## Electricity Operational Forum

**July 2019**

**Host – Ben Smith**

**Start: 10:00am**

<table>
<thead>
<tr>
<th>Time</th>
<th>Session</th>
<th>Presenter</th>
</tr>
</thead>
<tbody>
<tr>
<td>10:00</td>
<td>Welcome and Introduction</td>
<td>Paul Lowbridge</td>
</tr>
<tr>
<td>10:15</td>
<td>Balancing Services Use of System (BSUoS) update</td>
<td>Nigel Swan</td>
</tr>
<tr>
<td>10:50</td>
<td>Control Room - Difficult Day Analysis</td>
<td>Paul Corrie</td>
</tr>
<tr>
<td>11:20</td>
<td>Break</td>
<td></td>
</tr>
<tr>
<td>11:45</td>
<td>Operability Strategy Report</td>
<td>Will Kirk-Wilson</td>
</tr>
<tr>
<td>12:15</td>
<td>Platform for Ancillary Services (PAS) Update</td>
<td>Matt Hopkins</td>
</tr>
<tr>
<td>12:40</td>
<td>Questions</td>
<td></td>
</tr>
<tr>
<td>13:00</td>
<td>Finish – Lunch / Networking</td>
<td></td>
</tr>
</tbody>
</table>
Our Canadian Geese....
Balancing Service Use of System (BSUoS) Update

Nigel Swan
February 2019: £2.45/MWh
Total Cost: £83.7m, Volume: 40.6TWh

Constraints

Energy

Constraint

Blackstart

RoCoF

Reactive

£83.7m
March 2019: £3.99/MWh
Total Cost: £145.3m, Volume: 41.2TWh
April 2019: £2.80/MWh
Total Cost: £81.5m, Volume: 38.2TWh

Constraints
<table>
<thead>
<tr>
<th>Feb</th>
<th>Mar</th>
<th>Apr</th>
<th>May</th>
</tr>
</thead>
<tbody>
<tr>
<td>70</td>
<td>80</td>
<td>60</td>
<td>50</td>
</tr>
</tbody>
</table>

Energy
<table>
<thead>
<tr>
<th>Feb</th>
<th>Mar</th>
<th>Apr</th>
<th>May</th>
</tr>
</thead>
<tbody>
<tr>
<td>50</td>
<td>60</td>
<td>70</td>
<td>80</td>
</tr>
</tbody>
</table>

RoCoF
<table>
<thead>
<tr>
<th>Feb</th>
<th>Mar</th>
<th>Apr</th>
<th>May</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>20</td>
<td>30</td>
<td>40</td>
</tr>
</tbody>
</table>

Blackstart
<table>
<thead>
<tr>
<th>Feb</th>
<th>Mar</th>
<th>Apr</th>
<th>May</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>20</td>
<td>30</td>
<td>40</td>
</tr>
</tbody>
</table>

Reactive
<table>
<thead>
<tr>
<th>Feb</th>
<th>Mar</th>
<th>Apr</th>
<th>May</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>20</td>
<td>30</td>
<td>40</td>
</tr>
</tbody>
</table>

£81.5m
May 2019: £2.41/MWh
Total Cost: £63.8m, Volume: 36.7TWh

Constraints
- Feb: £30.1m
- Mar: £13.2m
- Apr: £10.5m
- May: £3.5m

Energy
- Feb: £30.1m
- Mar: £13.2m
- Apr: £10.5m
- May: £3.5m

RoCoF
- Feb: £30.1m
- Mar: £13.2m
- Apr: £10.5m
- May: £3.5m

Blackstart
- Feb: £30.1m
- Mar: £13.2m
- Apr: £10.5m
- May: £3.5m

Reactive
- Feb: £30.1m
- Mar: £13.2m
- Apr: £10.5m
- May: £3.5m
Forecast Accuracy – BSUoS Report

Month ahead forecast vs actual

BSuoS £/MWh

Month ahead forecast vs actual graph with data points for June 2018 to May 2019.
Constraints and RoCoF costs
Cost performance vs benchmark

Cost Performance vs Benchmark (£M)

- Western Link HVDC out of service and high winds

Exceptional costs incurred to secure the system across winter. Actions to resolve system constraints until commissioning of Western Link HVDC on 16 October.
2019 April to May compared with last year

Comparing 2019 with 2018
- £8.6m more on energy balancing, reserve and response
- £10.3m more on constraints
- £5.3m more on RoCoF
- £0.3m less on Blackstart
- £1.4m less on Reactive
Proportional balancing costs

<table>
<thead>
<tr>
<th></th>
<th>Apr-May 2018</th>
<th>Apr-May 2019</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy</td>
<td>42%</td>
<td>42%</td>
</tr>
<tr>
<td>Constraint</td>
<td>29%</td>
<td>32%</td>
</tr>
<tr>
<td>Blackstart</td>
<td>6%</td>
<td>5%</td>
</tr>
<tr>
<td>RoCoF</td>
<td>12%</td>
<td>14%</td>
</tr>
<tr>
<td>Reactive</td>
<td>11%</td>
<td>8%</td>
</tr>
</tbody>
</table>

Bar chart showing proportional balancing costs for Apr-May 2018 and Apr-May 2019.
Wind volume driving constraint costs

- Scottish wind volume increasing year on year
- This chart illustrates why WLHVDC unavailability had a much greater effect in September, October and March than in April and May.
Wind volume driving constraint costs

