Grid Code Development Forum

10:00-12:00

Wednesday 08th July 2020

Digital only meeting via WebEx

Please register below to receive the details to join:

WebEx Registration Link

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Agenda

1. Introductions
2. Presentation: Multiple Fault Ride-Through
   (***Matt Baller***, National Grid ESO)
3. Presentation: Emergency and Restoration Code – Phase II
   (***Tony Johnson***, National Grid ESO)
4. Any other business
5. Close

Multiple Fault Ride-Through Project Update

Matt Baller & Eero Kantamaa
GCDF

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Agenda

- Background refresher
- Our studies
- Findings
- Additional reassurance
- Recommendations
- Questions

The Event

From 28-09-2016 at 16:16:

- Severe weather damages T&D assets; 6 voltage disturbances in 88s
- Voltage disturbances shuts down 456MW~ wind farms in <7s
- Heywood interconnector (already close to capacity @ 613MW) trips, islanding SA from rest of NEM
- Supply/demand imbalance unmanageable; remaining online generators tripped off
- 850,000 South Australians have no electricity supply from 16:18-19:00
- 80-90% of customers back online by 00:00
- Cost estimated at £196m~
- MFRT played a significant role (slide 4)
- Led to Damian Jackman (SSE) presenting at GCDF, triggering exploration to assess risk to GB

South Australia Blackout – Loss of Wind Generation

Rode through faults

Limit of **9** FRT events (maximum of only 5 events seen)

Did not ride through faults

Limit of only **2** FRT events (6 events seen)

Table 4 SA wind farm responses to six voltage disturbances between 16:17:33 and 16:18:15 on 28 September 2016

Wind farm	Pre-set limit to ride-through events in 120 seconds	Number of times wind turbines activated ride-through mode	Last state of wind turbines prior to system voltage collapse	Output pre-event at 16:18:07 [MW]	Output just prior to separation at 16:18:15.4 [MW]
Canunda	9	1	Operational	27.7	27.2
Lake Bonney 1	5-9	0	Operational	77.7	76.5
Lake Bonney 2,3	9	0	Operational	171.9	158.7
Waterloo	9	5	Operational	96.6	72.9
				Expected MW Reduction	38.6
Clements Gap	2	3	Disconnected	14.5	-0.5
Hallett	2	3	Most turbines disconnected	34.5*	1.7*
Hallett Hill	2	3	Most turbines disconnected	41.3*	19.5*
Mt Millar	Not known	5	Stopped Operation	67.0**	2.8**
North Brown Hill	2	3	Most turbines disconnected	85.5	11.0
Hornsdale	5	6	Stopped Operation	83.9	-1.1
Snowtown North	5	6	Stopped Operation	65.5	-0.8
Snowtown South	5	6	Stopped Operation	42.1	-1.2
The Bluff	2	3	Most turbines disconnected	41.9	-0.3
				Unexpected MW Reduction	445.1
Total MW output				850.1	366.4
Total MW Loss					483.7

