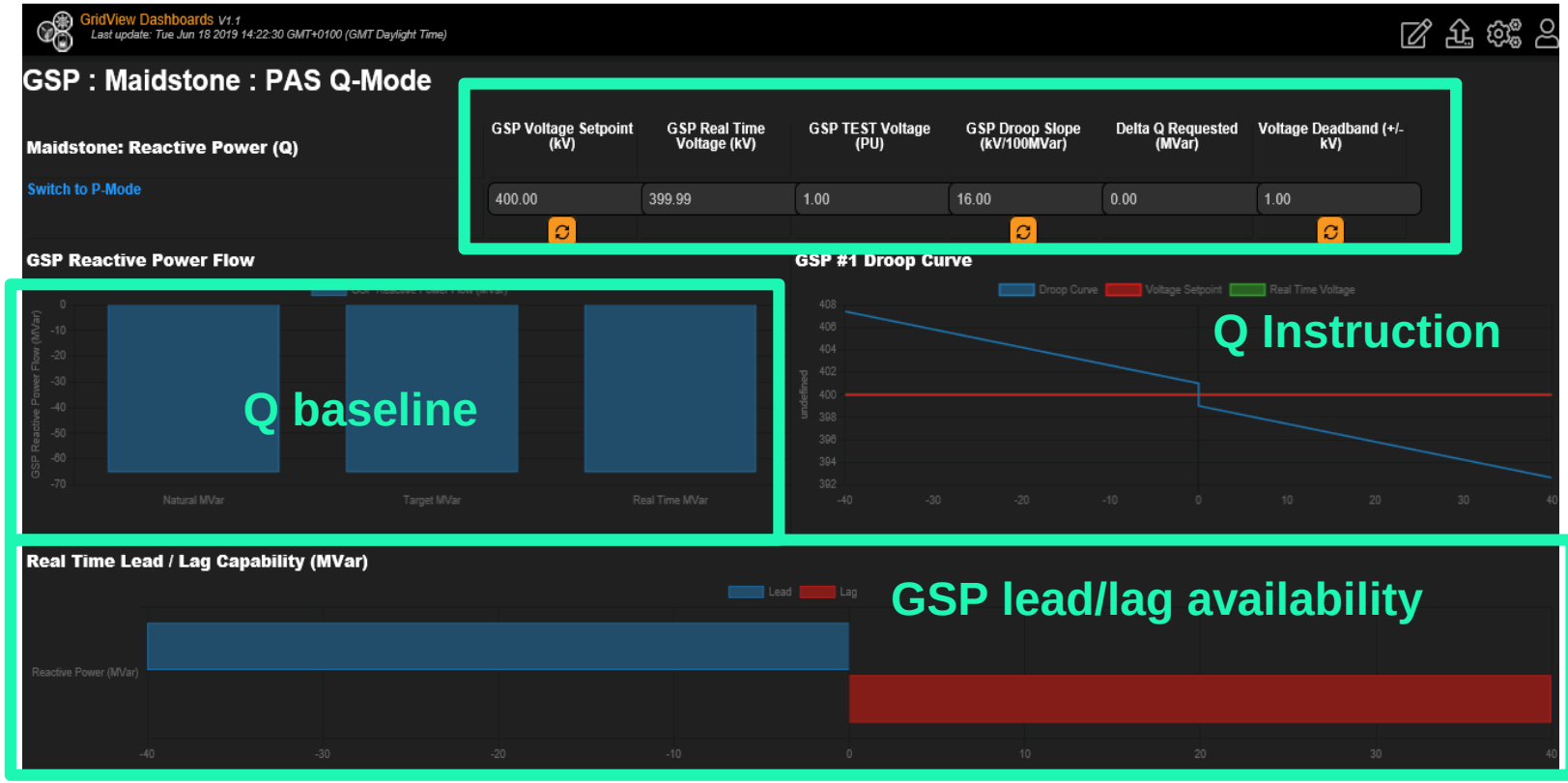
Power Potential Technical Solution



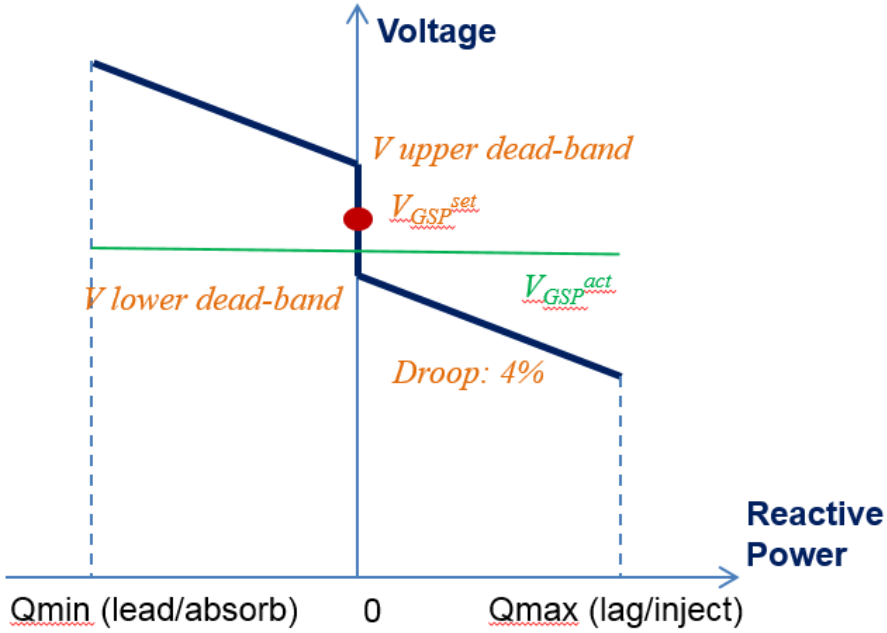
Wave 1 Mandatory Trials

- Wave 1 Mandatory Trials demonstrate that DER are technically capable of delivering reactive power services when instructed by the DERMS.
- This is compulsory for all DERs before participating in other trial waves.
- Mandatory Trials are driven by specific test methods, to be carried for individual and groups of DERs.
- Instructions are issued directly from DERMS (in UKPN control room) and not from PAS (NG control room), using a mock interface.

Wave 1 Mandatory Trials interface in DERMS



Wave 1 Mandatory Trials: DERMS master control



Instruction parameters:

- $V_{GSP}^{set\text{-}point}$: GSP voltage set-point (kV)
- Droop: GSP droop slope (kV/100Mvar)
- dB: voltage dead-band (+-kV)

Evaluated against:

- V_{GSP}^{act}: GSP real time voltage (kV)
- V_{GSP}^{test}: fictitious/test GSP test voltage (pu)

Wave 1 Mandatory Trials: Tests

- **TEST 1:** Response of the DERMS and DERs to simulated step changes in 400kV voltage (sudden voltage change)

  Fixed set-point $V_{GSP}^{set\text{-}point}$ vs. sudden change in 'fictitious/test' 400kV input V_{GSP}^{test}

