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

Presented by:

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- Richard Andrews (UK Power Networks)
- Dr Inma Martínez Sanz (National Grid ESO)
- Dr Biljana Stojkovska (National Grid ESO)

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

**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

**Timescales**
- Start Date – January 2017
- End Date – December 2020
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

Wave 1: technical trials
Objective: establish the commercial viability of this approach
- Providers paid availability

Wave 2: price discovery
Objective: demonstrate proof of concept
- Providers paid availability

Wave 3: transition to BAU
Objective: prepare DERs for a transition to current business as usual operations
- Providers paid availability and utilisation

Current focus:
Interim DERMS solution
Full DERMS solution
Full DERMS solution
Commissioning and DER preparation

Richard Andrews
Innovation Workstream Lead,
UK Power Networks
Power Potential Technical Solution

- PAS
- DERMS
- Settlement
- DER UI
- NGESO SCADA data
- PowerOn
- Upgraded RTU
- DER Control
- UKPN Control Centre
- UKPN SCADA data
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
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

GSP: Maidstone: PAS Q-Mode

Maidstone: Reactive Power (Q)

Switch to P-Mode

GSP Reactive Power Flow

Q baseline

GSP #1 Droop Curve

Q Instruction

Real Time Lead / Lag Capability (MVar)

GSP lead/lag availability
Wave 1 Mandatory Trials: DERMS master control

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

Evaluated against:
- $V_{GSP}^{\text{act}}$: GSP real time voltage (kV)
- $V_{GSP}^{\text{test}}$: 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 $V_{GSP}^{set-point}$ 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 $V_{GSP}^{set-point}$ 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 $V_{GSP}^{set-point}$ 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
Wave 1 Optional Trials: PAS instruction screens
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

Market solution:
Transmission connected generators & DERs

STATCOM/SVC
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)?
Example – How it works in trials?

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

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Scenario</th>
<th>Factors</th>
<th>Pre-fault capability (%)</th>
<th>Post fault capability (%)</th>
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<tbody>
<tr>
<td>1</td>
<td>High Voltage *</td>
<td>Demand/ generation High import/ export from IC</td>
<td>100</td>
<td>100</td>
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<tr>
<td>2</td>
<td>High Voltage</td>
<td>Demand/ generation Low import/ export from IC</td>
<td>100</td>
<td>0</td>
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<tr>
<td>3</td>
<td>Medium Voltage</td>
<td>High import/ export from IC</td>
<td>50</td>
<td>100</td>
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<tr>
<td>4</td>
<td>Medium Voltage</td>
<td>Low import/ export from IC</td>
<td>50</td>
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</tr>
<tr>
<td>5</td>
<td>Low voltage</td>
<td>High import/ export from IC</td>
<td>0</td>
<td>100</td>
</tr>
<tr>
<td>6</td>
<td>Low voltage</td>
<td>Low import/ export from IC</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>
Assessment Process

1. Start Assessment (lead and lag requirements)
2. Start with max band
3. Calculate forecast cost, procured volume and forecast price
4. Forecast price <= Max Acceptable Price (TAC)
   - Yes: Solution found; Return: Forecast cost, Sanction cost, Procurement band
   - No: Band exhausted?
     - Yes: Zero Solution found
     - No: Move to lower band

Thank you for listening!

Next steps to trials:

<table>
<thead>
<tr>
<th>Trials Type</th>
<th>Start Date</th>
<th>Duration</th>
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</thead>
<tbody>
<tr>
<td>Wave 1 Mandatory Trials</td>
<td>End of March 2020</td>
<td>2 weeks</td>
</tr>
<tr>
<td>Wave 1 Optional Trials</td>
<td>End of April 2020</td>
<td>11 weeks</td>
</tr>
<tr>
<td>Wave 2 Commercial Trials</td>
<td>July-August 2020</td>
<td>15 weeks</td>
</tr>
</tbody>
</table>

General queries: box.PowerPotential1@nationalgrid.com

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