DS3 Advisory Council

Crowne Plaza Hotel,

Northwood Park, Santry, Dublin 9, D09 X9X2

16 October 2019

EIRGRID SONI

Agenda - Morning

Topic	Time	Speaker
Introduction & Welcome	09:30	Jon O'Sullivan , EirGrid (10 mins)
Industry Discussion	09:40	Recent UK Incident (Graham Stein) Interconnector operation is influencing curtailment (Noel Cunniffe)
DS3 Discussion	10:45	Wind Statics Curtailment
Rate of Change of Frequency (RoCoF)	11:00	NIEN (David Hill) ESBN (Tony Hearne) TSO
DS3 Programme Status Update (including System Services)	11:30	Control Centre Tools Qualification Trial Process Wider Programme Update Procurement
Priority Dispatch / CEP	12:00	Jon O'Sullivan , EirGrid (10 mins)

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Agenda - Morning

Topic	Time	Speaker
Over Frequency Generation Settings	12:15	Peter Wall
Oscillations	12:30	Peter Wall
EirGrid Group Strategy	12:45	
DS3 +	12:50	
AOB	12:55	All (10 mins)
Closing Remarks and Actions	13:00	Jon O'Sullivan, EirGrid (5 mins)
Session Closed (13:00) followed by Lunch in Upper Foyer		

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Industry Discussion

October 2019

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Wind Integration Week

Graham Stein

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Contents

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Our mission

We enable the transformation to a sustainable energy system and ensure the delivery of reliable affordable energy for all consumers

Success in 2025 looks like:

- An electricity system that can operate carbon free
- A strategy for clean heat, and progress against that plan
- Competition everywhere
- The System Operator is a trusted partner

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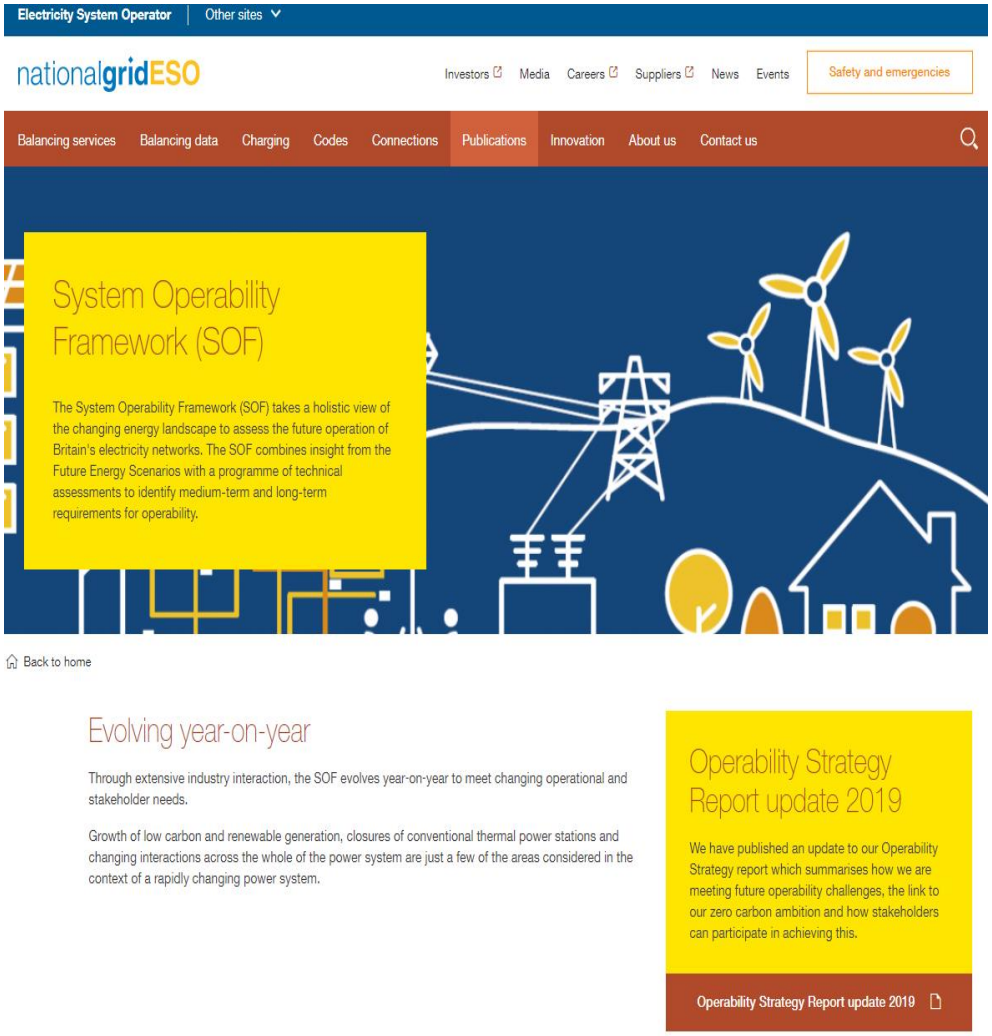
Operability Strategy Report



Topics

- Frequency Control
- Voltage Control
- Restoration
- Stability
- Thermal

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New Stability Support Product

Stability support product description

Transient voltage dip, short circuit level and inertial support.

Immediate post fault response to limit voltage deviation, and contain voltage angle movement.

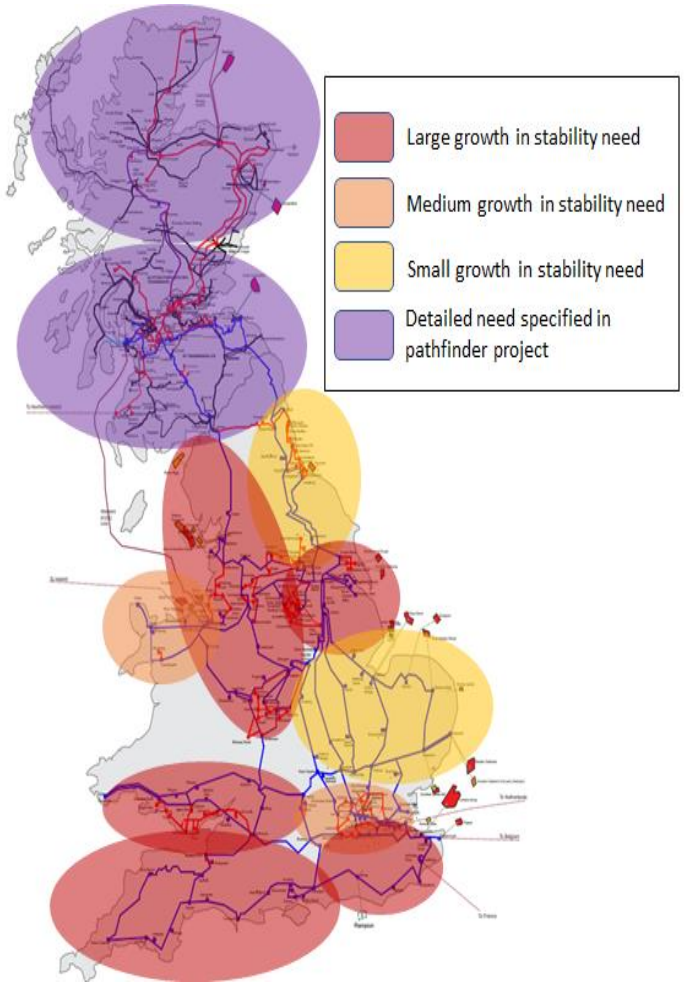
Potential providers are expected to meet the technical specification criteria specified in the Attachment 1 of the stability pathfinder RFI.

Some performance criteria are:

- Short circuit level contribution (MVA) ≥ 1.5 p.u. of MVA available in steady state operation
- Inertia (MVA.s) ≥ 1.5 p.u. of MVA available in steady state operation
- Transient voltage stabilisation and support capability
- Fast fault current injection
- Performance across range of minimum Short Circuit Levels

Areas of Stability Focus

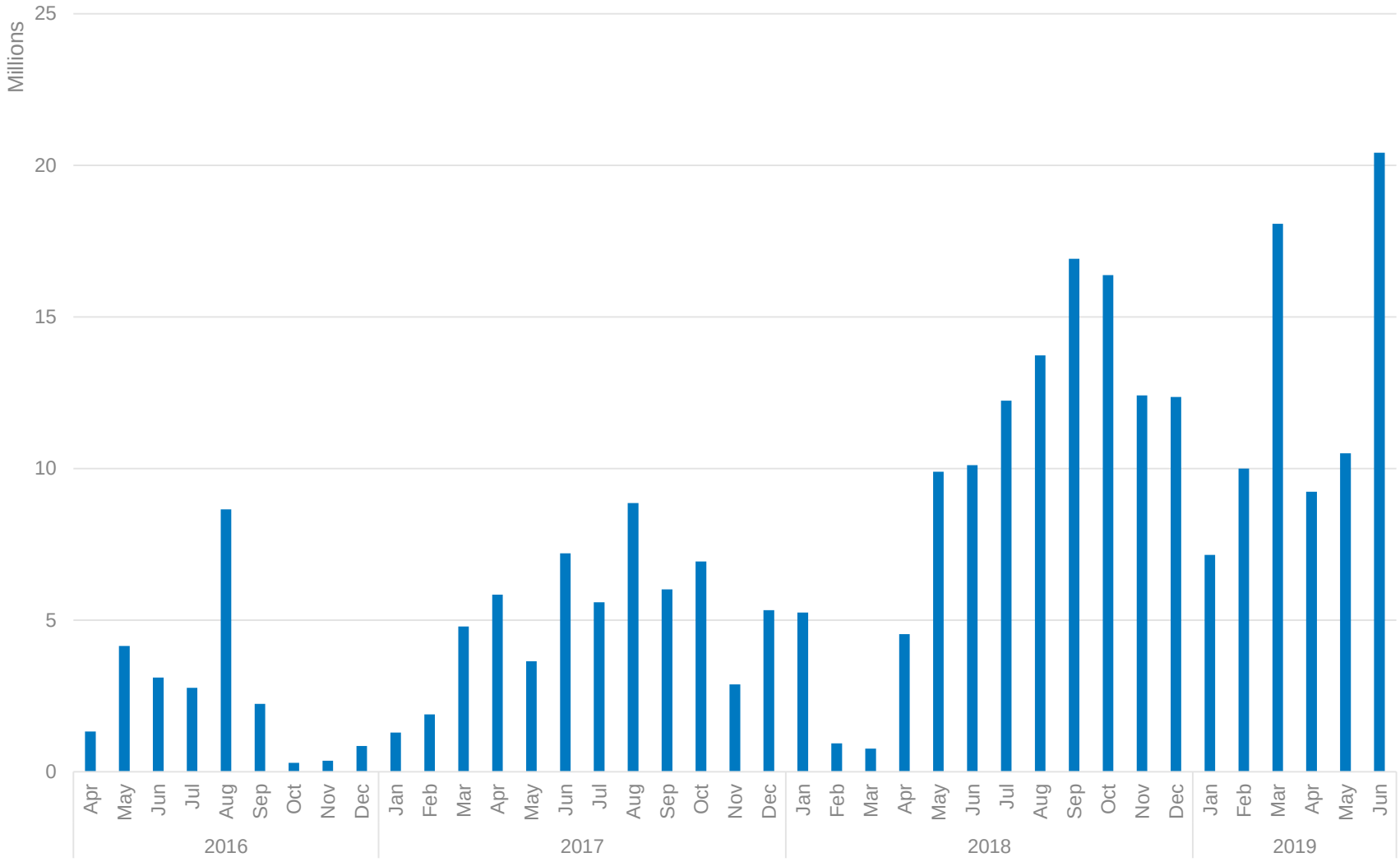
- Our assessment shows that our need for stability products is different across the country.
- High-Voltage pathfinders in Mersey and Pennine are addressing static high voltage requirement which is separate to our stability needs in these areas.
- For Stability Pathfinder, we have carried out detailed assessment of Scotland and high-level assessment of England & Wales (E&W)
  - Scotland solutions are our priority and we set out timeline proposals for these later in this pack.
  - For E&W, we will set out priority areas for solutions based on RFI responses and our needs for stability growth. We will set out next steps for E&W post RFI feedback.



Stability Pathfinder Request for Information (RFI)

- For first webinar, 180 stakeholder signed up
- For second webinar 100 stakeholders signed up
- Webinar slides (including recording of technical webinar) and Q&As are available on our website
- Our RFI feedback closed on 13th September

Loss of Mains



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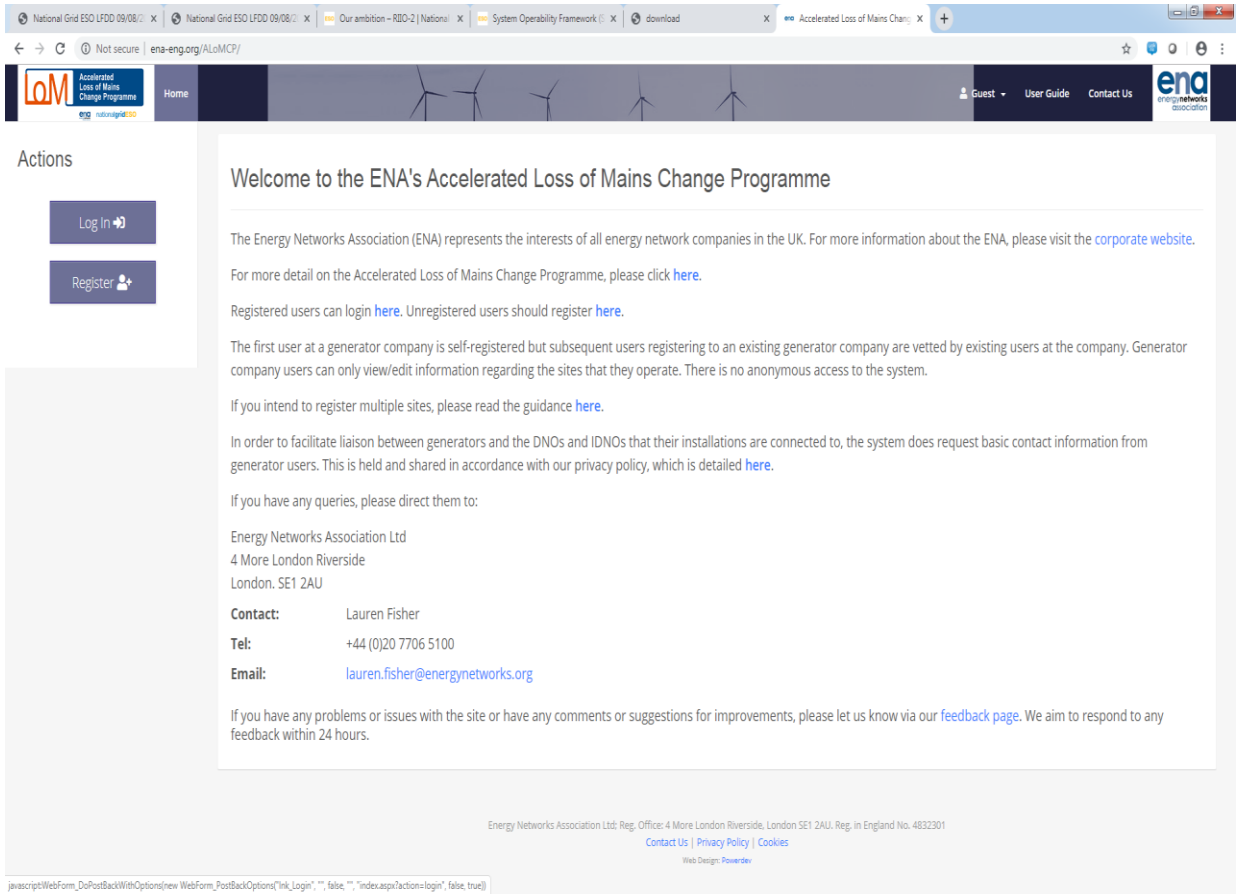
Accelerated Loss of Mains Change Programme

Designed to implement Distribution Code change DC0079

Features include:

- **payments to generators**
- **delivery assurance**
- **stakeholder involvement**