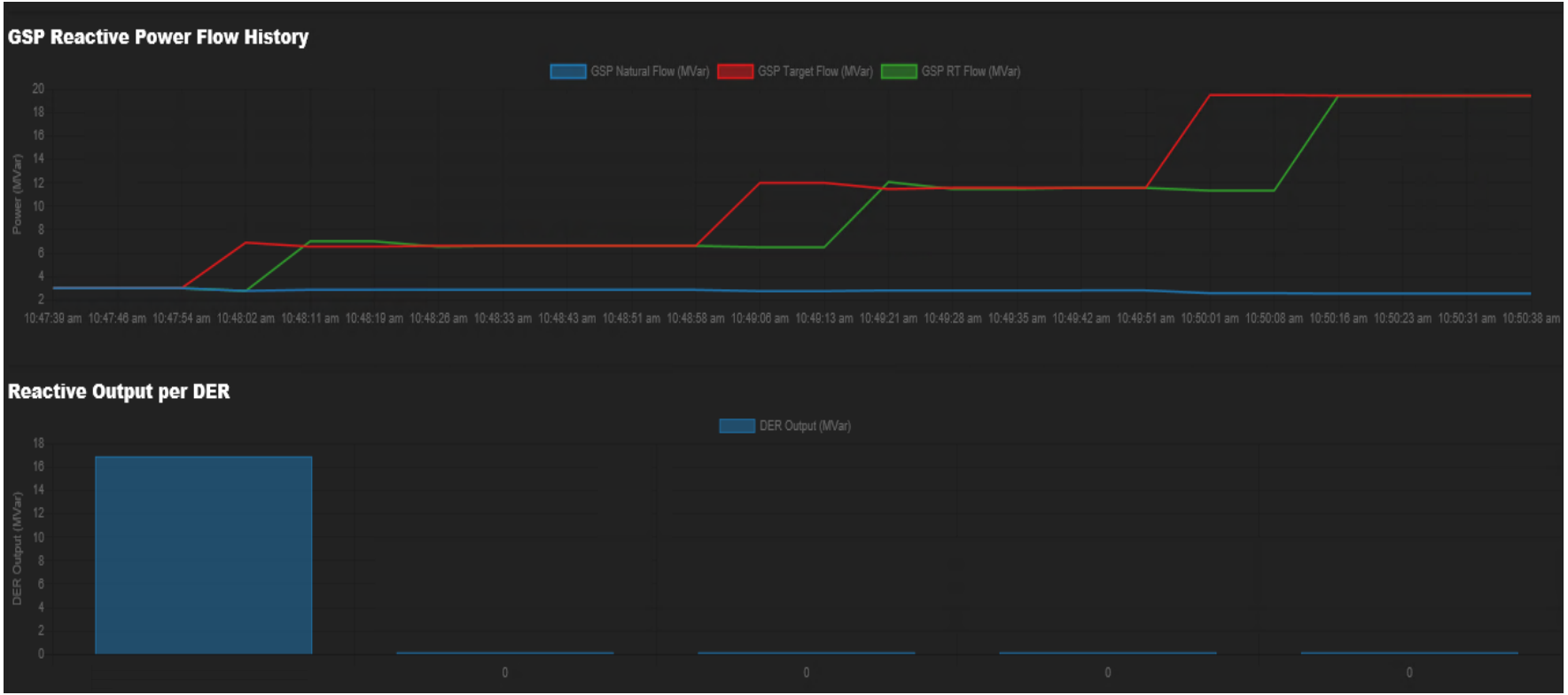
- **TEST 2:** Response of the DERMS and DERs to simulated ramp changes in 400kV voltage (slow voltage change)

  Fixed set-point $V_{GSP}^{set\text{-}point}$ vs. slow change in 'fictitious/test' 400kV input V_{GSP}^{test}

- **TEST 3:** Response of the DERMS and DERs to 400kV target voltage set-point changes (stability and sensitivities calculation)

  Vary set-point $V_{GSP}^{set\text{-}point}$ vs. actual 400kV measurement V_{GSP}^{act}