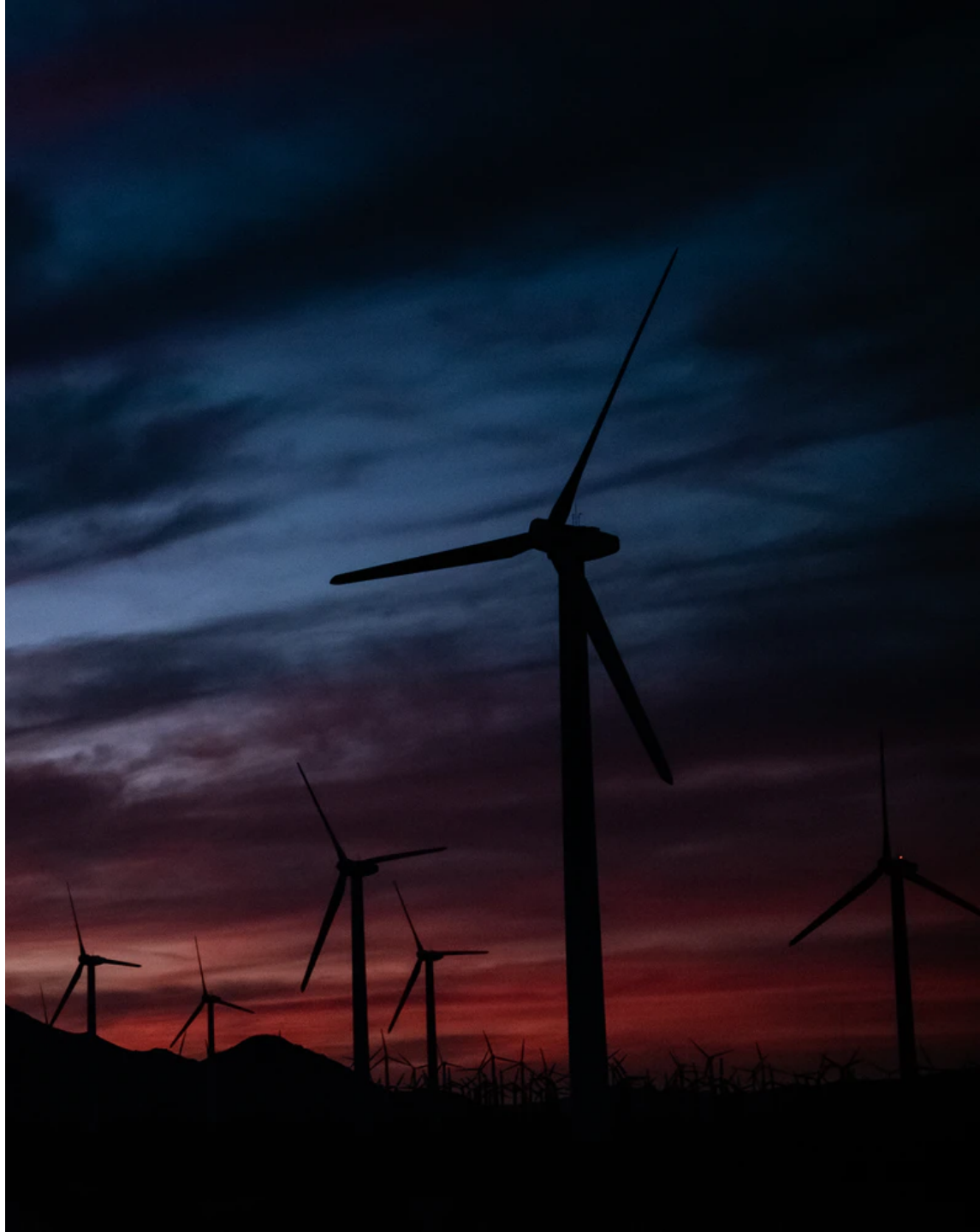
* Output not directly recorded. Estimated from other data.
** Value shown is MVA. Real power output (MW) would be somewhat less.

Timeline so far

- **Jan 2017:** SSE presentation at GCDF
- **Feb 2017:** Initial ESO survey circulated to industry
- **March 2017:** 3 responses back of some but limited use
- **Late 2017:** Redacted responses circulated to GCRP
- **Feb 2018:** Update provided at GCRP
- **Jul 2018:** Update provided at JPC
- **Sep 2019:** MB & EK begin new round of exploration: direct contact of key stakeholders, and analysis/modelling to assess risk
- **Jan 2020:** Update provided at JPC
- **Apr 2020:** Conclusions of research and analysis/modelling

Key Considerations

- Awareness at generation level for pre-RfG connected parties
- What settings are used? Why? Who decides?
- Can they be amended?
- What's the risk, realistically?
- In short: do we need to act specifically re MFRT capabilities?