March 19 - Outturn Costs and Wind Output

May 19 - Outturn Costs and Wind Output
RoCoF costs

- The RoCoF limit is trending down year on year, being driven mainly by higher renewable output, lower inertia contribution from conventional plant and lower transmission demand.
- Reducing infeed losses to manage RoCoF is cost optimal and actions have continued on Interconnectors and large infeed losses.
- We have seen RoCoF limits as low as 670MW during periods of high wind and low synchronous generation.
Stability Strategy

Inertia

There are four ways to manage system inertia:

1. Increase system inertia by replacing self-despatched generation with ESO despatched generation with a higher inertia.
2. Reduce the largest infeed loss on the system to reduce the rate of change of frequency for any loss.
3. Review the consumer benefit of faults which are secured for under the SQSS.
4. Introduce Stability products to manage increase inertia, fault level in-feed and reactive capability.

Option 3 is being actively reviewed to ensure the SQSS reflects consumer benefit. Option 4 is not currently available and is being developed through the stability pathfinder.

Loss of Main Protection settings result in an effective artificial level to manage the RoCoF, combined with a limited number of largest losses results in the most cost-effective method of management being reducing largest loss. It is a 1 in 20 relationship. Once the Loss of Main Protection settings have changed, market solutions developed through the Stability Pathfinder, and the development of faster acting frequency response products, will provide stability and ensure operability to manage lower system inertia.

<table>
<thead>
<tr>
<th>Actions</th>
<th>2019/20</th>
<th>2020/21</th>
<th>2021/22</th>
<th>2022/23</th>
<th>2023/24</th>
</tr>
</thead>
<tbody>
<tr>
<td>Estimated Balancing Costs p.a.</td>
<td>£130m</td>
<td>£150m</td>
<td>£150m</td>
<td>(£170m if LOM is not delivered)</td>
<td>(£190m if LOM is not delivered)</td>
</tr>
<tr>
<td>Loss of Mains Protection Changes (Power Protect)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stability Pathfinder</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>‘Stability’ Markets</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
February 2019: £2.45/MWh
Total Cost: £83.7m, Volume: 40.6TWh

£83.7m
March 2019: £3.99/MWh
Total Cost: £145.3m, Volume: 41.2TWh
April 2019: £2.80/MWh
Total Cost: £81.5m, Volume: 38.2TWh

Constraints

Energy

RoCoF

Blackstart

Reactive

£81.5m
May 2019 : £2.41/MWh
Total Cost: £63.8m, Volume: 36.7TWh
Forecast Accuracy – BSUoS Report

Month ahead forecast vs actual

BSoS £/MWh


- Actual
- Month ahead forecast
Constraints and RoCoF costs
Cost performance vs benchmark

Cost Performance vs Benchmark (£M)

Western Link HVDC out of service and high winds

Exceptional costs incurred to secure the system across winter. Actions to resolve system constraints until commissioning of Western Link HVDC on 16 October.
2019 April to May compared with last year

Comparing 2019 with 2018
• £8.6m more on energy balancing, reserve and response
• £10.3m more on constraints
• £5.3m more on RoCoF
• £0.3m less on Blackstart
• £1.4m less on Reactive
Proportional balancing costs

![Chart showing proportional balancing costs for Apr-May 2018 and Apr-May 2019. The chart indicates the percentage distribution of costs across Energy, Constraint, Blackstart, RoCoF, and Reactive categories.]
Wind volume driving constraint costs

Scottish Wind Output (TWh)

• Scottish wind volume increasing year on year
• This chart illustrates why WLHVDC unavailability had a much greater effect in September, October and March than in April and May.
Wind volume driving constraint costs

March 19 - Outturn Costs and Wind Output

May 19 - Outturn Costs and Wind Output
• The RoCoF limit is trending down year on year, being driven mainly by higher renewable output, lower inertia contribution from conventional plant and lower transmission demand.
• Reducing infeed losses to manage RoCoF is cost optimal and actions have continued on Interconnectors and large infeed losses.
• We have seen RoCoF limits as low as 670MW during periods of high wind and low synchronous generation.
Stability Strategy

Inertia

There are four ways to manage system inertia

1. Increase system inertia by replacing self-despatched generation with ESO despatched generation with a higher inertia
2. Reduce the largest infeed loss on the system to reduce the rate of change of frequency for any loss
3. Review the consumer benefit of faults which are secured for under the SQSS
4. Introduce Stability products to manage increase inertia, fault level in-feed and reactive capability.

Option 3 is being actively reviewed to ensure the SQSS reflects consumer benefit. Option 4 is not currently available and is being developed through the stability pathfinder.

Loss of Main Protection settings result in an effective artificial level to manage the RoCoF, combined with a limited number of largest losses results in the most cost-effective method of management being reducing largest loss. It is a 1 in 20 relationship.

Once the Loss of Main Protection settings have changed, market solutions developed through the Stability Pathfinder, and the development of faster acting frequency response products, will provide stability and ensure operability to manage lower system inertia.

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Loss of Mains Protection Changes (Power Protect)</td>
<td>(£130m)</td>
<td>(£150m)</td>
<td>(£150m)</td>
<td>(£170m if LOM is not delivered)</td>
<td>(£190m if LOM is not delivered)</td>
</tr>
<tr>
<td>Stability Pathfinder</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

"Stability" Markets