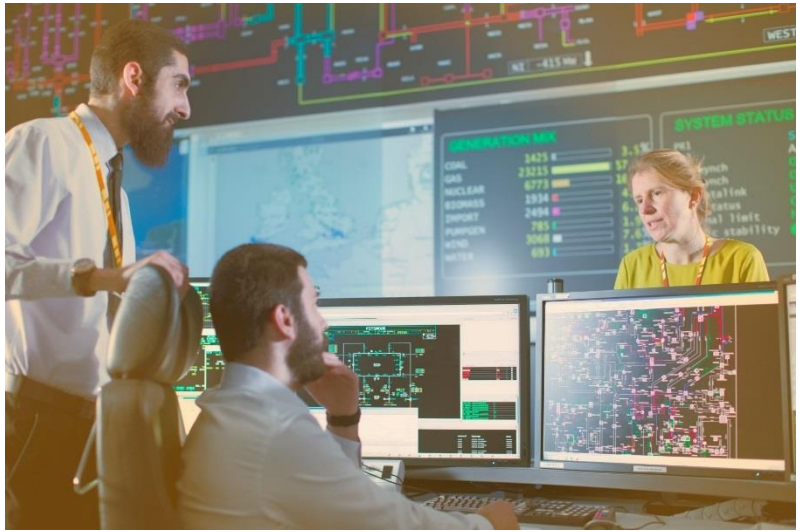
Wave 1 Mandatory Trials: Test 2 Example



Decrease in simulated voltage 0.996 – 0.994 – 0.990 pu

Wave 1 Optional Trials

- Wave 1 optional trials are for the Power Potential project to monitor the performance of the DER controlled by DERMS.
- National Grid ESO control room will issue reactive dispatch instructions via PAS.
- Learning in Wave 1 Optional Trials driven by system events
  - Unplanned event.
  - Planned transmission/distribution switching
- Run (24/7) for a number of weeks to gather sufficient experience
- DER will recover initial outlay costs based on their availability hours



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Wave 1 Optional Trials: PAS instruction screens

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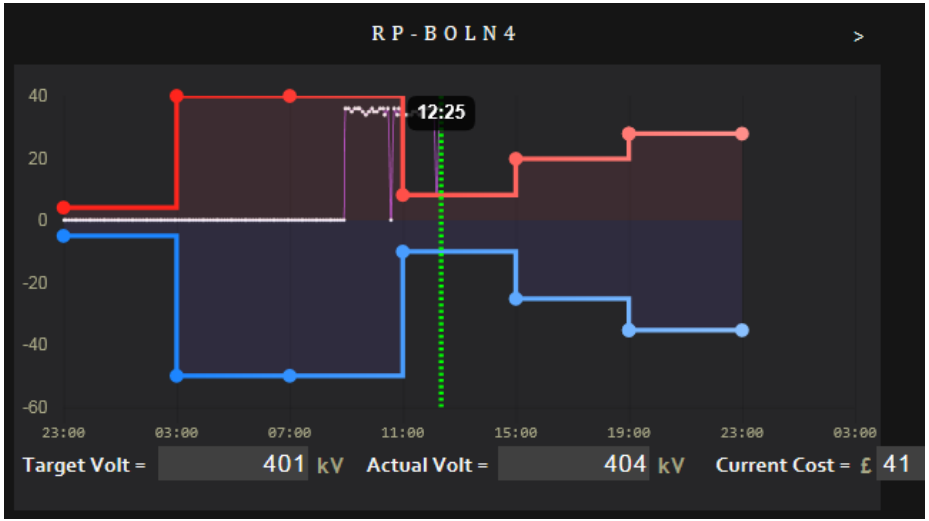
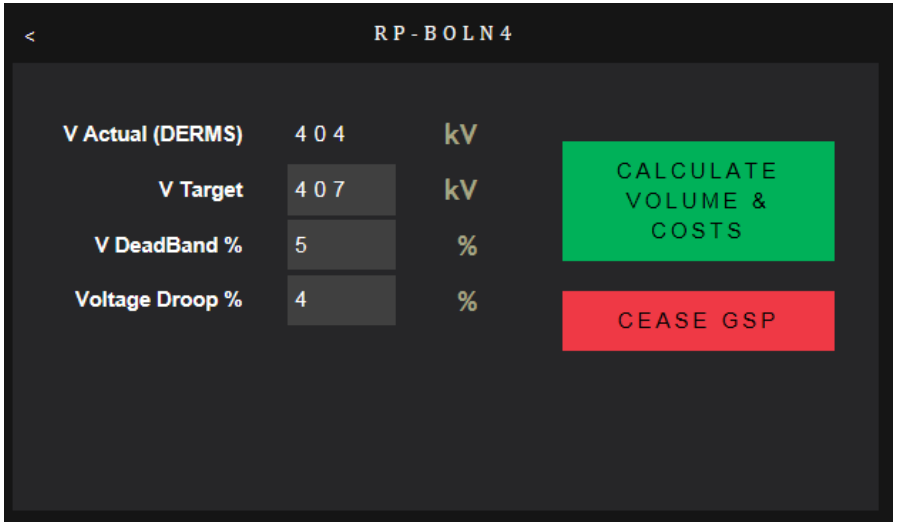
Wave 1 Optional Trials: PAS instruction screens





GSP Mvar lag available

GSP Mvar lead available

vs. GSP Utilisation

GSP Instruction parameters

Commercial Trials

Biljana Stojkovska

Innovation Manager,

National Grid ESO

Why Wave 2?