9 August Incident

Technical Report

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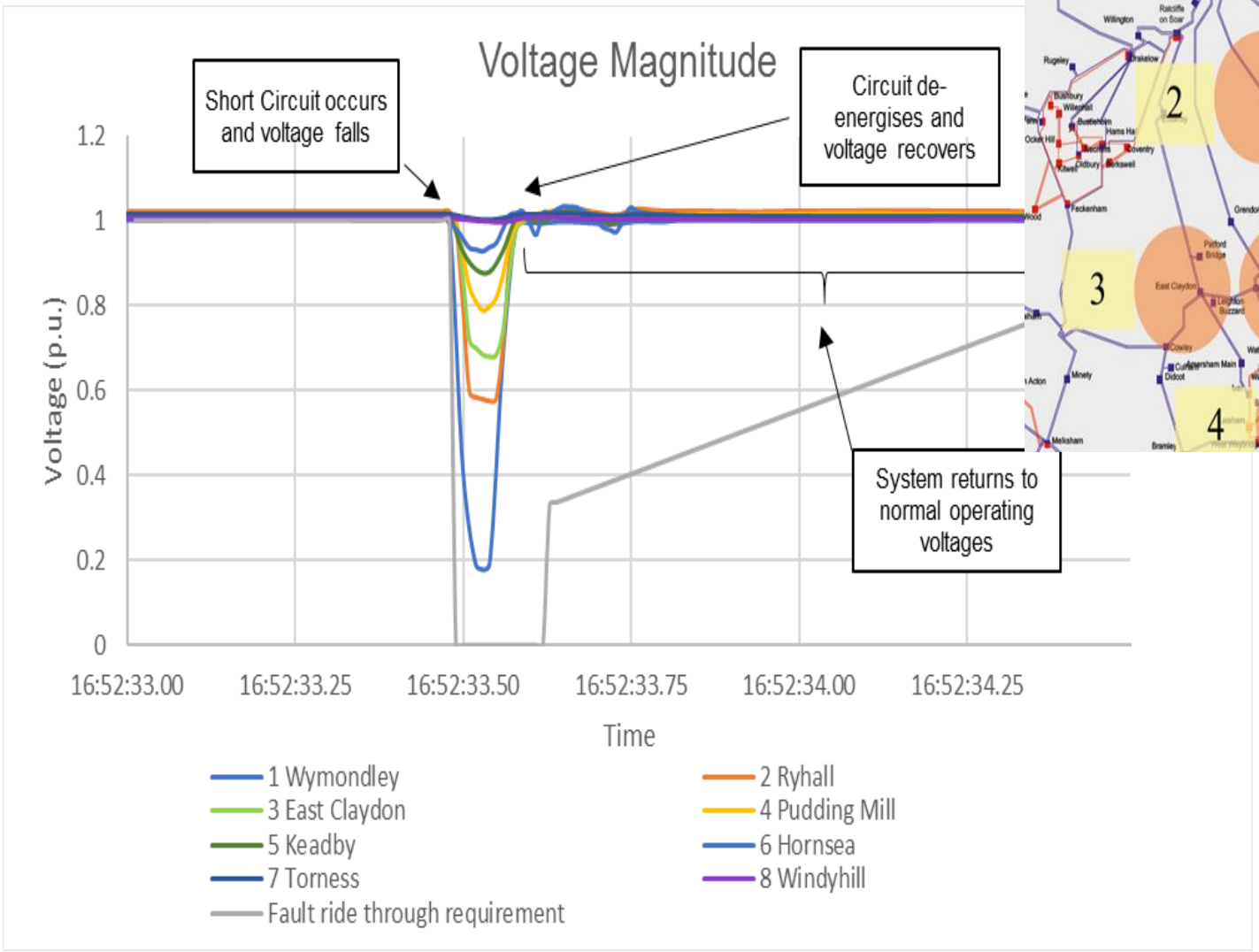

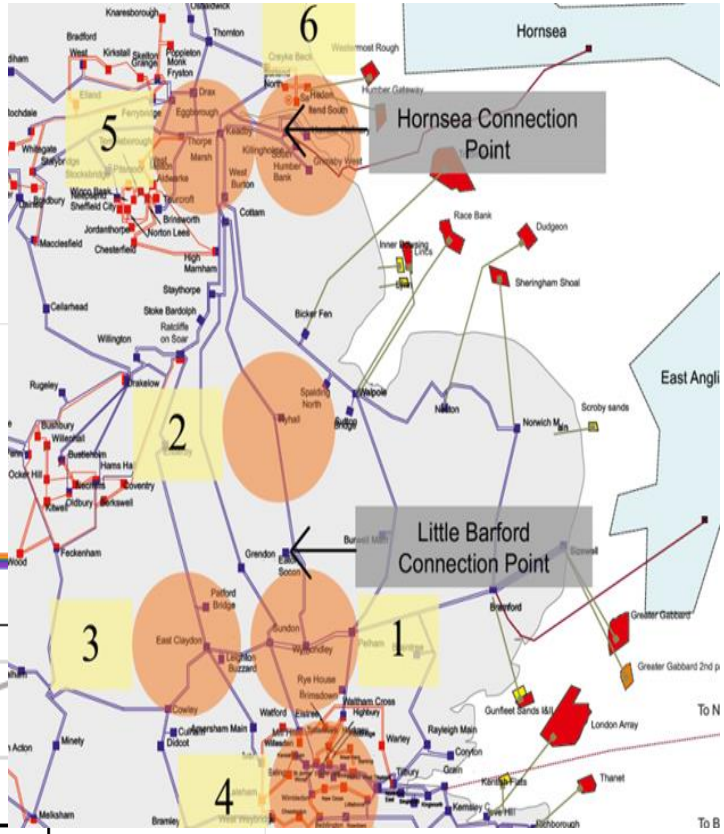

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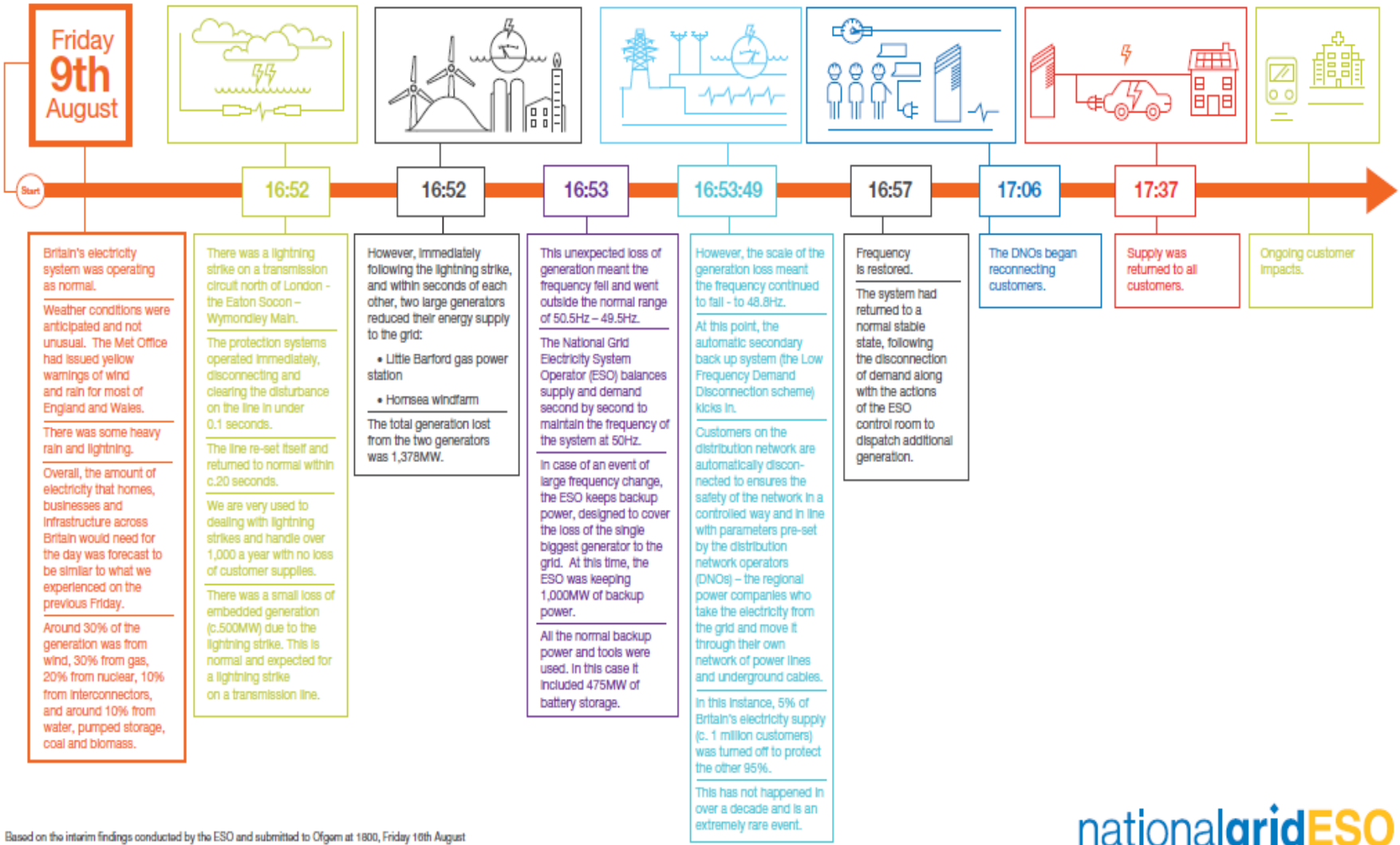
The sequence of events of Friday 9th August 2019



Based on the interim findings conducted by the ESO and submitted to Ofgem at 1800, Friday 16th August

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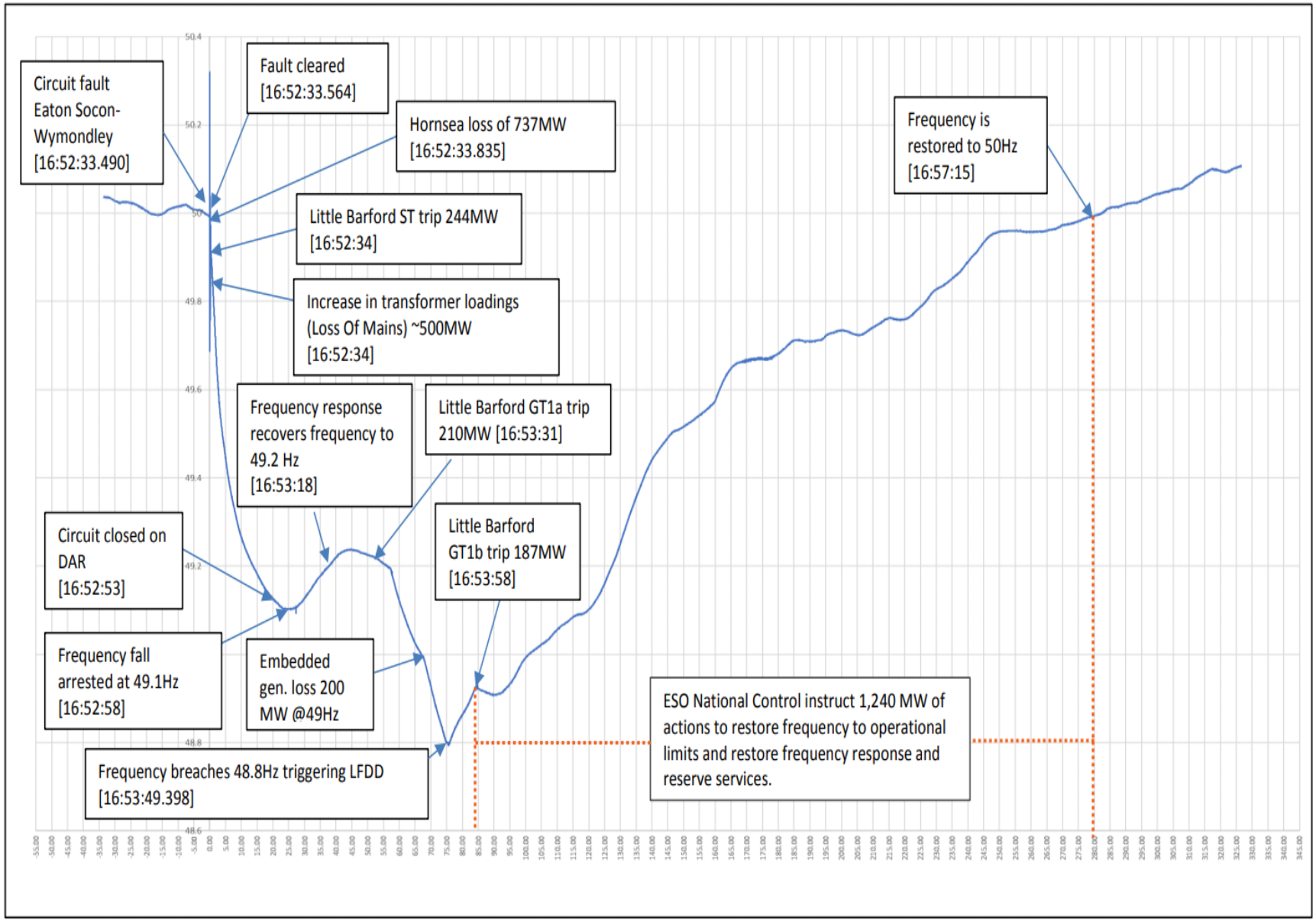
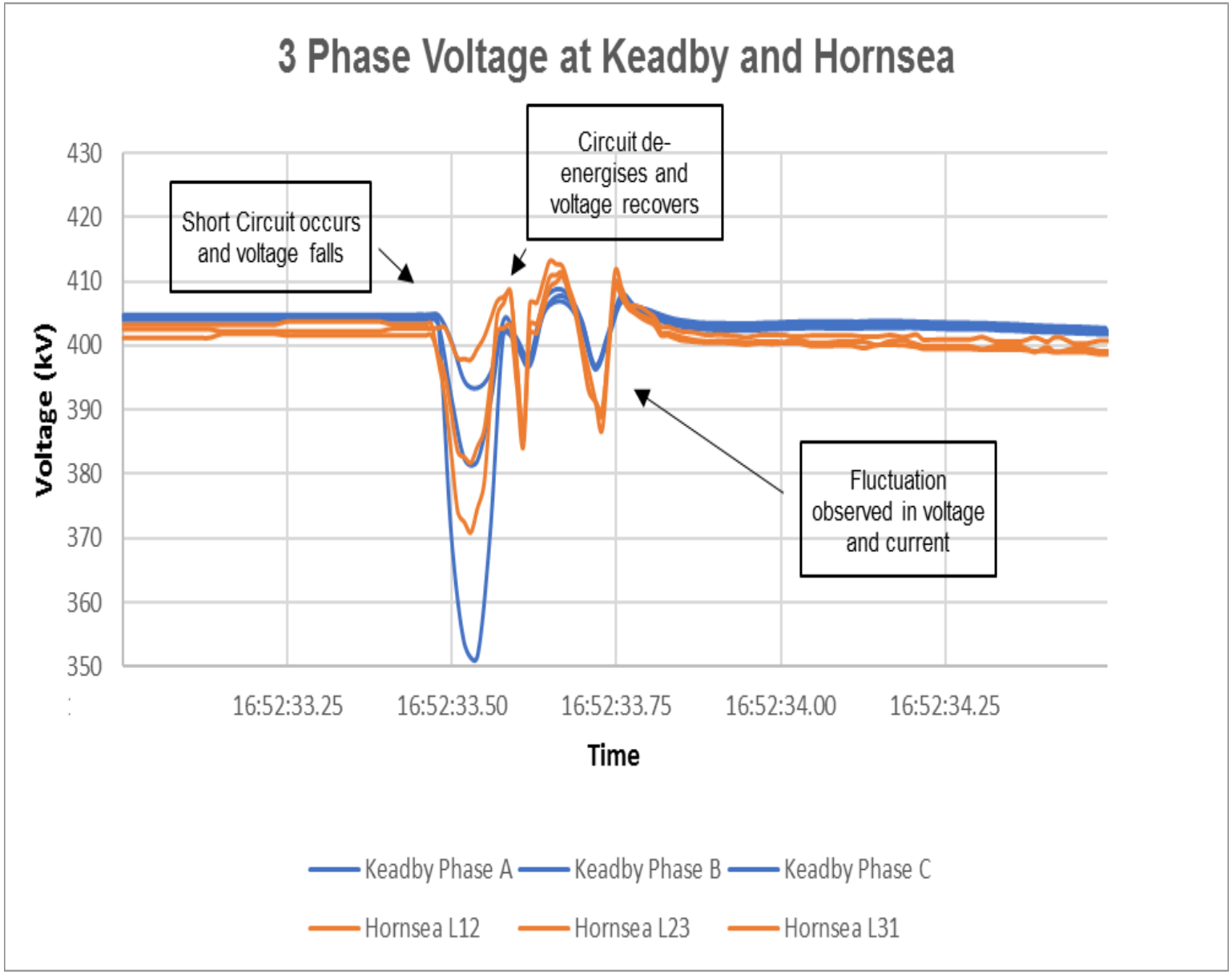
3.4. Impact on Frequency

Figure 2 – Annotated Frequency Trace of the Event





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9 August incident

- Our investigations show that the system responded exactly how we would have expected it to behave

- We made the following recommendations in our technical report:
  - Communication processes and protocols should be reviewed across ESO, DNOs, TOs, Government, Ofgem and media
  - The list of facilities connected to the LFDD scheme should be reviewed
  - The settings on the internal protection systems on electric trains should be reviewed
  - National Grid ESO will be following up with any reserve provider who fell short of their contracted position
  - A wider industry review of the Security Standards needs to take place
  - System standards for critical infrastructure and hospitals should be looked into
  - Timescales for the Accelerated Loss of Mains Change programme should be reviewed

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National Grid ESO, Faraday House, Warwick Technology Park,
Gallows Hill, Warwick, CV346DA

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Irish Wind Energy Association

Interconnector Operation & Curtailment

Noel Cunniffe, Head of Policy

16 October 2019
DS3 Advisory Council

RES Curtailment Events & Interconnector Operation

		2014	2015	2016	2017	2018	Q1 2019	Q2 2019	2014 to Q2 2019
Curtailment Events	Curtailment Events(nr.)	137	119	87	103	112	48	19	625
	EWIC Avg Net (MW)	190	-1	-64	-271	-191	-357	-202	-87
	EWIC Avg Net (%)	36%	0%	-12%	-51%	-36%	-67%	-38%	-16%
	Moyle Avg Net (MW)	99	-46	-127	-186	-50	-71	-107	-65
	Moyle Avg Net (%)	40%	-18%	-42%	-62%	-17%	-24%	-21%	-23%
All Periods	EWIC Absolute Avg (Day) (MW)	376	213	14	-18	30	-41	7	110
	EWIC Absolute Avg (Night) (MW)	78	-24	-15	-171	-146	-52	-125	-59
	Moyle Absolute Avg (Day) (MW)	154	61	-11	41	138	122	88	79
	Moyle Absolute Avg (Night) (MW)	50	-92	-59	-76	23	107	10	-23