Survey Round 1

- Limited responses
- Minimal consistency in approach between 3 manufacturers
- Seemingly arbitrary “numbers” of faults e.g. 6 in 30mins without further definition
- One using thermal load only
- One manufacturer gave a detailed response & was supportive of codifying requirement

What Have Other Countries Done?

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Action on MFRT – Australia Proposed Standards

Requirement	Automatic	Minimum
Number of recurring disturbances	15	6
Time	5 min	5 min
Sliding window time	Yes	NO sliding time window. Only 30 min grace period following a 5 min period of multiple disturbances
Recurring disturbance time	≥ 0ms	>200ms
Maximum # disturbances within 30 sec	Any, unless multiple disturbance requirements are exceeded	3

Action on MFRT - Elsewhere

- Germany unable to reach consensus after two years on number of faults; is proposing a different approach based on energy criteria

- Denmark takes a strict view: remain connected through 2 of any faults within 2mins, and 6 in 5.

What We've Done

Q4 2019 Onwards

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Follow-up Survey

- Focused on SE England (worst-case)
- Sought data from 3 large wind farms, and several interconnectors
- Aimed to locate relevant people to explore capabilities
- And to gain context on access to data for existing connections

Survey Outcomes

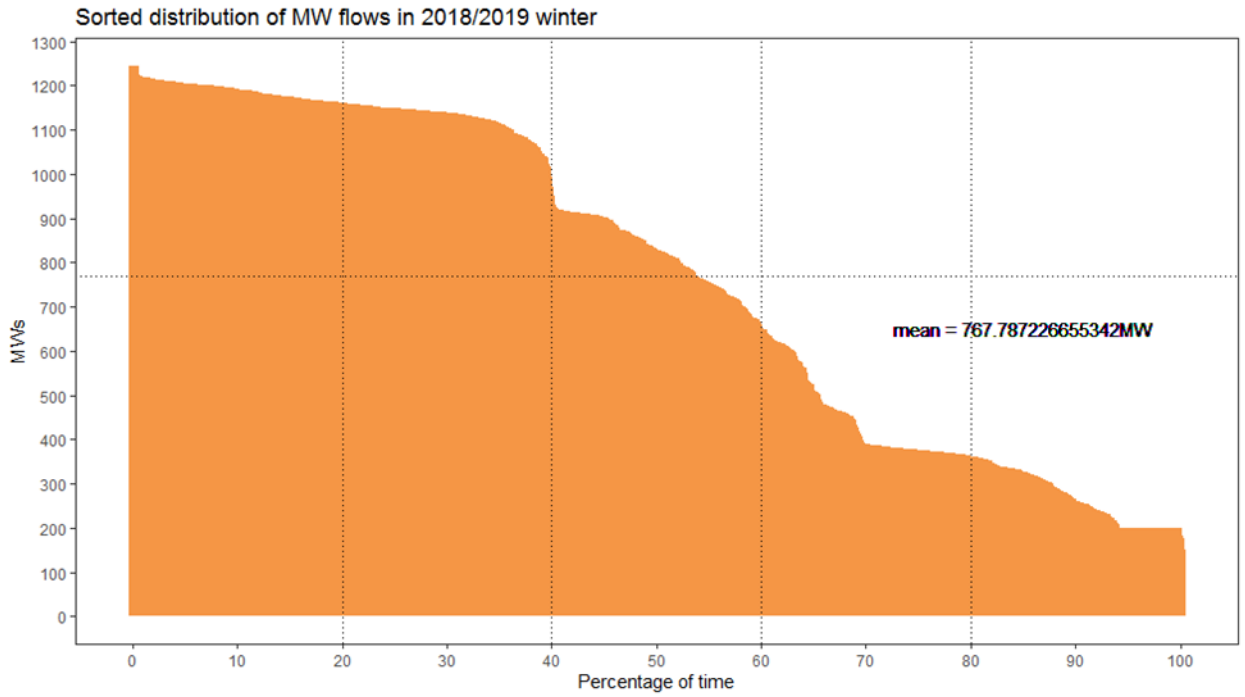
- Significant challenges in accessing wind farm data
- Ownership shifts pre/post connection = muddy waters
- Parties were willing but unable
- Sits with no particular role/remit
- Replication on a wide scale = time-suck, expensive, not worthwhile
- Interconnectors easier to find answers