Benefits of wave 2 trials:

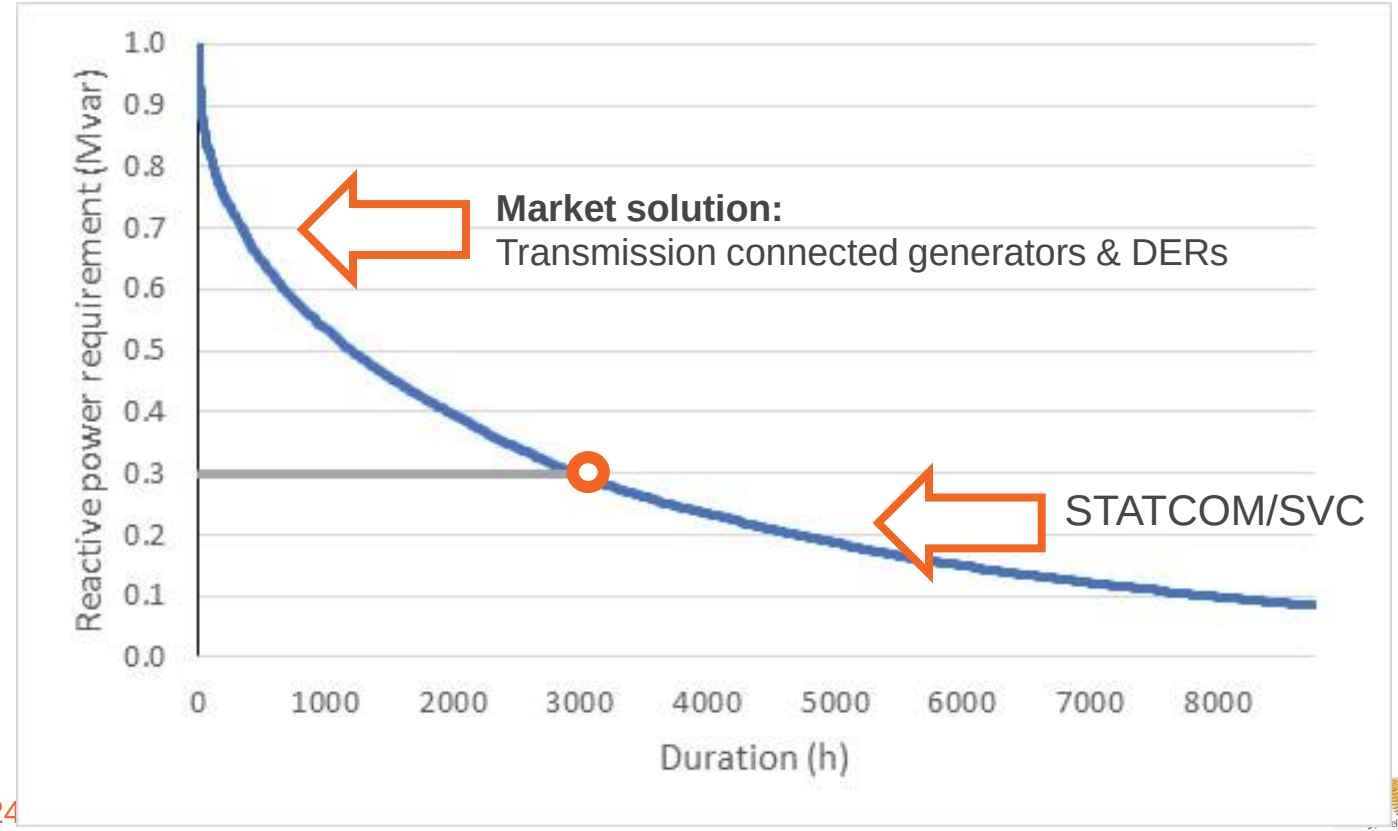
For DERs

- Genuine income opportunity
- Testing of the commercial process
- Evaluation of real system scenarios
- Budget spending indicator