Notes:

Positive figures represents imports, negative figures represent exports

EWIC Out of Service: 2014 = 43 days, 2015 = 14 days, 2016 = 109 days, 2017 = 53 days, 2018 = 49 days, 2019 = 12 days

Moyle Out of Service: 2014 = 65 days, 2015 = 2 days, 2016 = 46 days, 2019 = 9 days

- Review of interconnector activity during curtailment events indicates that generally exports increased over 5-year period
- Noted that SO countertrading had ceased at the start of I-SEM but increased recently
- Still potential for greater exporting on existing interconnectors during curtailment events
- Uncertainty on future export capacity of Moyle interconnector

IWEA
Irish Wind Energy Association

Source: MullanGrid analysis for IWEA Dispatch Down Working Group

Interconnector Operation during Curtailment post I-SEM

		Oct-18	Nov-18	Dec-18	Jan-19	Feb-19	Mar-19	Apr-19	May-19	Jun-19	Oct - Jun
Curtailment Events	Curtailment Events(nr.)	6	15	19	9	23	16	7	6	6	107
	EWIC Avg Net (MW)	-273	-218	-180	-411	-290	-368	-108	-92	-406	-261
	EWIC Avg Net (%)	-52%	-41%	-34%	-1	-1	-1	0	0	-1	-49%
	Moyle Avg Net (MW)	-30	-54	18	-96	-89	-29	-72	-117	-133	-67
	Moyle Avg Net (%)	-10%	-18%	6%	-19%	-18%	-6%	-14%	-23%	-27%	-25%

Positive figures represent imports, Negative figures represent exports

EWIC Capacity=530MW

Moyle Capacity=300MW(2018),500MW(2019)

- Issues with Moyle operation during Constraint events

		Oct-18	Nov-18	Dec-18	Jan-19	Feb-19	Mar-19	Apr-19	May-19	Jun-19	Oct - Jun
Constraint Events	Constraint Events (nr.)	12	15	13	6	10	13	12	7	3	91
	Moyle Avg Net (MW)	200	-23	294	378	160	178	284	19	9	167
	Moyle Avg Net (%)	67%	-8%	98%	76%	32%	36%	57%	4%	2%	33%
Curtailment Events	Curtailment Events (nr.)	6	15	19	9	23	16	7	6	6	107
	Moyle Avg Net (MW)	-30	-54	18	-96	-89	-29	-72	-117	-133	-67
	Moyle Avg Net (%)	-10%	-18%	6%	-19%	-18%	-6%	-14%	-23%	-27%	-25%

Positive figures represent imports, Negative figures represent exports

EWIC Capacity=530MW

Moyle Capacity=300MW(2018),500MW(2019)

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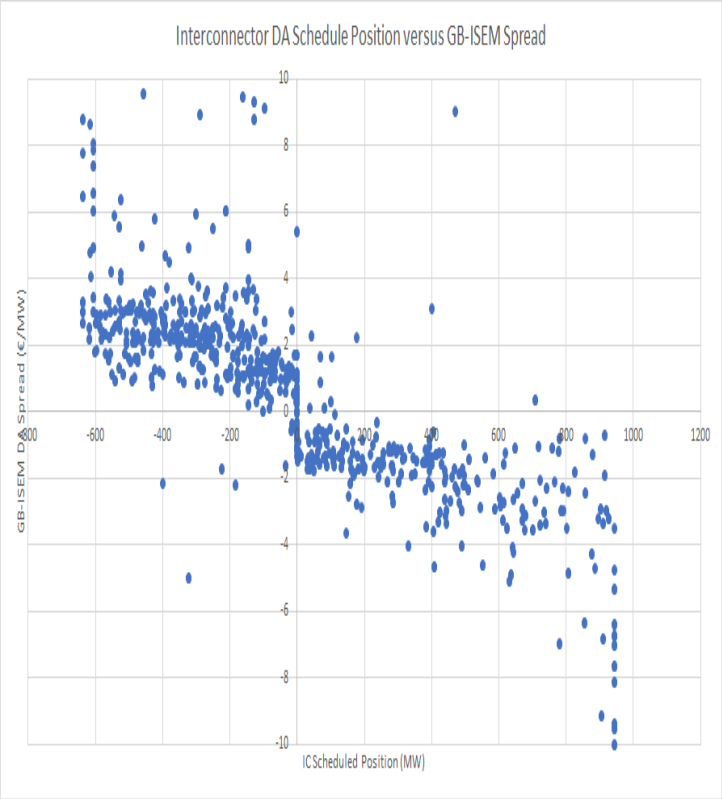
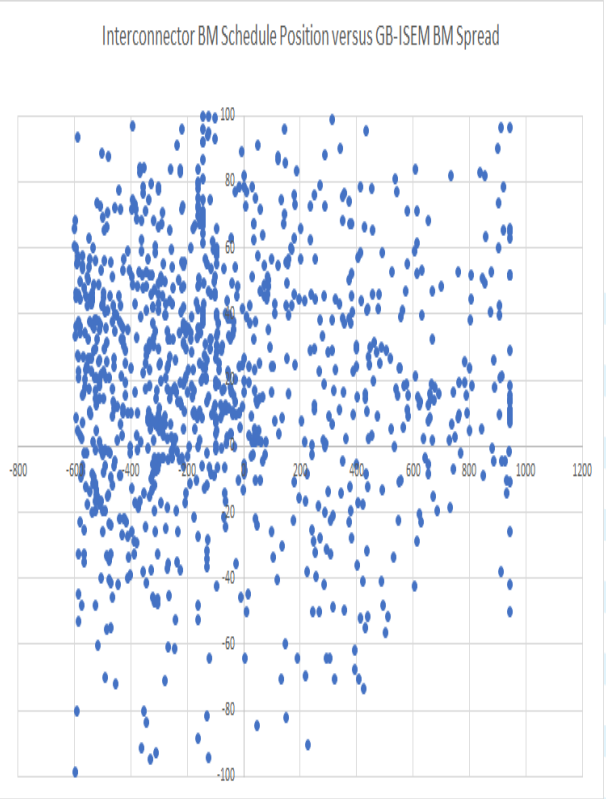
Source: MullanGrid analysis for IWEA Dispatch Down Working Group

Interconnector Operation in I-SEM

1st – 30th August shows interconnector scheduled to flow in the opposite direction to price signal in the Balancing Market

45% of the time during curtailment events





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Interconnector Operation in I-SEM – How to improve?

- There are a number of potential policy fixes to improve this alignment and reduce curtailment

Long Term Solution

- Integrate SEM closer with the GB market – 3 possible methods:
    a. Introduce XBID as soon as possible – XBID is the European Commission's target model for facilitating cross border trading in the intra-day markets - it will help renewable penetration as it facilitates the movement of the interconnectors scheduled flow up to 1 hour before real-time

    b. Move IDA2 market closer to real-time – allows use of more accurate weather forecasts and result in a more efficient market schedule

    c. Couple IDA3 with GB using the Euphemia algorithm – IDA3 currently not coupled with GB meaning that the periods of the trading day from 5pm to 10:55pm are last coupled at 8am, 9-14 hours beforehand - coupling allows for improved forecasting and more efficient market operation

Short Term Solution

- EirGrid carries out increased SO to SO trades to minimise renewable curtailment

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The benefits are clear

- Removing barriers to renewables across all sectors will reduce future consumer costs to 2030
- Cheaper auction bids as a result of lower curtailment forecasts
- Important to address these concerns now before further interconnection this decade
- May become a bigger issue in a post-Brexit world – in a 'no deal' scenario Day-Ahead Market Coupling with GB ceases

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DS3 Discussion

October 2019

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Wind Generation (Jan – September 2019)

- Wind Generation accounted for **32%** of All-Island system demand, a record **47%** of demand was provided by wind in February,
- At times, wind generation provided up to **84%** of All island demand with the maximum output of **3872** MW in April. With an average of **1,289 MW** across January to September 2019,
- The Power System was operated above 50% SNSP for **21%** of the time and between 25% and 50% for **50%** of the time, an increase of 10% from 2018.
- In 2019, 1GWh of additional wind energy was generated compared to the same reporting period in 2018. This is expected to increase in the Q4 of 2019.

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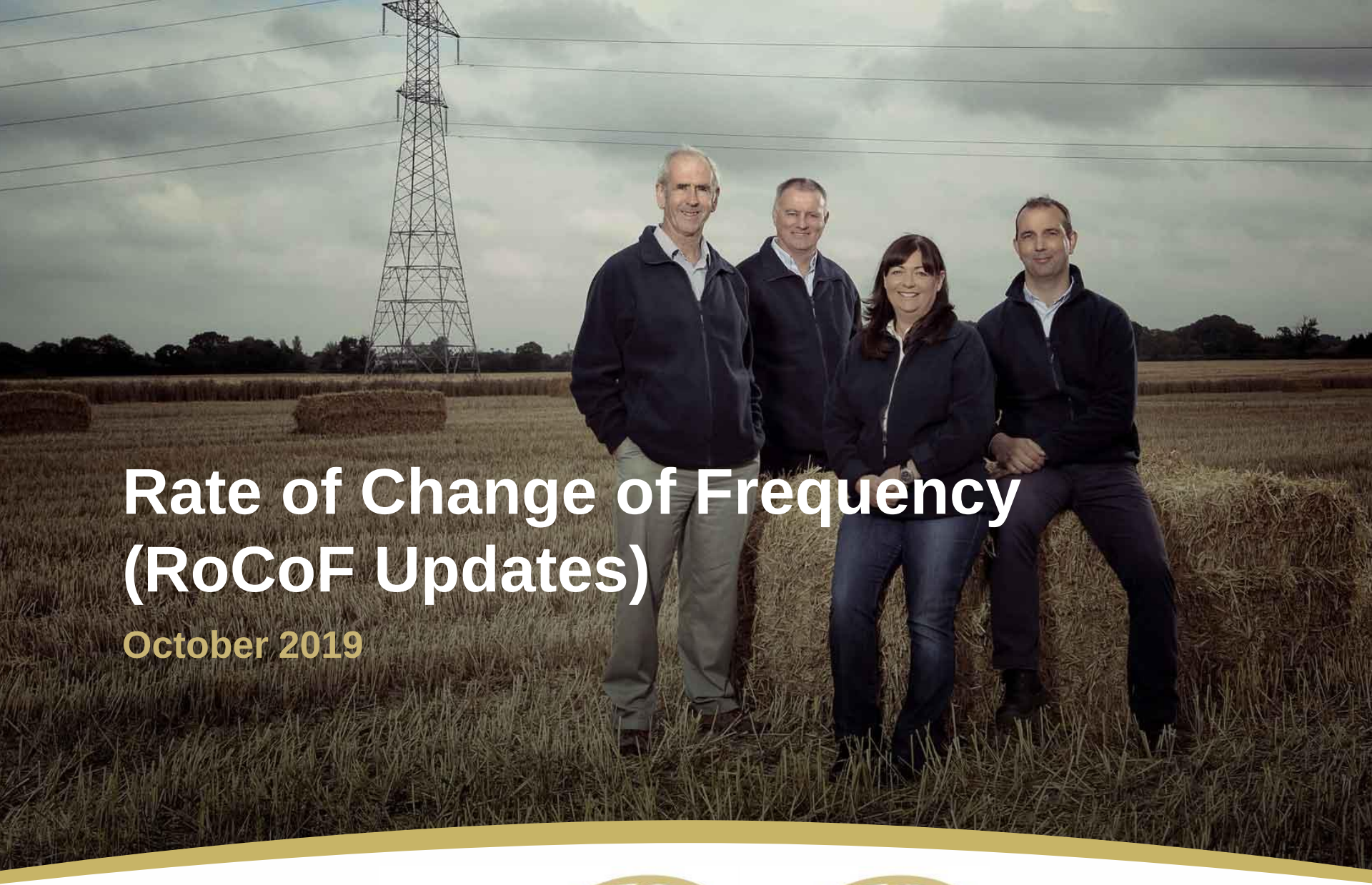

Rate of Change of Frequency (RoCoF Updates)

October 2019

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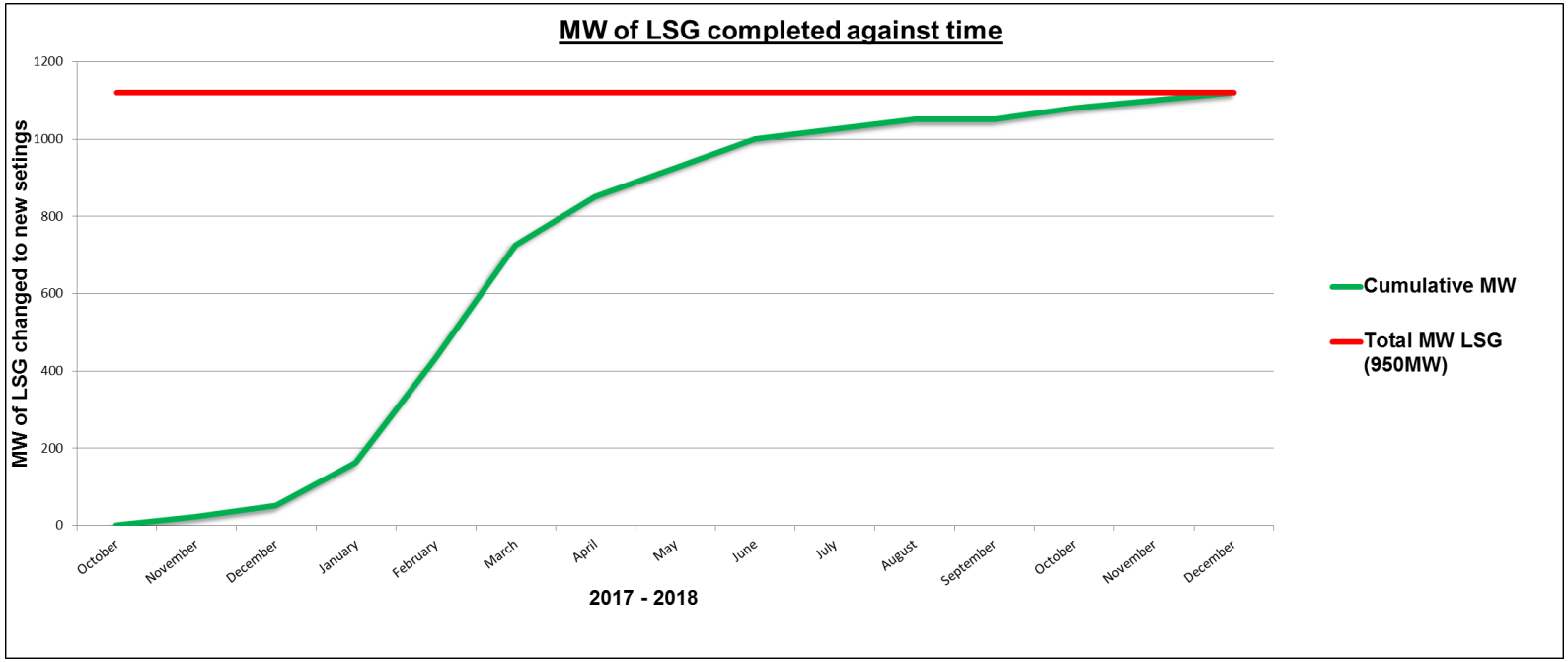
ROCOF IMPLEMENTATION PROGRAMME