Modelling/Simulations

- Statistical approach based on historical data, using protection settings as criteria
- MFRT protection criteria track the timeframe and voltage dip
- Defining occurrence:
  - Studied 20yrs' of events to assess likelihood of scenarios fulfilling time criterion
  - Simulated faults on the network to assess the extent of voltage dip propagation
  - Results in probability of occurrence of events specifically for the South East
- Analysis of gust speeds to look for trends during multiple fault events

Modelling/Simulations

- Impacts analysed by looking at probability of generation being above set MW intervals
- Flows during winter considered for winds/storms, summer for lightning
  - In winter, only hours with wind speed above 11m/s considered



Total flow a sum of all wind generation in area

Due to higher impact, Wind events carry ~90% of the risk

Modelling/Simulations – Assumptions

- Used only three-phase, zero impedance faults to calculate the outcomes; reality would be very different
- Assumed the same protection settings across all wind generation to maximise impact
- Used criteria of the two most commonly employed protection settings from prev. survey
- Also considered interconnectors & embedded Loss of Mains protection
  - Interconnectors resilient in both technologies in use (LCC, VSC)

Modelling/Simulations - Outcomes

Two different conditions considered:

1. **6 faults in 30 minutes, with voltage depression below 0.9pu**
2. **3 faults in 10s or 11 faults in 24 hours, with voltage depression below 0.75pu**

Risk = The occurrence for events affecting South East, combined with likely impact

Where 2. resulted in higher risk values, outlined below:

Loss of infeed	Risk (%)	Every x years
1.3 GW	3.1	32
1.7 GW	2	50
1.9 GW	0.5	200

Loss values include worst-case embedded generation loss

Modelling/Simulations Outcomes

- Real risk likely much lower than suggested due to assumptions used
- Storms and high winds are a likelier cause compared to lightning
- Wind generation could deload from overspeed protection before reaching MFRT trigger
- Be cautious on assumptions on rest of GB grid; risk profile might be different in Scotland
- Interconnector settings (so far) are resilient & thus deemed low-risk for MFRT deloading

Additional Reassurance

- 9th August event has led to increased focus on FRT
- ALoMCP at embedded level means significantly reduced risk of low-frequency demand disconnection (local power cuts)
- VSM is on its way: additional inertia & synchronizing torque (voltage stability)
- Compliance testing & modelling processes being modified/enhanced (GC0141)

What Next

Recommendations

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Recommendations (1/3)

- **No modifications at this time**
  - No clarity over “best” settings
  - Not financially worthwhile; gen compliance can assess the data upon connection application & make a call
  - See what RfG2 produces

Recommendations (2/3)

- **Ask wind farms to push settings out**
  - For new connections this could be part of the process early on

- **Further surveys & modelling**
  - Repeat process for NE Scotland
  - Consider periodic repetition of both studies e.g. where wind capacity grows significantly

Recommendations (3/3)

- **Work on improving comms/symbiosis with externals**
  - Should be less “us/them”; common goals

- **Assess new connection requests’ MFRT capabilities against geographical considerations to establish if robust**

- **Retain Eero’s methodology to achieve the above, reviewing periodically so it’s always up to date**

Headlines

- S.Australia had significant grid issues leading to a blackout
- GB way ahead with stability/security
- Thus not a direct comparison
- Chance of it happening here minimal (from MFRT)
- Myriad other reassuring factors
- Code change not recommended
- ESO → Stakeholder/Customer comms need work
- Repeat project for Scotland worth consideration
- Periodic refresh also worth consideration
- In short: risk minimal; more worthy areas of focus currently

Thank You – Questions?