For the project

- Price discovery through competition among DERs
- Opportunity to share what the real costs of participation are
- Confirmed phase of Power Potential market trials

Illustrative Example of System Reactive Power Requirements



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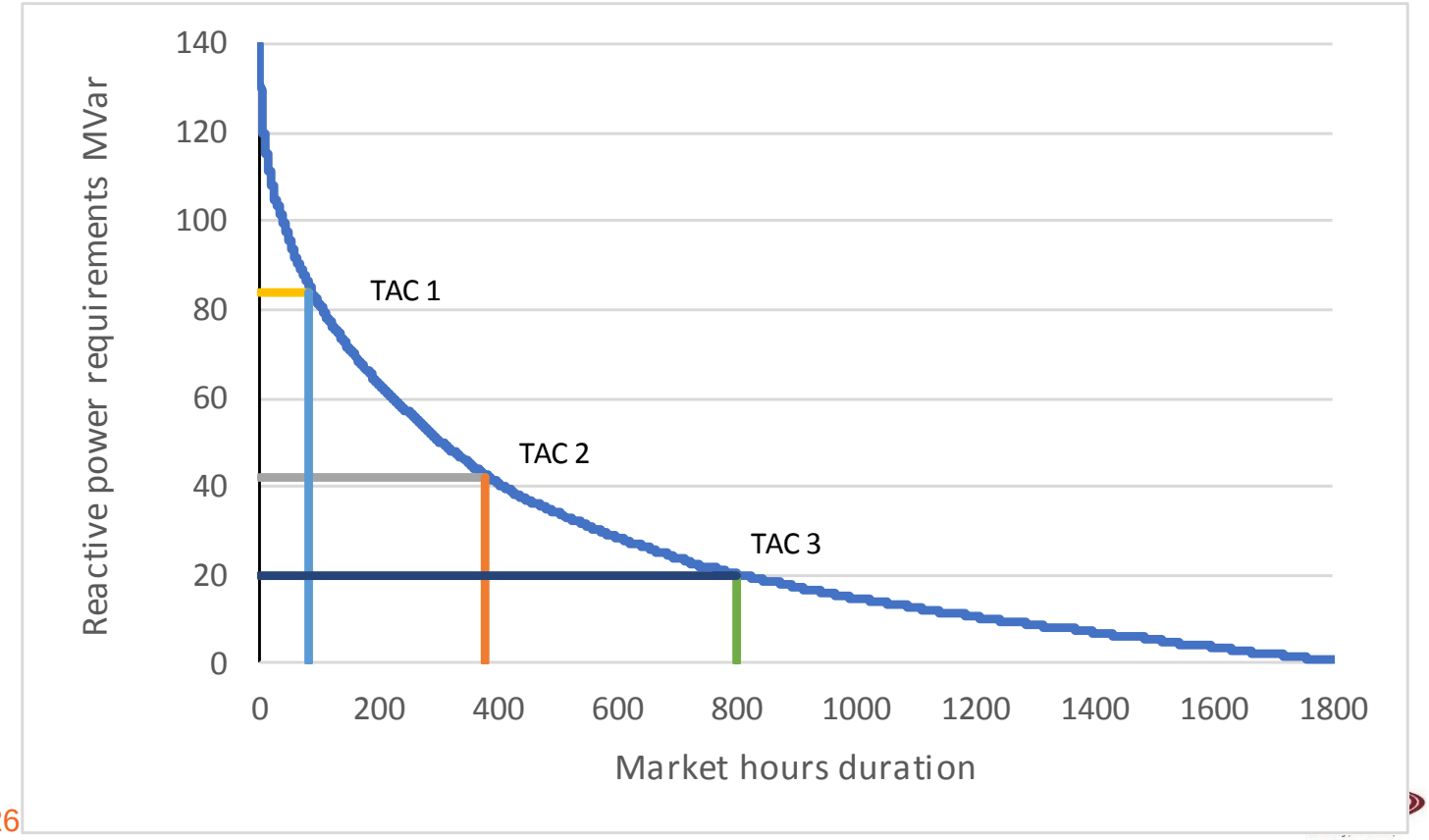
Trials budget and limitations

1. Trial budget in Wave 2 (£350k).
2. Project commitment to 1800 “market hours”
3. Target Average Cost (TAC) will be used in assessment logic
4. If on a rolling basis, actual costs incurred are equal to or less than the TAC, then there should be sufficient budget to ensure that the project commitment to 1800 “market hours” is met.
5. However, if the rolling average cost is higher than the TAC, then this is an indicator that there may be insufficient budget to deliver 1800 market hours.