DS3 Advisory Council Update 16/10/19

David Hill

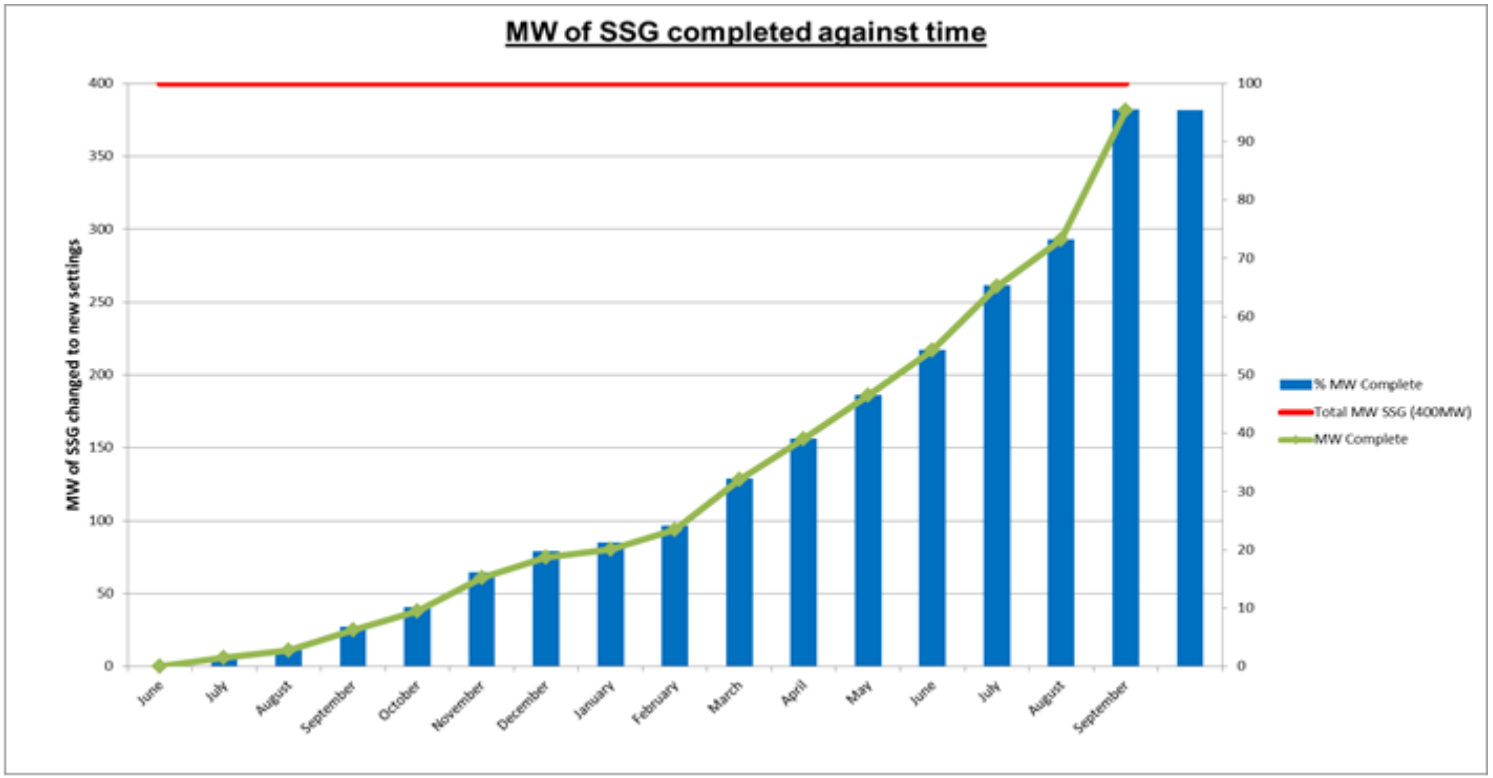
LSG RoCoF – Complete

- All LSG sites >5MW have been changed to new RoCoF setting
- 1120 MW changed to 1Hz/s RoCoF setting (including new LSG's connected during the programme)



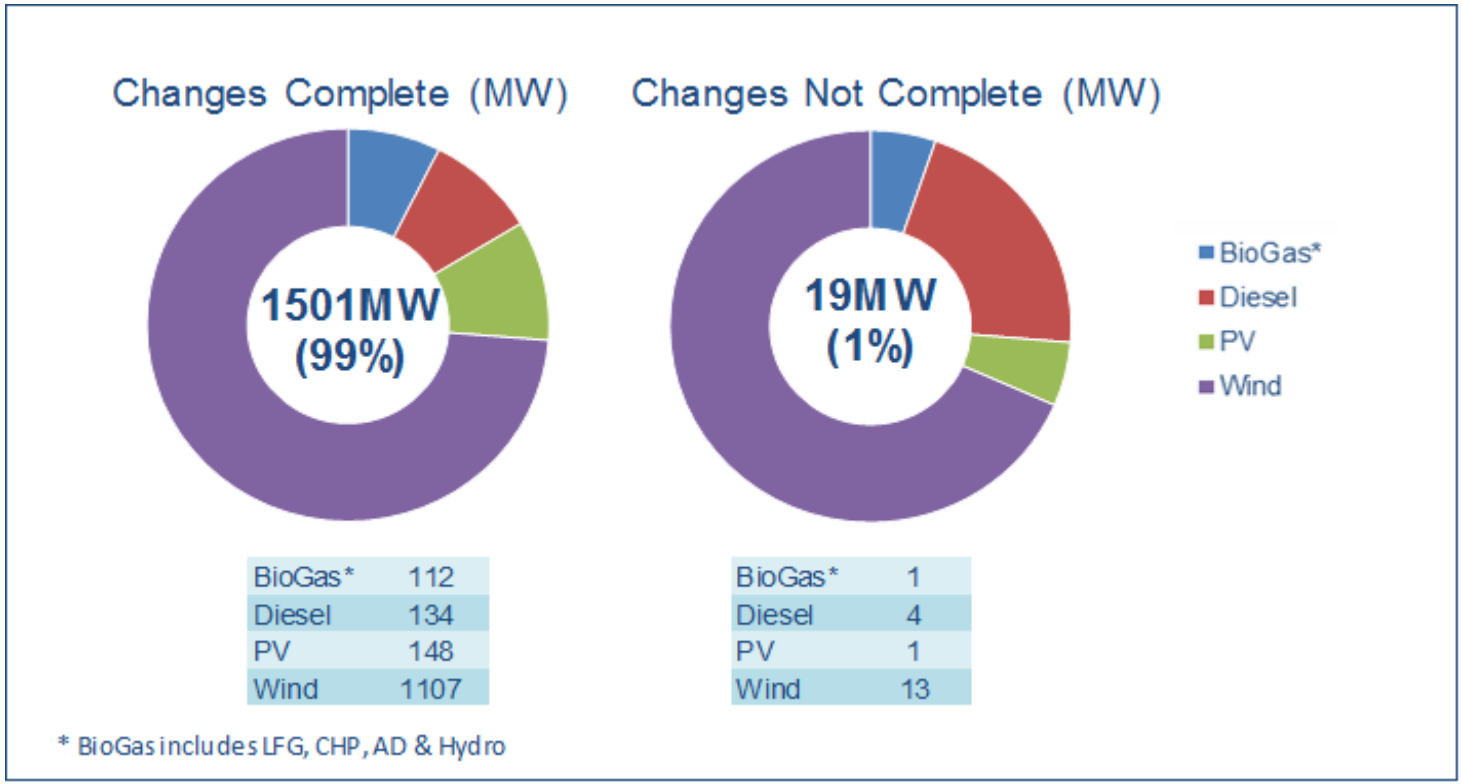
SSG RoCoF – Current Status

- 1221 SSG's (87%) have been changed to new RoCoF setting
- 381 MW (95%) SSG now changed to 1Hz/s RoCoF setting



Total RoCoF (LSG & SSG) – Current Status

- 1289 Generators (88%) have been changed to new RoCoF setting
- 1501 MW (99%) Generators now changed to 1Hz/s RoCoF setting



BioGas*	112
Diesel	134
PV	148
Wind	1107

BioGas*	1
Diesel	4
PV	1
Wind	13

* BioGas includes LFG, CHP, AD & Hydro

ROCOF Implementation Programme

DS3 Advisory Group meeting 16/10/19

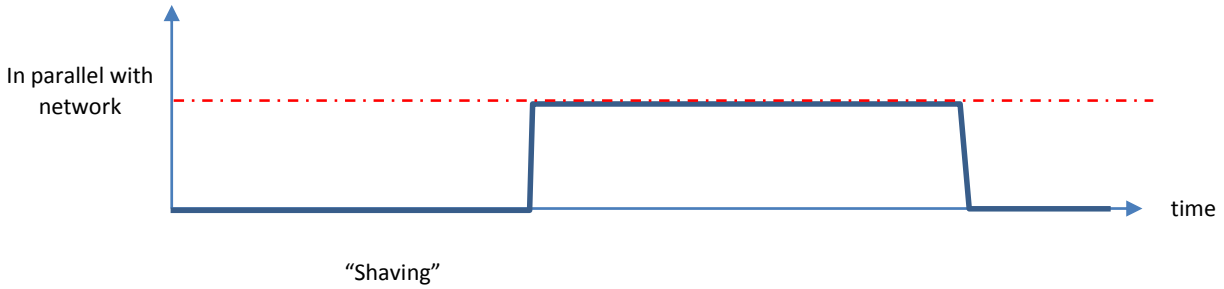
Tony Hearne

TSO-DSO Interface Manager

Non-wind, Non-exporting: High vs low risk

High Risk:

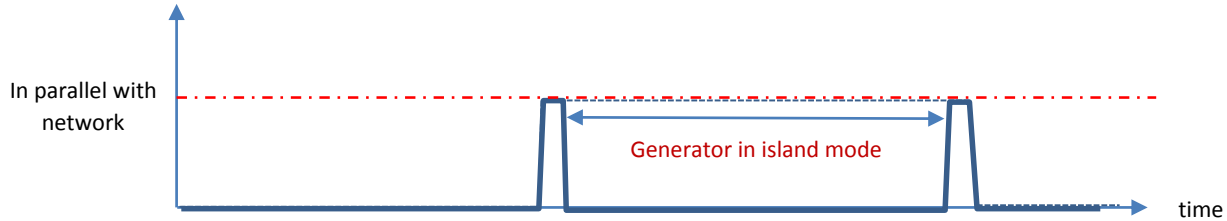
- High likelihood of running
- Operating in “shaving” mode ie operates in parallel for entire duration of running



“Shaving”

Low Risk

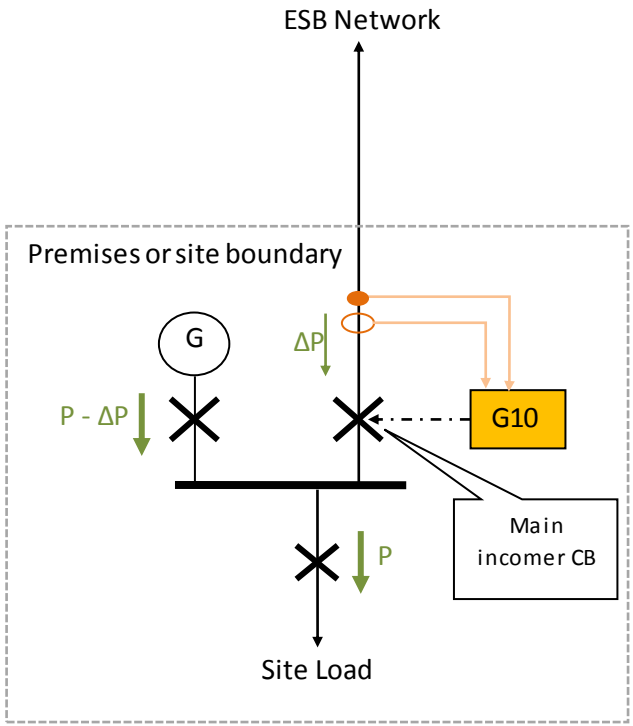
- Lower likelihood of running
- Operating in “lopping” mode ie only operates in parallel for some minutes when going into and out of island mode



“Lopping”

Emergence of “Trickle Feed” sites

- During engagements with Non-wind , Non-exporting Generators, the occurrence of a particular kind of site – setup, was encountered.
- Where this arrangement exists, the generator can take the whole site load and could go into island mode but instead, they choose to keep a small trickle import (typically ~30KW).
- Also, crucially, the Main Incomer CB opens.
- From ESBN perspective, this makes detection of a genuine local island more difficult – hence a tendency to leave legacy ROCOF settings in place
- From EirGrid perspective, system impact of CB opens is quite benign, with a loss of demand load of the trickle only.
- Where confirmed, these sites were deemed to be completed



Outcome Nov 2018

All Wind Completed [MW]
1266

All new wind connections since 2016, with RoCoF compliant settings

Non-wind, Non-exporting	Continuous and duration paralleling [MW] [High Risk]	Total complete[1]	Incomplete as of June 2019
MW	421.9	342.9	79
%	100	81.2	19.8

Status of High Risk Non-wind, Non-exporting

	Settings Changed [MW]	Confirmed as Trickle feed topology [MW]	Sub-total [MW]
Diesel	56	79.8	135.8
CHP	151.3	5.2	156.5
LFG	26.3	0	26.3
W2E	23.5	0	23.5
Biogas	0	0	0
Hydro	0.8	0	0.8
Sub-total [MW]	257.9	85	
		Total [MW]	342.9

	Uncompleted as of June 2019	
	MW	No of units
Diesel	54	28
CHP	16.3	16
LFG	5.1	6
Biogas	0.27	2
Hydro	3.5	8
Total [MW]	79	60

Questions?

RoCoF Status – October 2019

Physical Changes	• Physical and Software changes • Wind, Conventional, Small Scale , Micro • Network Protection , Unit Protection and Withstand Capability
Validation	• TSO evaluation of Physical changes and Risk assessment to progress to Trial • Based on Units/DSO responses to TSO questions
Trial	• Entry Criteria e.g. no more than 70MW non compliant • 2 phase trial • Ramping tool needed for 2nd Phase • Successful trial, results in new Operational standard for 1Hz RoCoF

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RoCoF Status – October 2019

TOTAL (approx. 11,686 MW)

10823 MW (92%) complete

Conventional Generation (8,638MW total)

7877 MW (91%) complete

- 3 NI Units (761MW) have not completed testing
- IR All Units complete RoCoF Process

IR: 6,811MW/6,811 MW complete (100%)
NI: 1066/1,827MW complete (58%)

Wind (2,223 MW total)

2,223 MW (100%) complete

- Roll-out completed in both jurisdictions as of January 2019

IR: 1,266/1,266 MW complete (100%)
NI: 957/957 MW complete (100%)

Small-scale/embedded (approx. 821 MW total)

723 MW (88%) complete

- IE 342/421MW Complete (79 MW remaining) 81% Complete
- NI 381/400MW Complete (19 MW remaining) 95% Complete

IR: 342/421 MW 81% Complete
NI: 381/400 MW 95% complete

RoCoF 1Hz/s

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RoCoF Programme Impacts

- RoCoF trial planned for Oct 2019 start can not take place.
- Revised Plan proposes a 6 month delay to RoCoF trial – now start (April 2020)
- Delay due to level of non-compliance at this stage across NI gen and DSOs.

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DS3 Programme Update

October 2019

Ian Connaughton

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DS3 Control Centre Tools

October 2019

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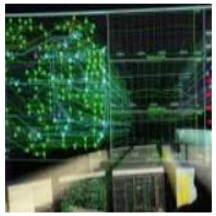
DS3 Control Centre Tools Overview



Design, procure & deliver enhanced capability to the Control Centres

Fully capitalised, approved by both RA, will increment opex in FY2020

Collaborate with external vendors to deliver, supported by internal business partners