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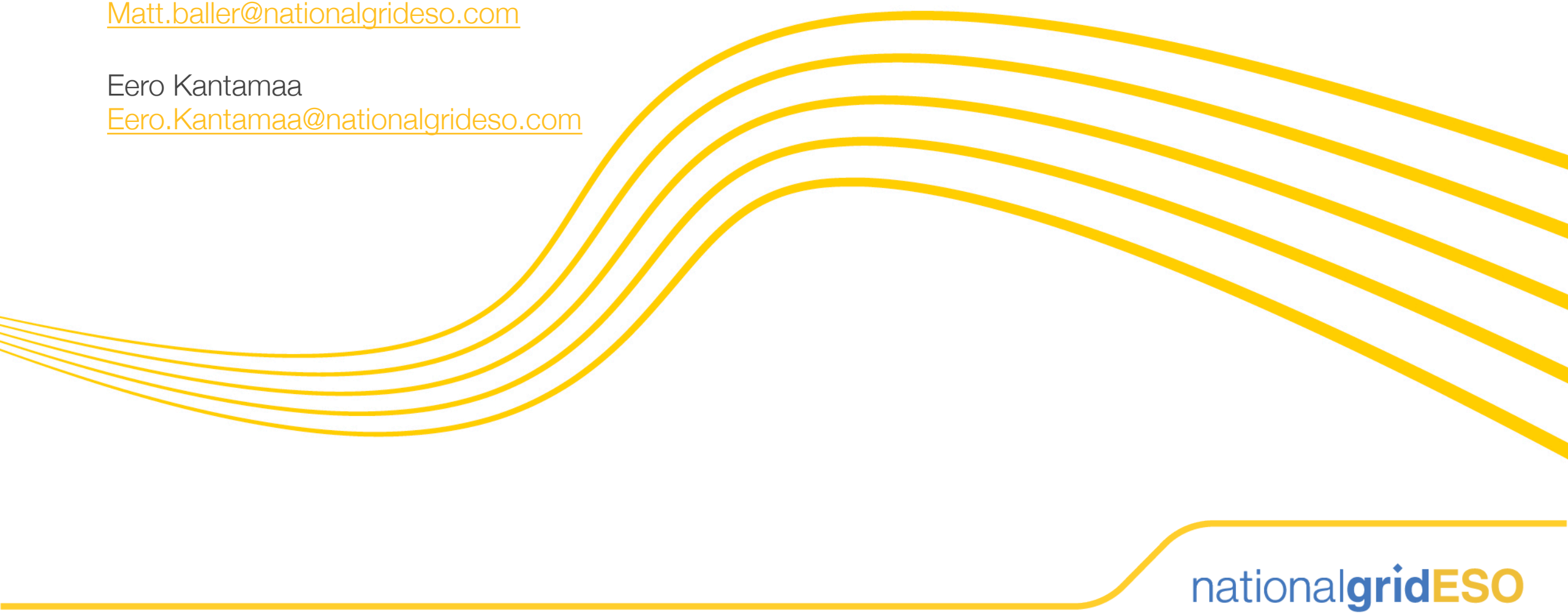

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July 2020 - Grid Code Development Forum

Emergency and Restoration Code – Phase II

Antony Johnson - National Grid ESO

Summary

- Background
- The Issue and Defect
- Articles falling into Phase II of E&R Code
- Related E&R Articles
- Other Considerations
- Distributed Re-Start
- Proposal
- Interested Parties