What is the Target Average Cost (TAC)?



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Example – How it works in trials?

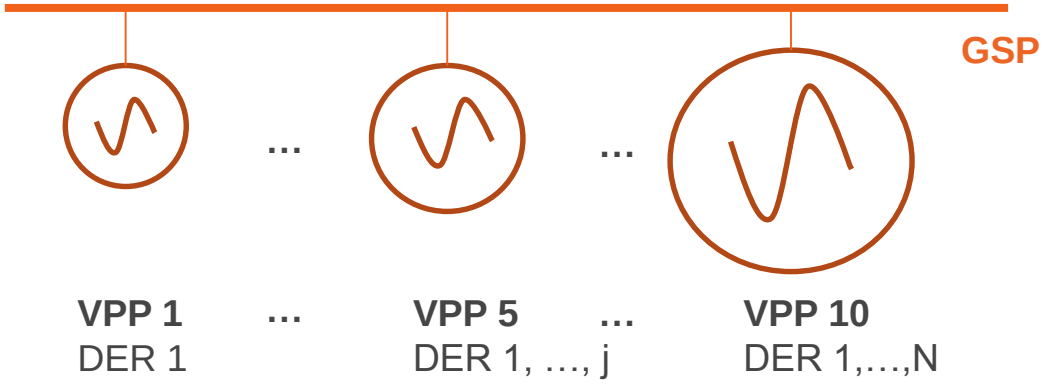
1 week

Q 11 TAC1 1	Q 12 TAC1 2	Q 13 TAC1 3	Q 14 TAC1 4	Q 15 TAC1 5	Q 16 TAC1 6
Q 21 TAC21	Q 22 TAC22	Q 23 TAC23	Q 24 TAC24	Q 25 TAC25	Q 26 TAC26
Q 31 TAC31	Q 32 TAC32	Q 33 TAC33	Q 34 TAC34	Q 35 TAC35	Q 36 TAC36
Q 41 TAC41	Q 42 TAC42	Q 43 TAC43	Q 44 TAC44	Q 45 TAC45	Q 46 TAC46
Q 51 TAC51	Q 52 TAC52	Q 53 TAC53	Q 54 TAC54	Q 55 TAC55	Q 56 TAC56
Q 61 TAC61	Q62 TAC62	Q 63 TAC63	Q 64 TAC64	Q 65 TAC65	Q 66 TAC66
Q71 TAC71	Q 72 TAC72	Q 73 TAC73	Q 74 TAC74	Q 75 TAC75	Q76 TAC76

1. Ahead of the trial start we will have a TAC for each EFA period, for each day for all 1800 h market hours
2. We will create a lookup table which we will be using during the trials for market assessment
3. We will aim to share more information on a week ahead basis on:
   - The various scenarios and associated requirements for each week
   - TAC ranges (minimum and maximum and the likelihood of being accepted within that range)

Cost Curves for Q service

- Commercial information presented to NGESO as 10 VPPs (or bands) per GSP (.cvs file with 10 rows). Band 10 contains all the DER in a GSP, it is constructed first and then broken into smaller bands.
- VPP contains effective GSP reactive power volumes (lead/lag), maximum volumes and associated costs
- Procurement decision for **one** VPP in line with system requirements