Key pillar of DS3 project & essential to increasing SNSP

Key Deliverables

Ramping Margin Tool
Enhanced Frequency Control

Look-Ahead Stability Assessment Tool
Enhanced Stability Analysis

Voltage Trajectory Tool
Enhanced Voltage Control

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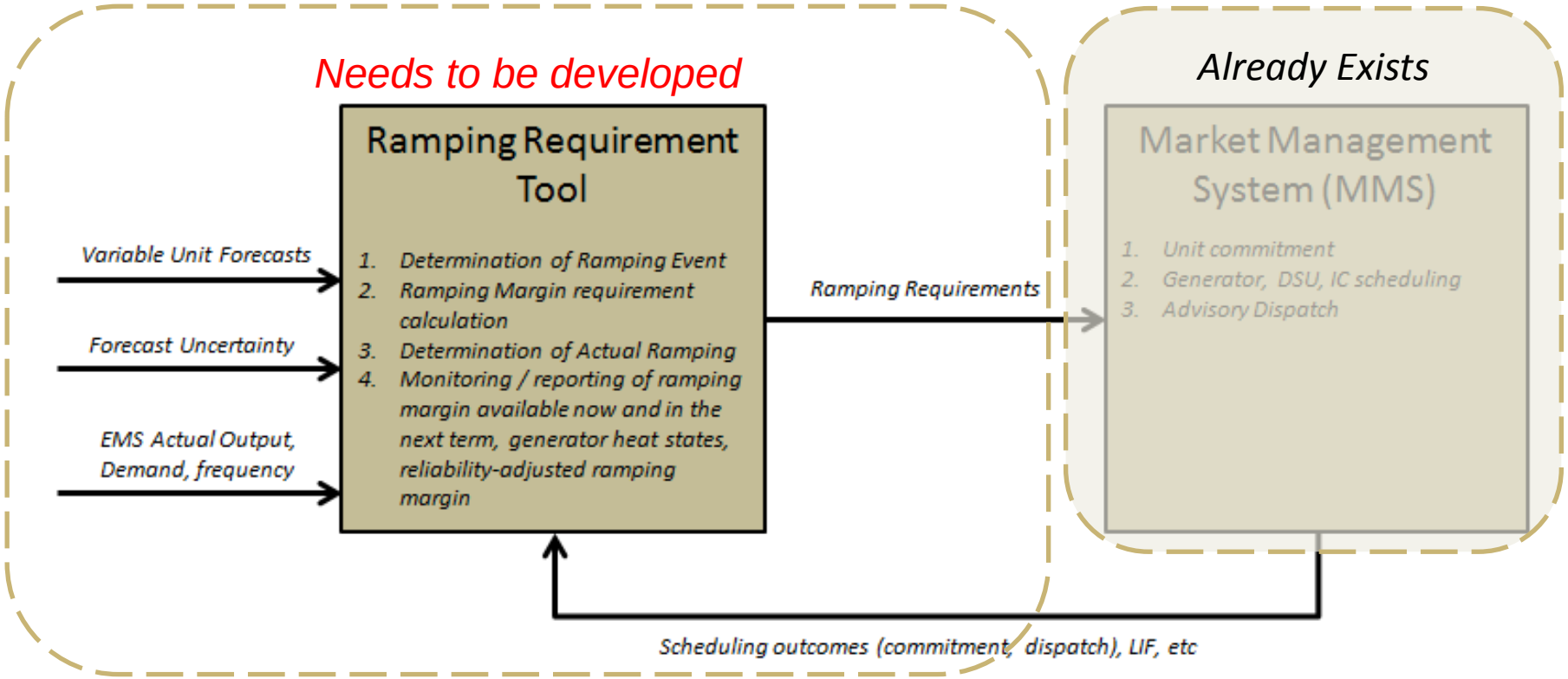
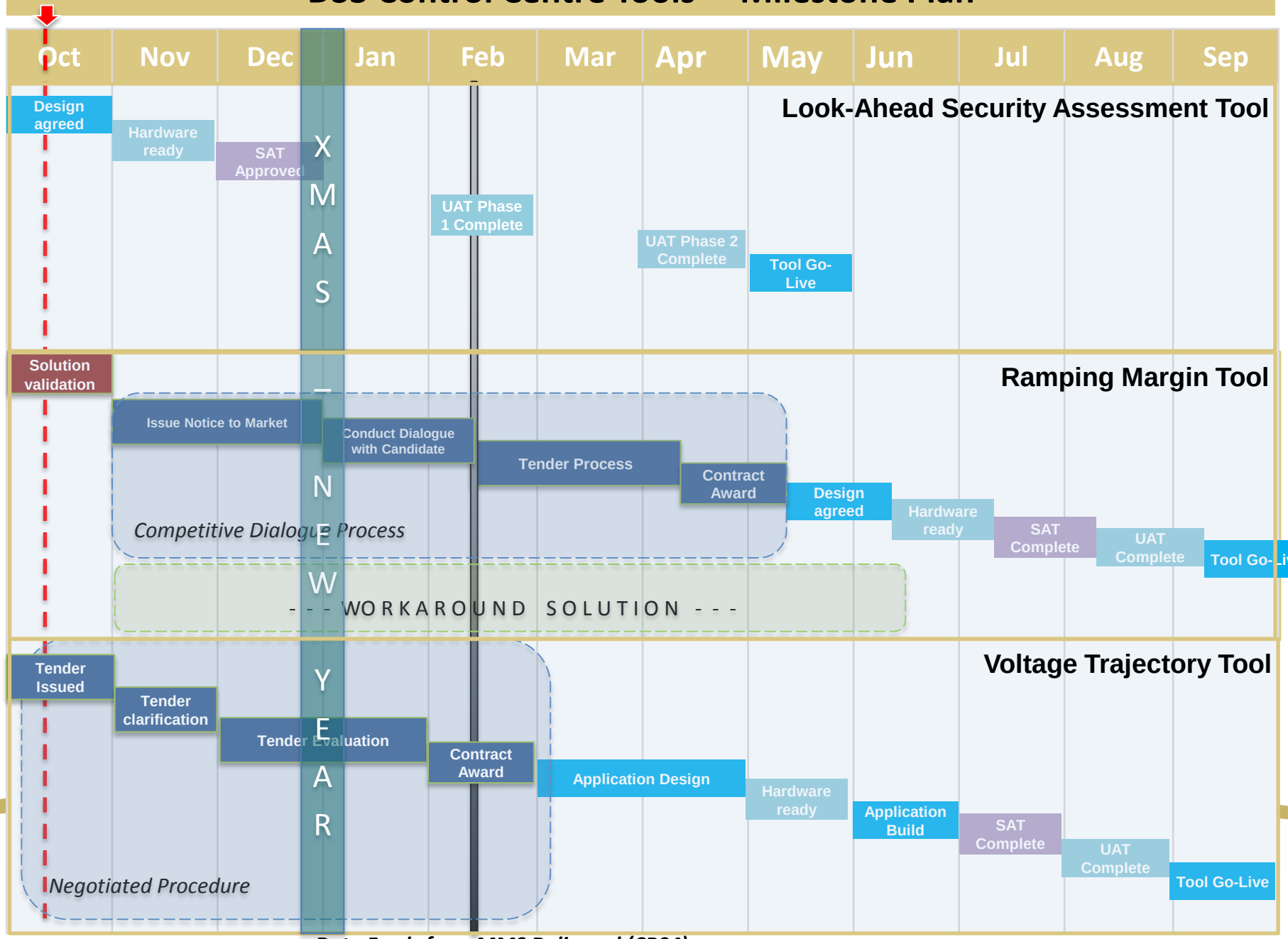
Ramping Margin Tool - Overview



DS3 Control Centre Tools – Milestone Plan



Data Feeds from MMS Delivered (CR94)

LSAT Status –Project Mobilisation

- LSAT notification of success sent to Vendor on 3rd October
- Standstill from 4th October to 18th October – legal documents ready to be sent
- Project Mobilisation commences 18th October…

Date	Milestone
Oct-19	Project Kick Off Scope of Work signed off
Nov-19	Infrastructure ready
Dec-19	SAT approved
Jan-20	
Feb-20	Phase 1 UAT
Mar-20	
Apr-20	Phase 2 UAT
May-20	Tool Go-Live

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Voltage Trajectory Tool - Status

- Two Vendors were qualified in the PQQ stage - next step is to complete the tender request
- Tender preparation underway with expected submission End October, which would allow for contract award in Feb 2020
- Planned Go-Live September 2020

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DS3 Task Plan

Task	2019 Q3	2019 Q4	2020 Q1	2020 Q2	2020 Q3	2020 Q4
Studies		Phase B RoCoF Studies	70% SNSP lower inertia limit study	Reserve studies		75% lower inertia study with reserves
Policies	Cat 1&2 Gen Studies	**RoCoF -> 1 Hz/s**	1 Hz/s Min sets: 7 17,500 MW.s	Reserve Policy FFR New Tech Dispatch Policy	Revised FFR, POR policies Min sets: 6?	Voltage control Policy
Control Centre Tools	Studies 5 min WSAT SS Tools FFR monitor	Robust WSAT	**Look Ahead SAT Ramping**	**Scheduling Reserves Wind/DSM/Inter**		Voltage Trajectory
Perf.	Interim OFGS	New Tech. Trials LoM settings	Enduring OFGS	Renewables Variation	Reserves from New Tech	
Capability	**RoCoF changed**	New FFR			DRR FFAPR	

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Future Operational Metrics

	2020 Q1	2020 Q2	2020 Q3	2020 Q4	2021 Q1	2021 Q2
SNSP	65%	65%	65%	70%	70%	75%
RoCoF	0.5 Hz/s	0.5 -> 1 Hz/s	0.5 -> 1 Hz/s	1 Hz/s	1 Hz/s	1 Hz/s
Inertia	23,000 MW.s	23,000 MW.s	20,000 MW.s	20,000 MW.s	17,500 MW.s	17,500 MW.s
Min Sets	8	8	8 *	8 *	7 *	7*
Ramping			In the Control Centre	In the Control Centre	In the Control Centre	In the Control Centre
Reserve	POR: 75% FFR: 47%	POR: 75% FFR: 47%	Updated reserve policy implemented in Control Centre			

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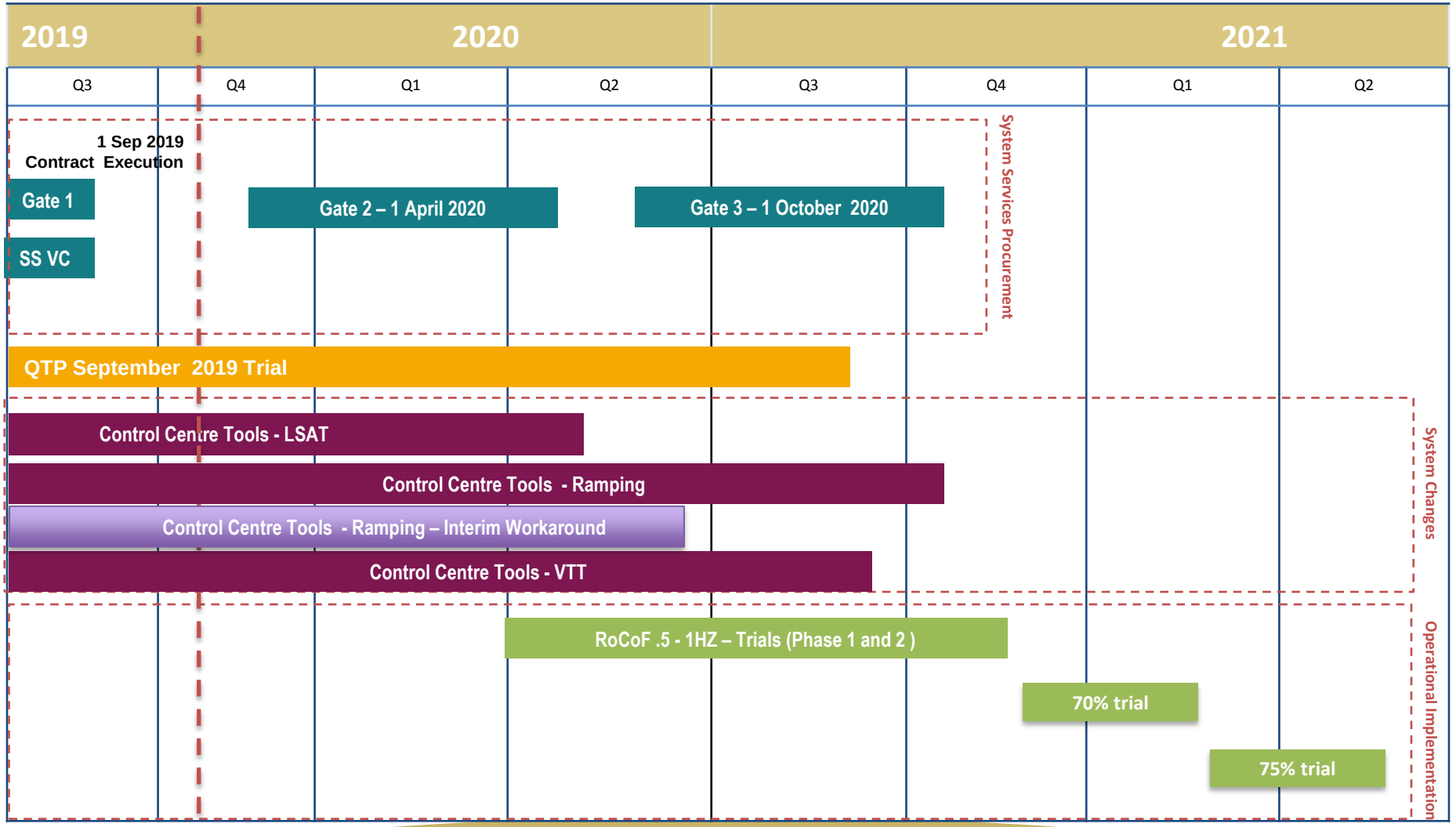
Revised DS3 Plan October 2019



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Qualification Trial Process

October 2019

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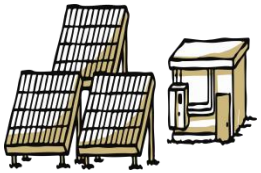
Technology Trials QTP

2019 Trials, Enhancing the portfolio

In 2019…



Solar Technology - The overall objective is to prove solar technology capable of providing a range of the DS3 System Services

Aggregated Residential Services -The aim of the trial is to focus on the provision of DS3 System Services from residential heat and transport with a focus on large electrical appliances.

Alternative Communication Method - industry participants that are interested in utilising a new telecommunications protocol.

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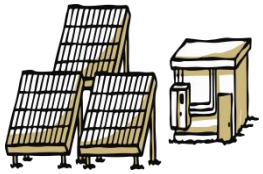

Technology Trials QTP

2019 Trials, Enhancing the portfolio

Solar Technology Trial – 12 month Trial taking place in Northern Ireland trialling the provision of

FFR	POR	SOR	TOR1	SSRP	FPFAPR	DRR
●	●	●	●	●	●	●

Focus Areas for learnings

- Provenability of services,
- Forecast v Actual response.
- Operational Complexities for Solar Integration.

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Technology Trials QTP

2019 Trials, Enhancing the portfolio

Residential Technology Trial – 18 month Trial

- 2 Service Providers - taking place in Ireland & Northern Ireland,

<u>Focus Areas for learnings</u>

- Provenability of services,
- Forecast v Actual response.
- Operational Complexities & Barrier of Integration
- TSO – DSO impact

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Technology Trials QTP

2019 Trials, Enhancing the portfolio

Participant 1

FFR	POR	SOR	TOR1/2	SSRP
●	●	●	●	●

- 34 customer sites
- Localised Response
- Battery Storage, EV's, Solar

Participant 2

POR	SOR	TOR1	TOR2
●	●	●	●

- 20 customer Homes
- Aggregated response
- Focus on Battery & Solar

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Technology Trials QTP

Communication Trial – 12 month Trial

- 2 Service Providers - taking place in Ireland & Northern Ireland, on two separate technology types

<u>Area of Focus</u>

- Remote Terminal Unit (RTU) interface device and IEC101 telecommunications protocol to exchange data with the TSO.
- The system trial will be completed on the TSO proposed telecommunication protocols and hardware under the QTP trial process.
- The trial participants will work with the TSO to examine a number of factors such as the visibility, implementation, cyber security and reliability when compared against the current standards.

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Technology Trials QTP

Publications

- PID Publications scheduled for end of October
- Progress reports published every Quarter
- Close out reports September 2019 for Solar and Communication trial

19/20 Qualification Trial Input

- QTP trial included as part of FlexTech consultation seeking input for focus areas – Responses open until 4/11/2019

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Volume Capped Procurement update

October 2019

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Procurement outcomes

Overview

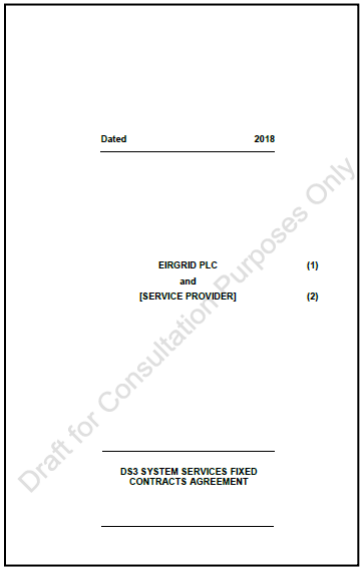
- 18 Service Providers
- 110 MW procured from Battery Storage

Results

- 1 x 50MW
- 2 x 30MW
- All located in Ireland
- Estimated Contract Value of 35m over 6 years,
- Equivalent Regulated arrangement value of up to 210m

Status

- All contracts have been signed


Dated 2018

EIRGRID PLC (1)
and
[SERVICE PROVIDER] (2)

Draft for Consultation Purposes Only

DS3 SYSTEM SERVICES FIXED CONTRACTS AGREEMENT

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Volume Uncapped update

16 October 2019

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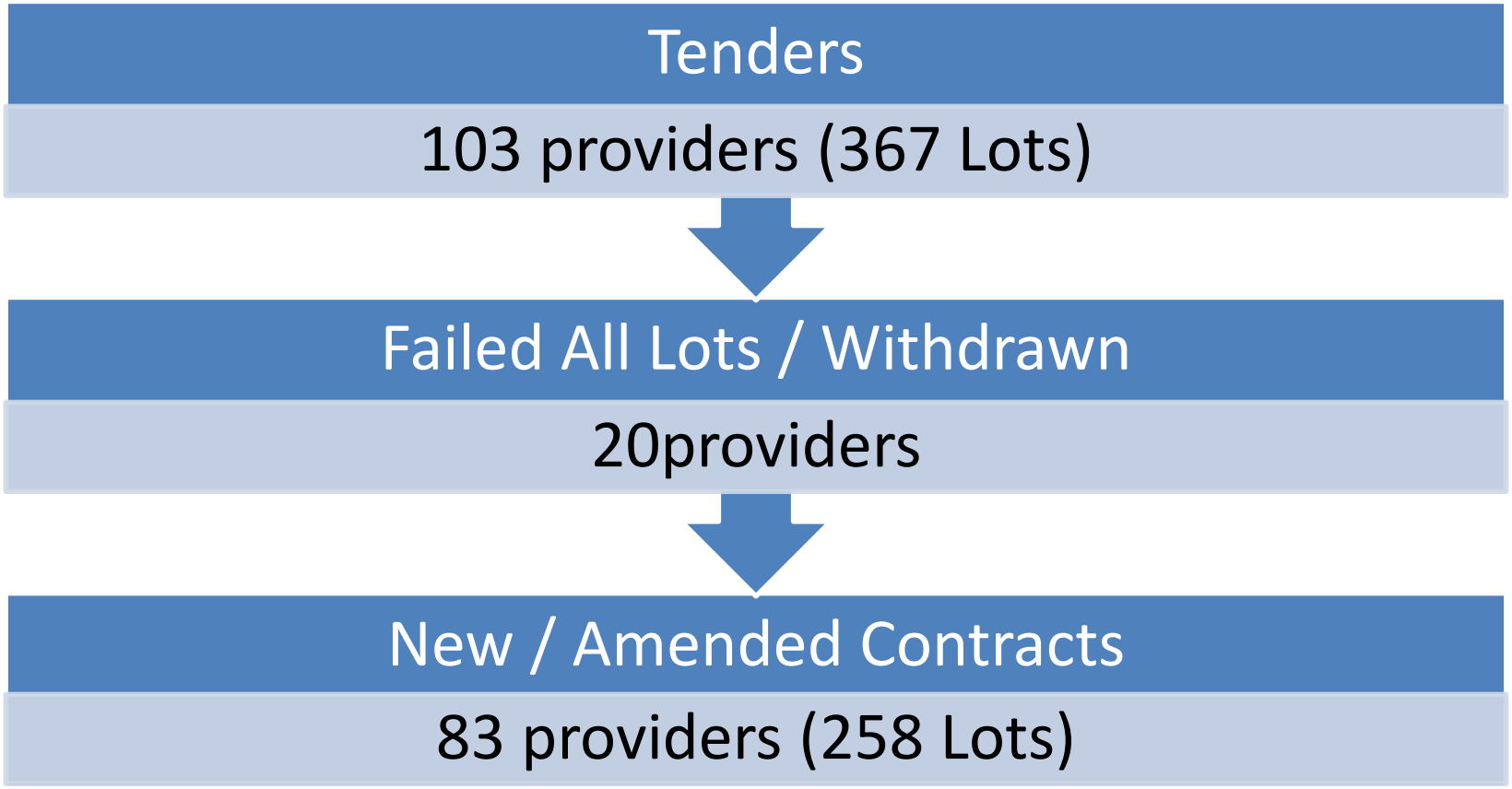
Gate 1 Outcome