Background

- In 2019, the ESO submitted its proposed solution to Ofgem for implementation of the European Emergency and Restoration Code
- This comprised of several submissions:-
  - Grid Code Modification GC0125 (EU Code Emergency & Restoration: Black Start testing requirements for Interconnectors) – *Approved – 5th February 2020*
  - Grid Code Modification GC0127 (EU Code Emergency & Restoration: Requirements resulting from System Defence Plan) – *Approved – 5th February 2020*
  - Grid Code Modification GC0128 (GC0128 EU Code Emergency & Restoration: Requirements resulting from System Restoration Plan) *– Approved 5th February 2020*
  - System Defence Plan – *Submitted December 2019 - Awaiting Approval*
  - System Restoration Plan – *Submitted December 2019- Awaiting Approval*
  - Test Plan – *Submitted December 2019 - Awaiting Approval*
  - Terms and Conditions related to Emergency and Restoration EU Network Code
  - Market Suspension Proposals *– Currently subject to Grid Code Modification GC0144*
  - A link to the above documents are available from the attached link:-

https://www.nationalgrideso.com/industry-information/codes/european-network-codes/other-enc-documents

The Issue and Defect

- **The EU Emergency and Restoration Code (Regulation EU 2017/2196) contains two timeframes:-**
  - Requirements to be delivered by 18 December 2019 (*Completed – see previous slides*)
  - Specific Articles defined in the EU Emergency and Restoration Code which have a completion date of 18 December 2022.
- **The purpose of this presentation is to:**
  - Highlight the issues in the EU Emergency and Restoration Code which have a completion date of 18th December 2022 and which need to be implemented in GB to ensure compliance
  - Address outstanding issues identified from Phase I of the implementation of the EU Emergency and Restoration Code
    - Application of the EU Emergency and Restoration Code to Smaller players (eg Non-CUSC Parties)
    - Application of Storage Units switching from import to export during low System Frequencies
    - Interaction with other developments – eg the Distributed Re-Start Work, GC0134 and GC0117
    - Consider what future changes may need to be made to the System Defence Plan, System Restoration Plan and Test Plan noting these three documents are still with Ofgem awaiting approval

Articles falling into Phase II of E&R Code (1)

- **Article 15(5) to 15(8) and Article 41 of the E&R apply from 18th December 2022.**

Article 15(5) to 15(8)

- Design of the Low Frequency Demand Disconnection scheme (LFDD) including the effect of Netted Demand
- The need to consider the effect of Embedded Generation and least load behaviour on the LFDD scheme
- The need to consider time delays, avoidance of tripping generation contributing to system inertia and limit risks which could lead to operation outside security limits
- Conditions to be considered under which netted demand would be integrated as part of the low frequency demand disconnection scheme and whether or not this is appropriate in GB

Articles falling into Phase II of E&R Code (1) continued

Article 41

- Communication resilience, equipment redundancy and backup power supplies for 24 hours required for the Restoration Plan
- Technical requirements for voice communication facilities (agreed with DSO's, SGU's and Restoration Service Providers
- Interaction and dependability of TSO to TSO vice communication Systems
- Ability of SGU's which own and operate Type A and Type B Power Generating Modules to only have data communication facilities instead of voice communication facilities
- The optional use of an additional voice communication system to support the system restoration plan if required.

Articles falling into Phase II of E&R Code (2)

- **Articles 42(1), (2) and (5) of the E&R Code also apply from 18th December 2022.**
  - Art 42 (1), (2) and (5)
    - (1) – Each TSO to make available critical tools and facilities referred to in Art 24 of SOGL (eg monitoring system state, telecommand systems, control room interaction, operational security analysis and communications facilities to facilitate cross border trade) for 24 hours in the case of a primary power loss.
    - (2) – Each DSO, SGU and Restoration Service Providers to make critical tools and facilities (see bullet point 1 above) available for 24 hours in the case of primary power loss.
    - (5) – Substations identified as essential for the restoration plan are required to be operational in the case of primary power loss for 24 hours

Related E&R Articles

- The following articles are related to Articles 15(5) – 15(8), 41, 42(1),(2) and (5) and will require some attention as part of this modification.