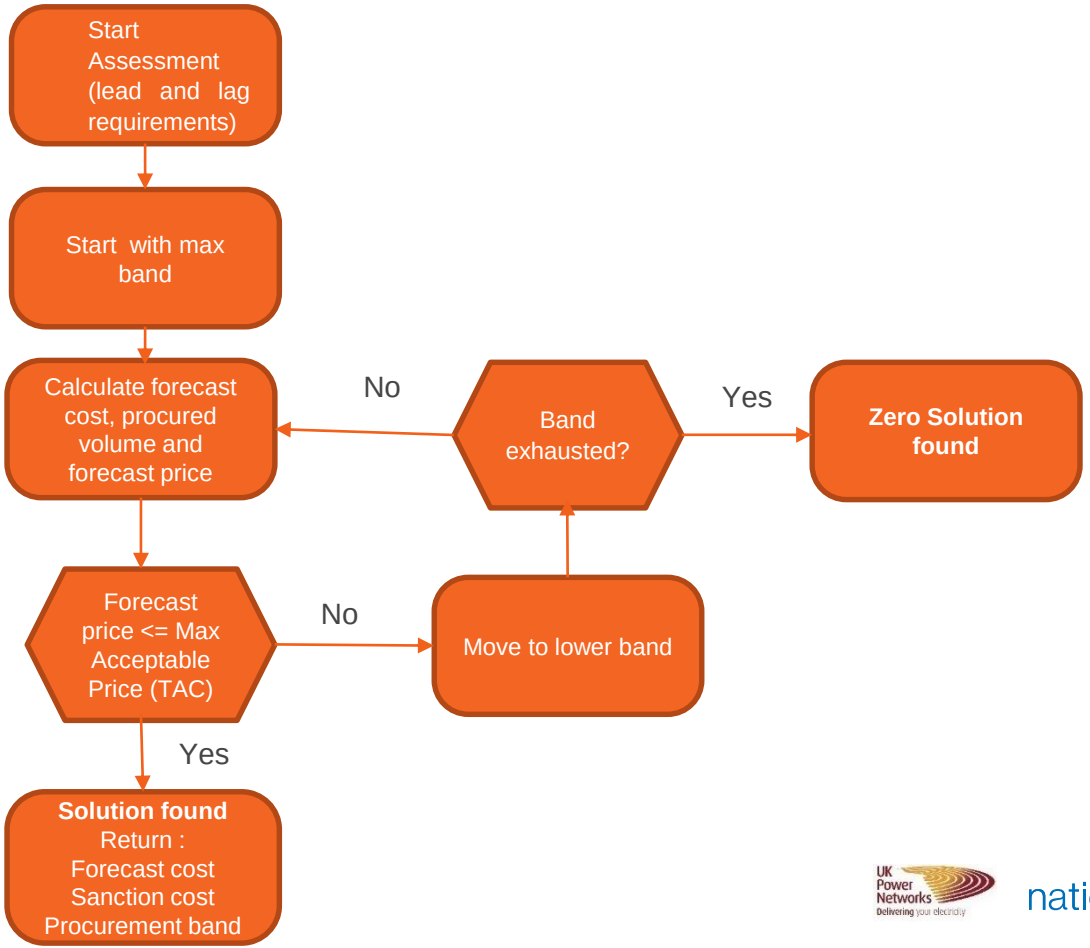


Parameters of each VPP:
Band ID
Band lead Mvar (and associated lag)
Band lag Mvar (and associated lead)
Band Maximum lead Mvar
Band Maximum lag Mvar
Band availability cost £/h
Band utilisation cost £/h
Band maximum utilisation cost £/h

Examples of Reactive Power Requirements Scenarios

	Scenario	Factors	Pre-fault capability (%)	Post fault capability (%)
1	High Voltage *	Demand/ generation High import/ export from IC	100	100
2	High Voltage	Demand/ generation Low import/ export from IC	100	0
3	Medium Voltage	High import/ export from IC	50	100
4	Medium Voltage	Low import/ export from IC	50	0
5	Low voltage	High import/ export from IC	0	100
6	Low voltage	Low import/ export from IC	0	0

Assessment Process



Thank you for listening!

Next steps to trials:

Wave 1 Mandatory Trials	End of March 2020 start	2 weeks
Wave 1 Optional Trials	End of April 2020 start	11 weeks
Wave 2 Commercial Trials	July-August 2020 start	15 weeks

General queries: box.PowerPotential1@nationalgrid.com

…and visit our website!
http://www.nationalgrideso.com/powerpotential

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