Gate 1 Outcome - Reserve

	FFR (MW)			POR (MW)			SOR (MW)			TOR1 (MW)		
	Sep-19	2018	Gate 1	Sep-19	2018	Gate 1	Sep-19	2018	Gate 1	Sep-19	2018	Gate 1
Total Vol	755.21	309.83	445.38	1289.07	1129.04	160.03	1711.46	1533.67	177.79	2027.66	1762.44	265.22
Total Units	50	32	18	116	79	37	124	82	42	130	82	48
EirGrid Vol	608.46	301.25	307.21	850.54	713.56	136.98	1244.59	1090.25	154.35	1486.69	1315.32	171.37
EirGrid Units	39	27	12	86	57	29	92	60	32	98	64	34
SONI Vol	146.75	8.57	138.18	438.53	415.49	23.05	466.87	443.42	23.45	540.97	447.12	93.85
SONI Units	11	5	6	30	22	8	32	22	10	32	18	14

	TOR2 (MW)			RRS (MW)			RRD (MW)		
	Sep-19	2018	Gate 1	Sep-19	2018	Gate 1	Sep-19	2018	Gate 1
Total Volume	2386.37	2291.77	94.61	4757.50	4590.70	166.80	2722.95	2629.17	93.78
Total Units	84	76	8	63	61	2	68	62	6
EirGrid Vol	1681.60	1605.11	76.49	3547.90	3391.10	156.80	1979.66	1915.07	64.59
EirGrid Units	64	58	6	49	48	1	52	47	5
SONI Vol	704.77	686.65	18.12	1209.60	1199.60	10.00	743.29	714.10	29.19
SONI Units	20	18	2	14	13	1	16	15	1

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Gate 1 Outcome – SSRP, SIR, Ramping

	SSRP (MVar)			SIR (MWs^2)		
	Sep-19	2018	Gate 1	Sep-19	2018	Gate 1
Total Volume	7798.45	7562.42	236.04	669859.21	627866.65	41992.56
Total Units	97	92	5	43	42	1
EirGrid Vol	6569.99	6387.54	182.45	562493.42	521805.67	40687.75
EirGrid Units	83	78	5	31	31	0
SONI Vol	1228.46	1174.87	53.59	107365.79	106060.98	1304.82
SONI Units	14	14	0	12	11	1

	RM1 (MW)			RM3 (MW)			RM8 (MW)		
	Sep-19	2018	Gate 1	Sep-19	2018	Gate 1	Sep-19	2018	Gate 1
Total Volume	7507.24	6733.31	773.93	8526.80	8492.92	33.88	9148.12	9114.24	33.88
Total Units	92	82	10	73	71	2	73	71	2
EirGrid Volume	6010.16	5253.24	756.92	6644.86	6627.36	17.50	7223.79	7206.29	17.50
EirGrid Units	72	63	9	56	55	1	56	55	1
SONI Volume	1497.08	1480.07	17.00	1881.94	1865.56	16.38	1924.33	1907.95	16.38
SONI Units	20	19	1	17	16	1	17	16	1

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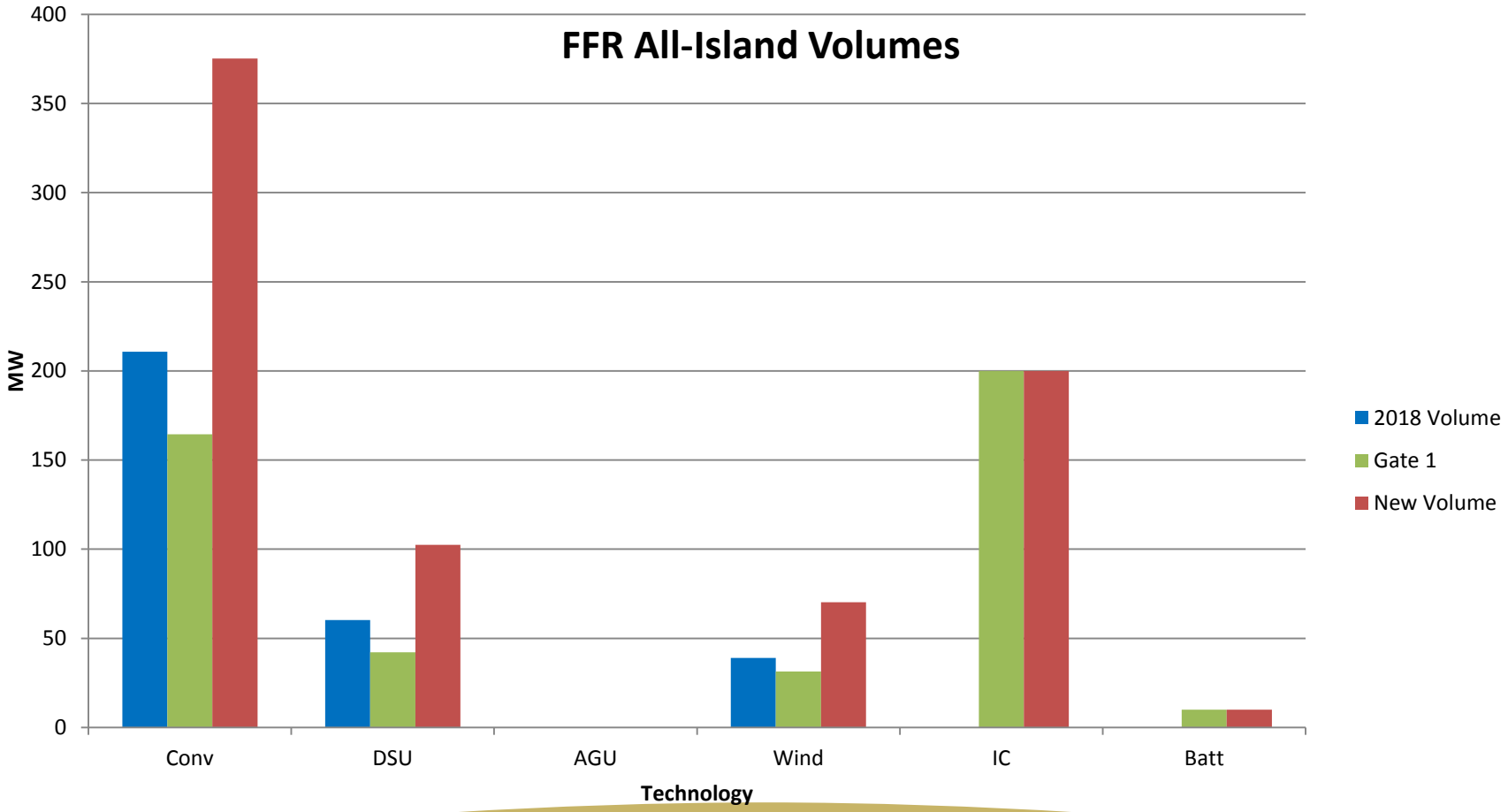
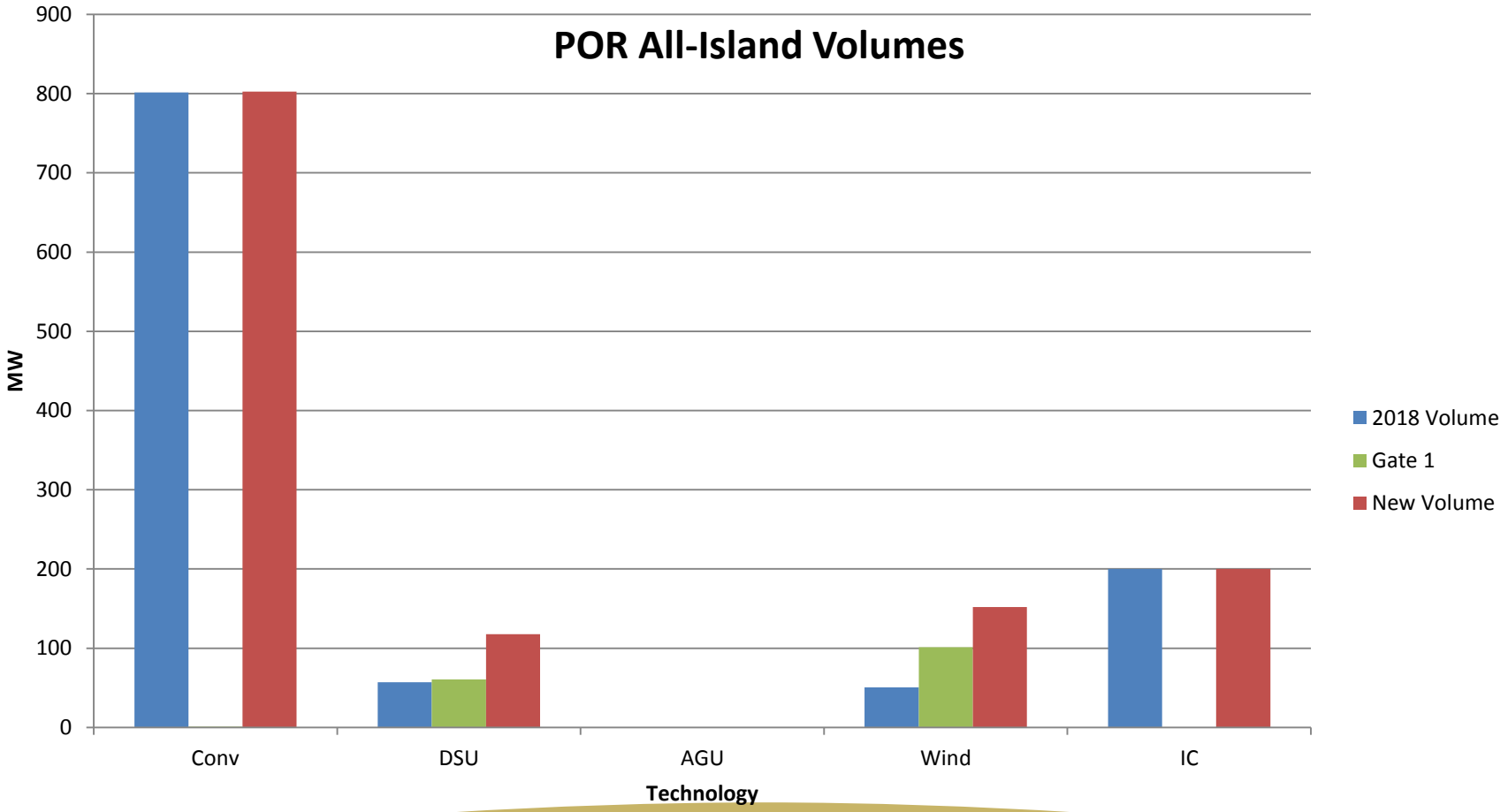
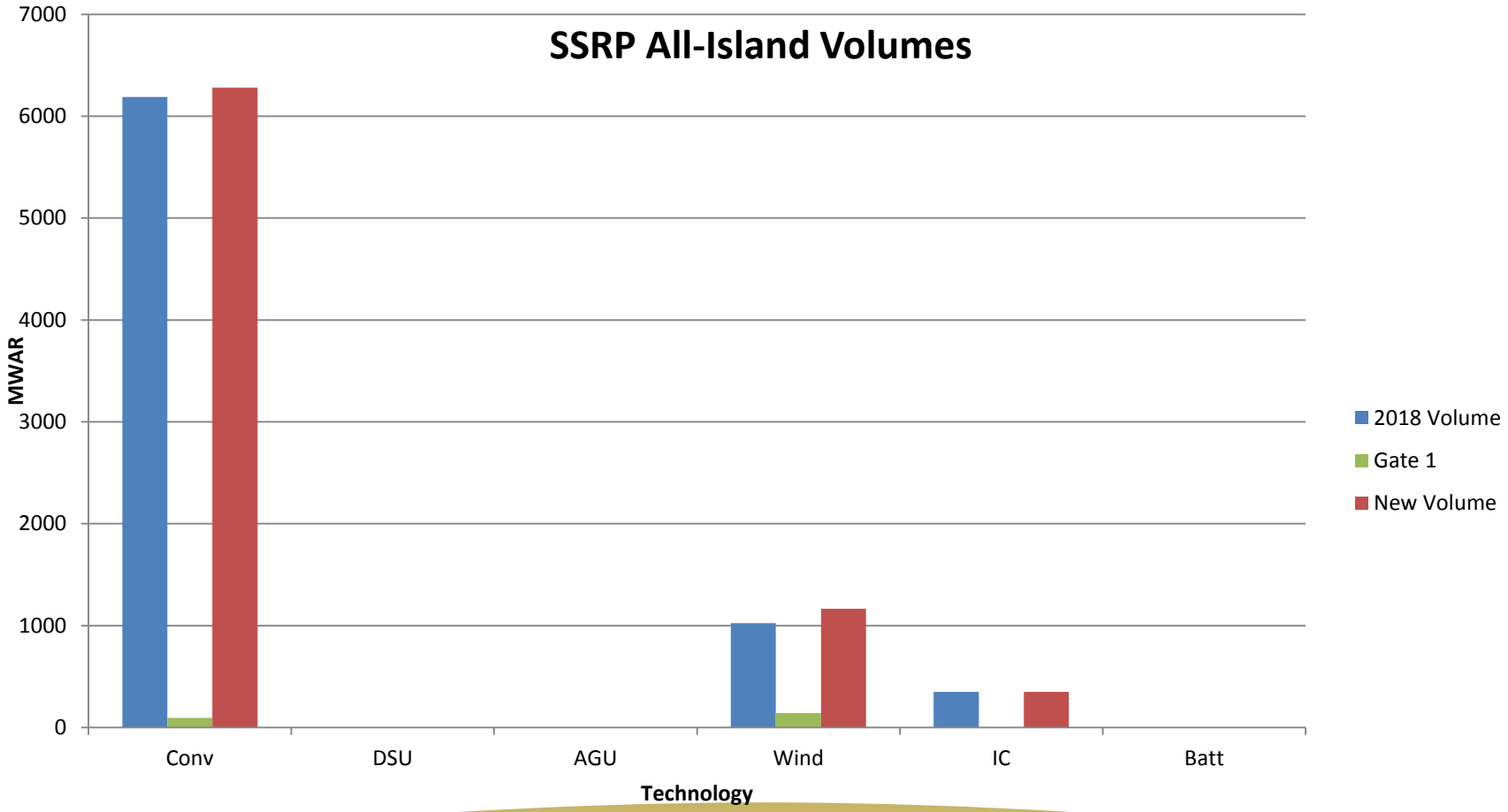
Gate 1 – Sample Outcome – FFR