- Article 50 – Low frequency demand disconnection issues / review of the System Defence Plan

- Article 48(3) – Test Plan for testing Inter TSO communication facilities – 18 December 2024

- Article 15(9) – Low Frequency Demand Disconnection Scheme – Netted Demand.

Other Considerations

- In addition to the areas of the EU Emergency and Restoration Codes which are required to be implemented by 18 December 2022 there are some other areas of unfinished business from Phase I and more widely which need to be addressed through this work
    - Application of the EU Emergency and Restoration Code to Smaller players (e.g. Non-CUSC Parties)
    - Application of Storage Units switching from import to export during low System Frequencies – The current Grid Code only requires tripping.
    - Interaction with other developments – e.g. the Distributed Re-Start Work, GC0117 (Improving transparency and consistency of access arrangements across GB by the creation of a pan-GB commonality of PGM requirements) and GC0134 (Removing the telephony requirements for small, distributed and aggregated market participants who are active in the Balancing Mechanism)
    - Consider what future changes may need to be made to the System Defence Plan, System Restoration Plan and Test Plan noting these three documents are still with Ofgem awaiting approval

Distributed Re-Start

- The Distributed Re-Start Project is one which recognises that the traditional suppliers of Black Start Services (Transmission Connected Thermal Plant) are becoming increasingly scarce
- The aim of this project is to look at the ability of:-
  - Other providers to provide Black Start Services including Embedded Generators
  - The ability of Distribution Network Operators to restart parts of their network during a Black Start Event using Embedded Generators which offer Restoration services
  - Encourage Smaller participants into the Defence and Restoration arena.
  - Where Non-CUSC Parties are providing such services they would need to be caught under the remit of the EU Emergency and Restoration Code
- In view of the significant synergies and overlap between the Emergency and Restoration Code and Distributed Re-Start Work, it seems appropriate to combine all of the deliverables into one workgroup
- The distributed Re-Start Project is due to run between March 2019 and March 2022

Proposal

- Issue to be discussed at July GCDF
- Present the issues and deliverables to the GCRP – July/August
- Propose that a Grid Code Workgroup should be established under the normal Governance route and to consider the following issues:-
  - Update the GB Framework to include E&R Articles 15(5) – 15(8), Art 41 and Art 42 (1),(2) and (5) and assess the related Articles of 50, 48(3) and 15(9).
  - Consider how Non-CUSC Parties are caught by the requirements of the EU E&R Code
  - Develop requirements for Electricity Storage Modules to transition from import to export during low system frequencies
  - Update the System Defence Plan, System Restoration Plan and Test Plan
  - Consider what changes are required to the GB Industry Codes – e.g. Grid Code (OC5, OC9 and BC2), STC (in particular STCP 06-1) and Distribution Code (DOC9 / G98 / G99)
  - Many of the issues are also relevant to the Distributed Re-Start Project – the ability of embedded Generation and DNO's to participate in a Black Start and System Restoration event. It seems appropriate that this working group would achieve the same objective
  - Be aware of related Work (GC0117, GC0134) and the Open Networks Work

Interested Parties

- Generators (Large, Small and Medium Power Stations)
- Aggregators and Virtual Lead Parties
- Non-CUSC Parties
- Distribution Network Operators
- Transmission Licensees
- Defence and Restoration Service Providers
- The ESO

Code Administrator General Updates

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Dates for your diary

	July	August	September	October
GCDF Submission Date	29/06/2020	27/07/2020	21/08/2020	25/09/2020
GCDF Papers Day	01/07/2020	29/07/2020	25/08/2020	30/09/2020
GCDF	08/07/2020	05/08/2020	02/09/2020	07/10/2020
New Modification Proposal Submission Date	15/07/2020	12/08/2020	09/09/2020	14/10/2020
GCRP Papers Day	22/07/2020	19/08/2020	16/09/2020	21/10/2020
Grid Code Review Panel	30/07/2020	27/08/2020	24/09/2020	29/10/2020

Any Other Business (AOB)

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