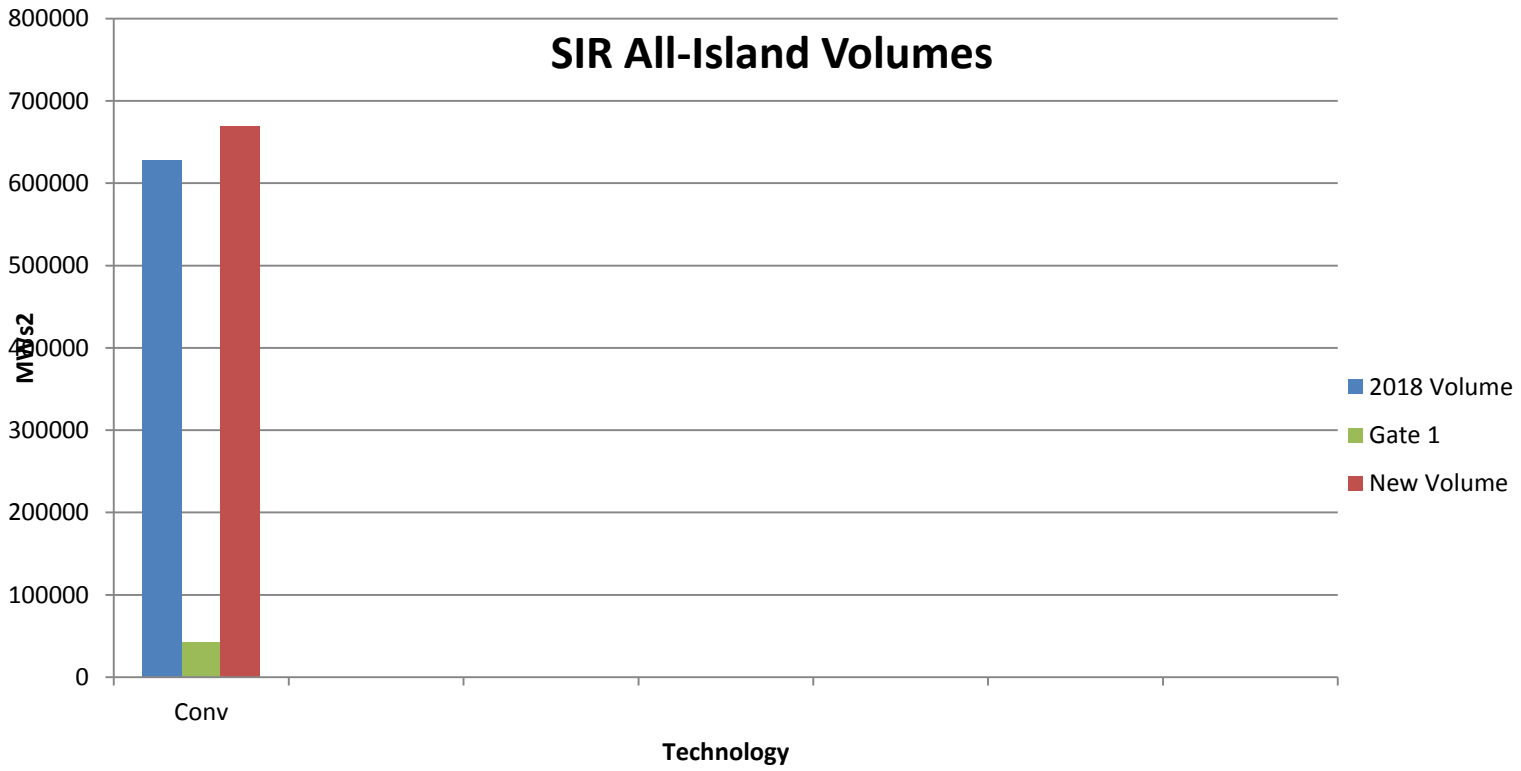
Gate 1 – Sample Outcome – POR



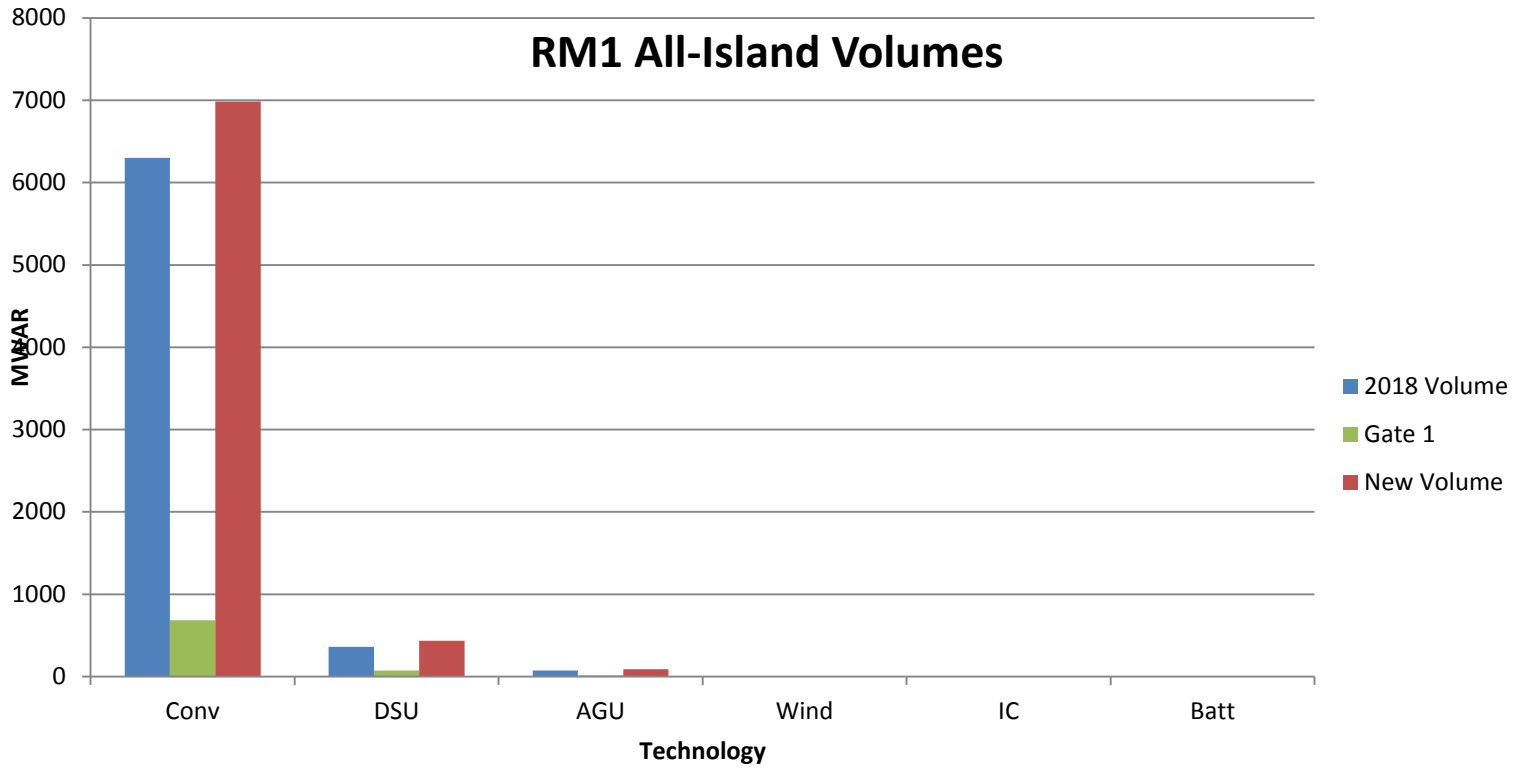
Gate 1 – Sample Outcome – SSRP



Gate 1 – Sample Outcome – SIR



Gate 1 – Sample Outcome – RM1



Priority Dispatch/ CEP

October 2019

Jonathan O' Sullivan

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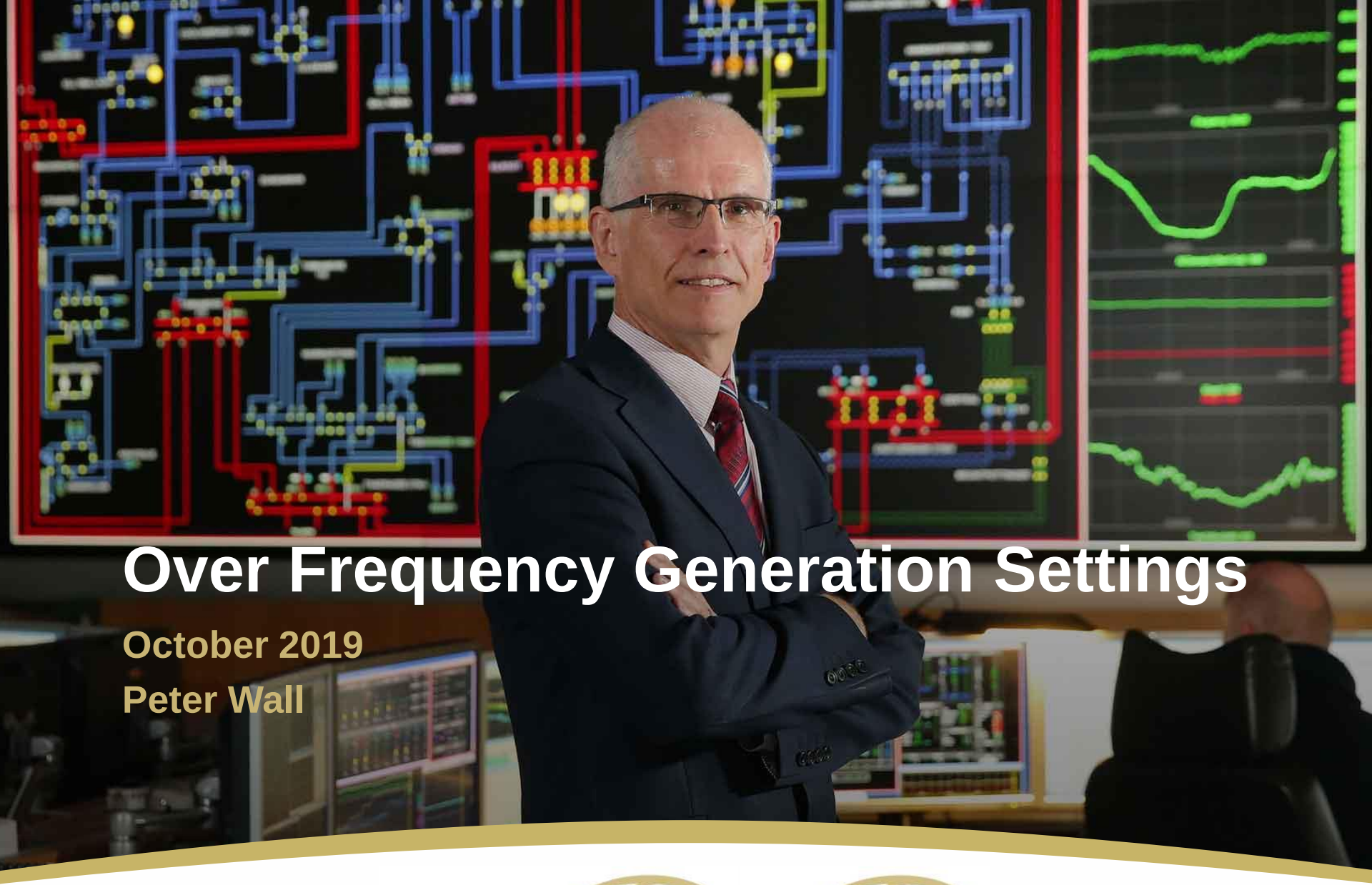

Over Frequency Generation Settings

October 2019

Peter Wall

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Over Frequency Generation Shedding

Summary of Study and Recommendations

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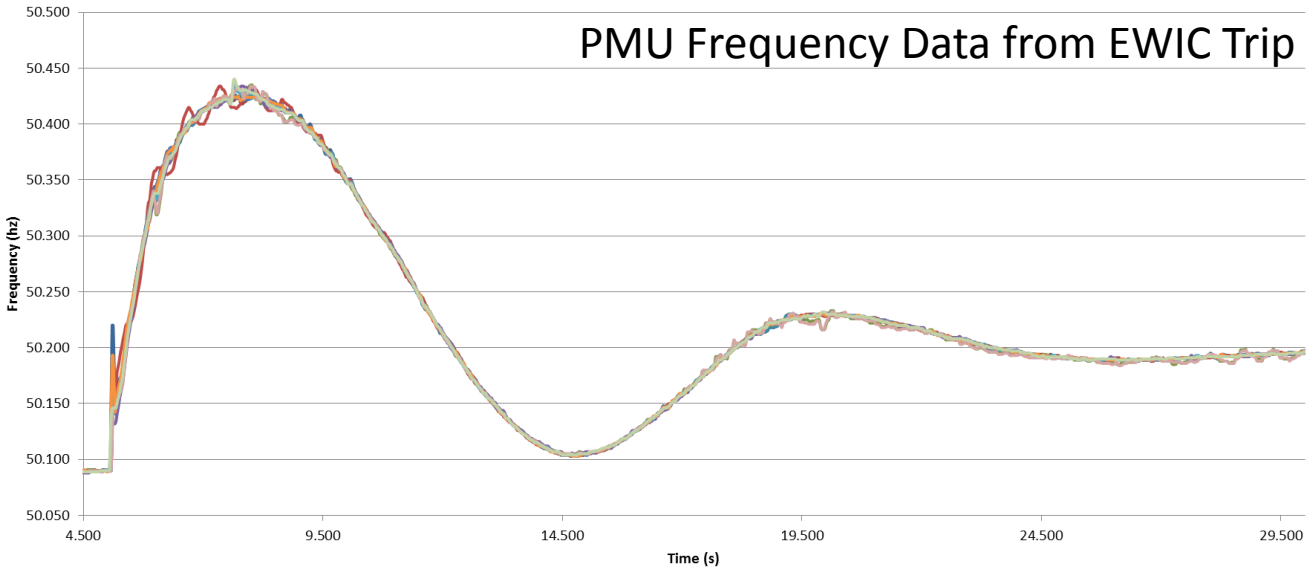
Background

- High export on EWIC raises issue of a significant over frequency event in case of EWIC trip on export
- Over Frequency Shedding Scheme in place to contain this
  - Combination of wind tripping and generator runback scheme was implemented as an interim scheme to limit frequency to 50.5 Hz
  - Has successfully contained an EWIC export trip
  - EWIC Trip on 472 MW export at 02:47 on 28/02/18



Background

- Generator runback scheme rarely activated and EirGrid committed to remove this scheme
  - This can be achieved by including more wind tripping
  - This wind only scheme is the enduring scheme
- Studies had been performed to design this enduring scheme; however a redesign was required due to changed assumptions
  - 2015 settings assumed legacy wind that trips at 50.8 Hz had moved to at least 52 Hz (1GW of wind)
  - provide required shedding using WFs that have existing TSO O/F relays
  - NI settings for system separation have already been adopted

Objectives

- Define a new tripping schedule that, using the wind farms that are available to trip, mimics the previous schedule, as far as is reasonable;
- Assess the potential for an EWIC trip on high export at times of low wind;
- Use TSAT studies to verify the effectiveness of the new enduring scheme;
- Study restricted to IE wind farms and EWIC trip as NI settings for system separation already implemented; and
- Changed assumptions do not impact system separation on NI/IE export

Review of WFs with O/F relays

- 16 wind farms have TSO O/F relays in IE
- 8 WFs in interim tranches and 8 set to 52.1Hz
- Concentration of resource in south west

Region of Resource	MW O/F	Count
South West	545	10
South East	135	3
North	201	3
Total	**881**	**16**

- 2018: 16 wind farms and 881MW available to shed
- 2015: 27 wind farms and 1063MW shed

Methodology for Selecting Settings

- Maximum allowable frequency – 50.8Hz
- First and final trigger frequency – 50.5 Hz and 50.75 Hz
- Ensuring wind in one sub-region was not tripped in adjacent stages (to minimize likelihood of voltage issues),
- Reasonably balanced tripping stages to limit the impact of any one stage tripping,
- Where necessary, larger stages of tripping appear later in the schedule to reduce consequences of unnecessary tripping, and
- Ensuring wind farms in areas with known voltage issues on tripping are only tripped in later stages.

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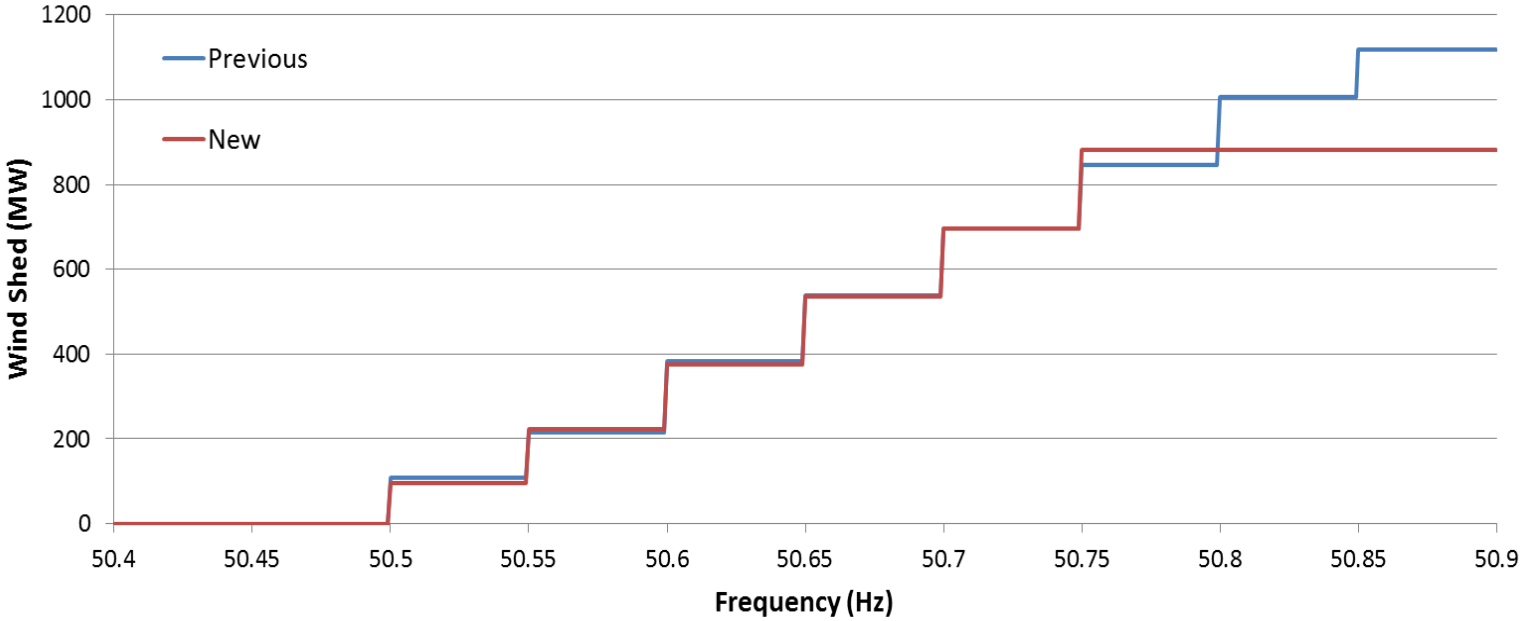
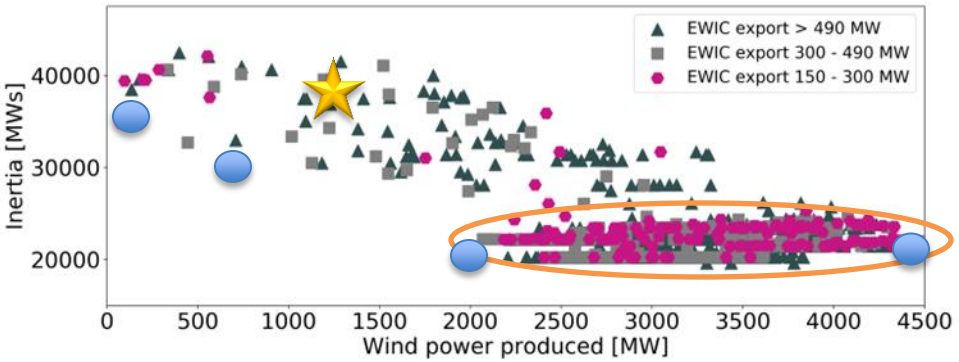
Tripping Schedule

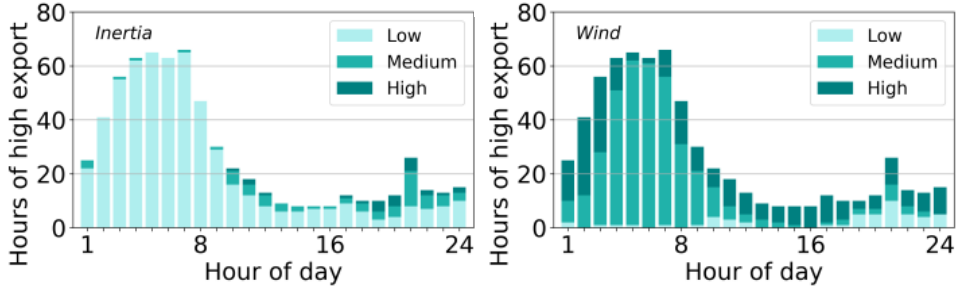
- Close match to 2015 profile was achieved
  - Above 50.8 Hz no tripping planned due to legacy wind



Case Selection

- 75% SNSP, 1Hz/s, 20 GWs future operation studied
- Inertia and wind for EWIC export levels have a clear envelope that is independent of export
- Clear concentration of export for low inertia medium to high wind
- High export (>490) primarily occurs overnight for low Inertia and medium wind





Medium Inertia is 25 GWs to 35 GWs
Medium Wind is 2250 MW to 3250 MW

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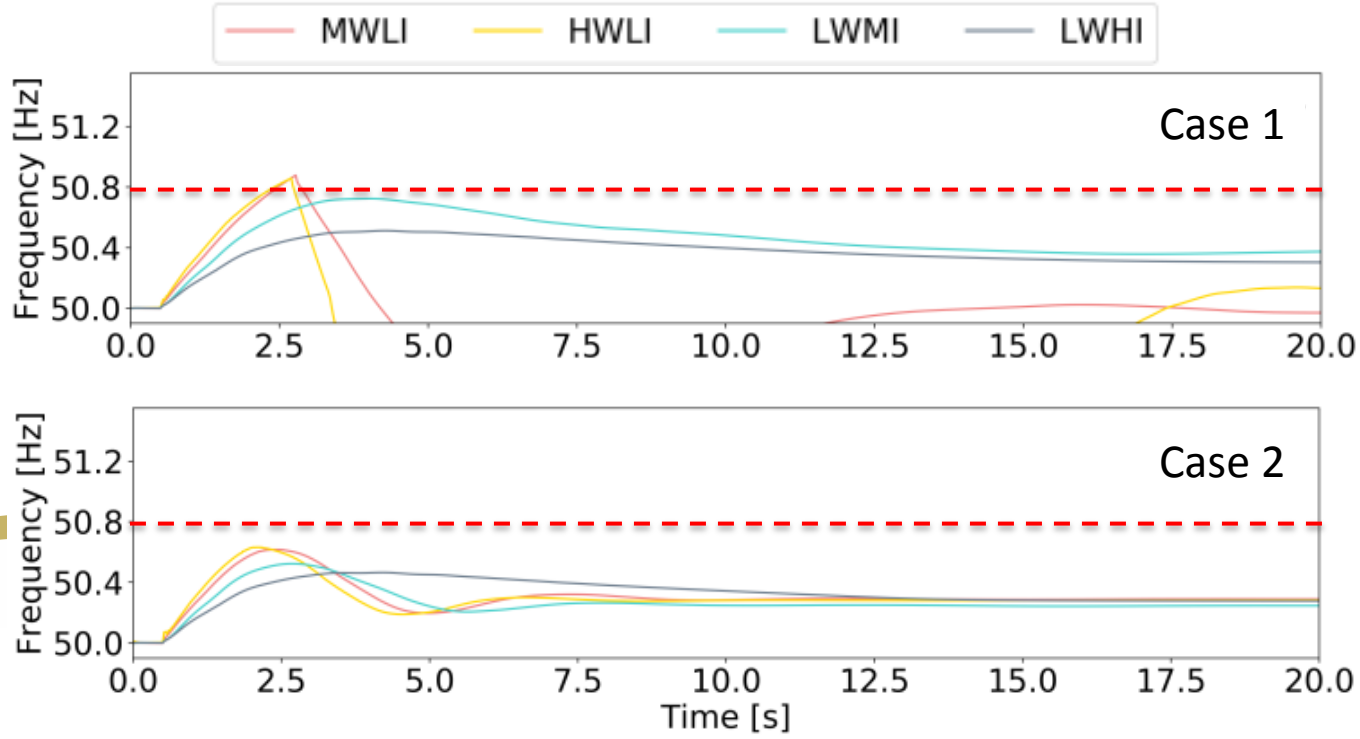
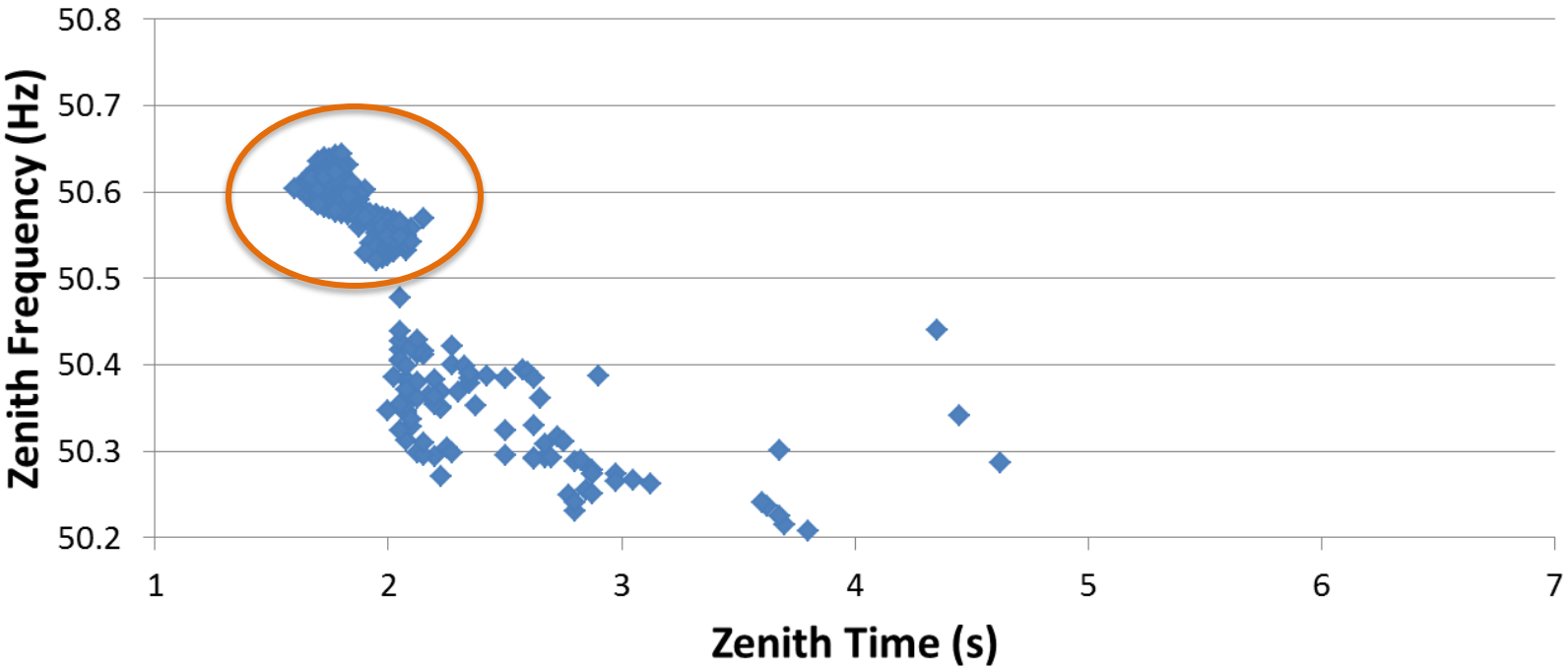
Snapshot Studies

- All snapshots are secure if scheme is in place
- Cases: Case 1: no OFGS
  Case 2: Wind tripping and wind in APC (50%)



Study Results with Enduring Scheme

- Frequency secure for all hours for all cases studied
  - All cases with export in excess of 490 MW
  - Zeniths separated into *natural* zeniths and *trip* zeniths



When to Review Study

1. Reduced inertia floor to 17,500 MWs,
2. Any increase in the SLO above 500 MW,
3. Any indication that the loss of EWIC could cause the sympathetic tripping of Dublin Area data centres,
4. Any connection of very large demand sites (~500MW) may require a more detailed review of the low inertia, low wind hours of operation, and
5. A significant change in the correlation between EWIC export and wind/inertia (boundary of high export operation).

Next Steps

1. Implement new enduring settings in Ireland
2. Remove generator runback SPS
3. Incorporate OFGS review studies into future program of work.
   To be performed within at least two years of last studies approval, or if any of the changes highlighted in the recommendations occur
4. Review opportunities to, wherever possible, reduce legacy wind as incremental reduction would be beneficial
5. Draft new Negative Reserve operational policy

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Oscillations

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Very Low Frequency Oscillations on the All-Island System

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Outline

1. Introduction to VLF oscillations
2. Outcomes of past work
3. Conjecture on root cause
4. Ongoing Monitoring
5. Next Steps

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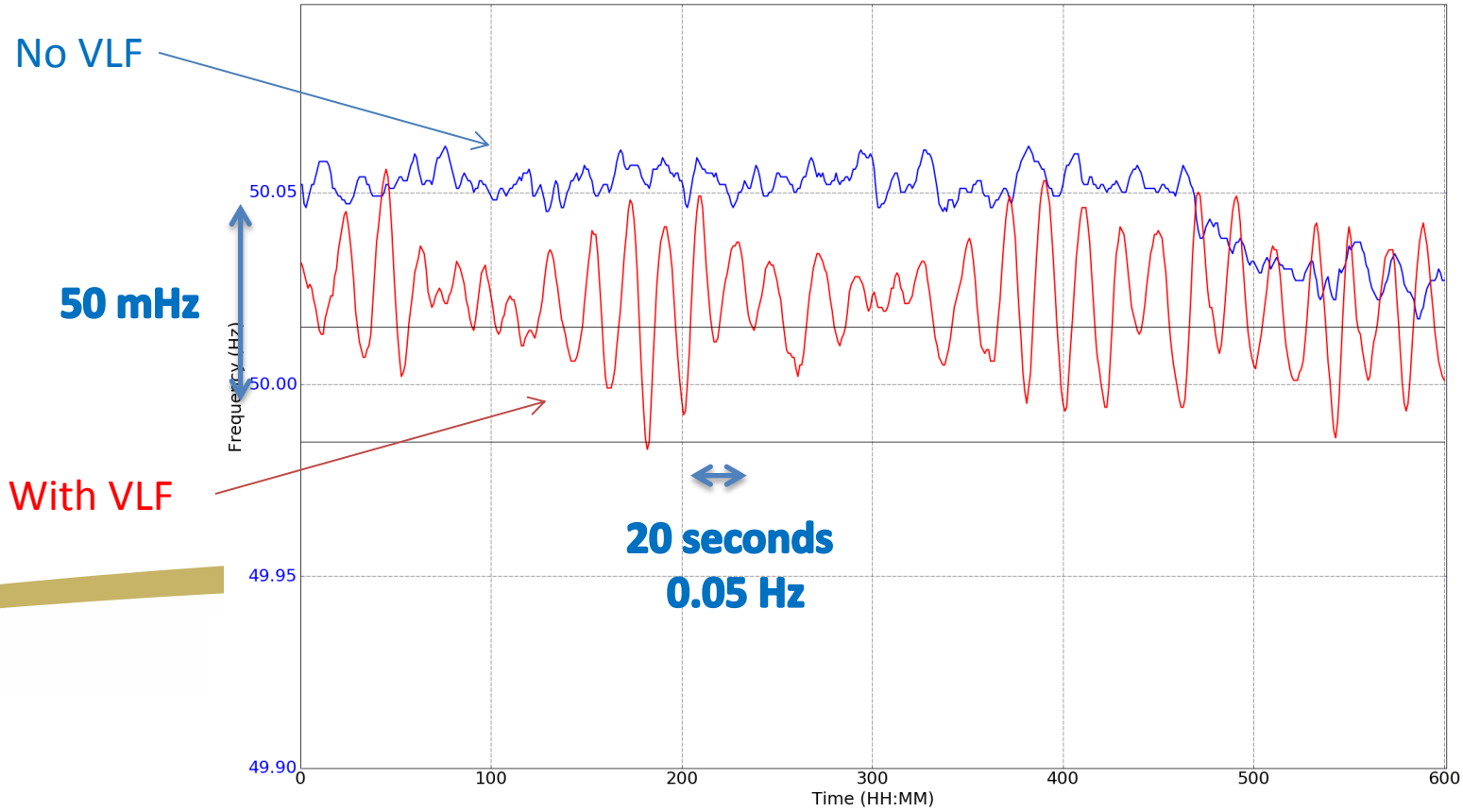
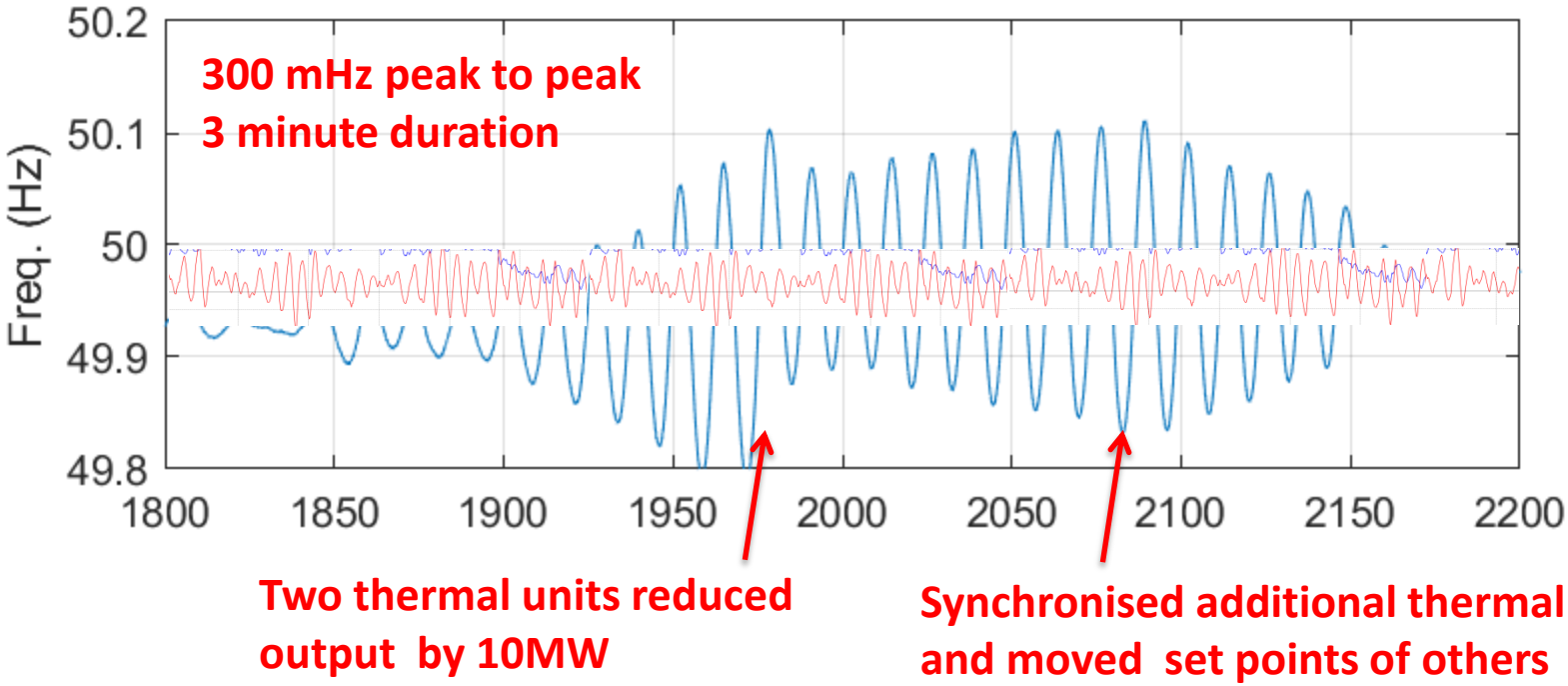
VLF Oscillation

- Modulation of system frequency
- Usually has oscillatory frequency of approx. 0.05Hz



VLF Oscillation

- Can result in significant events (no clear exciting event)



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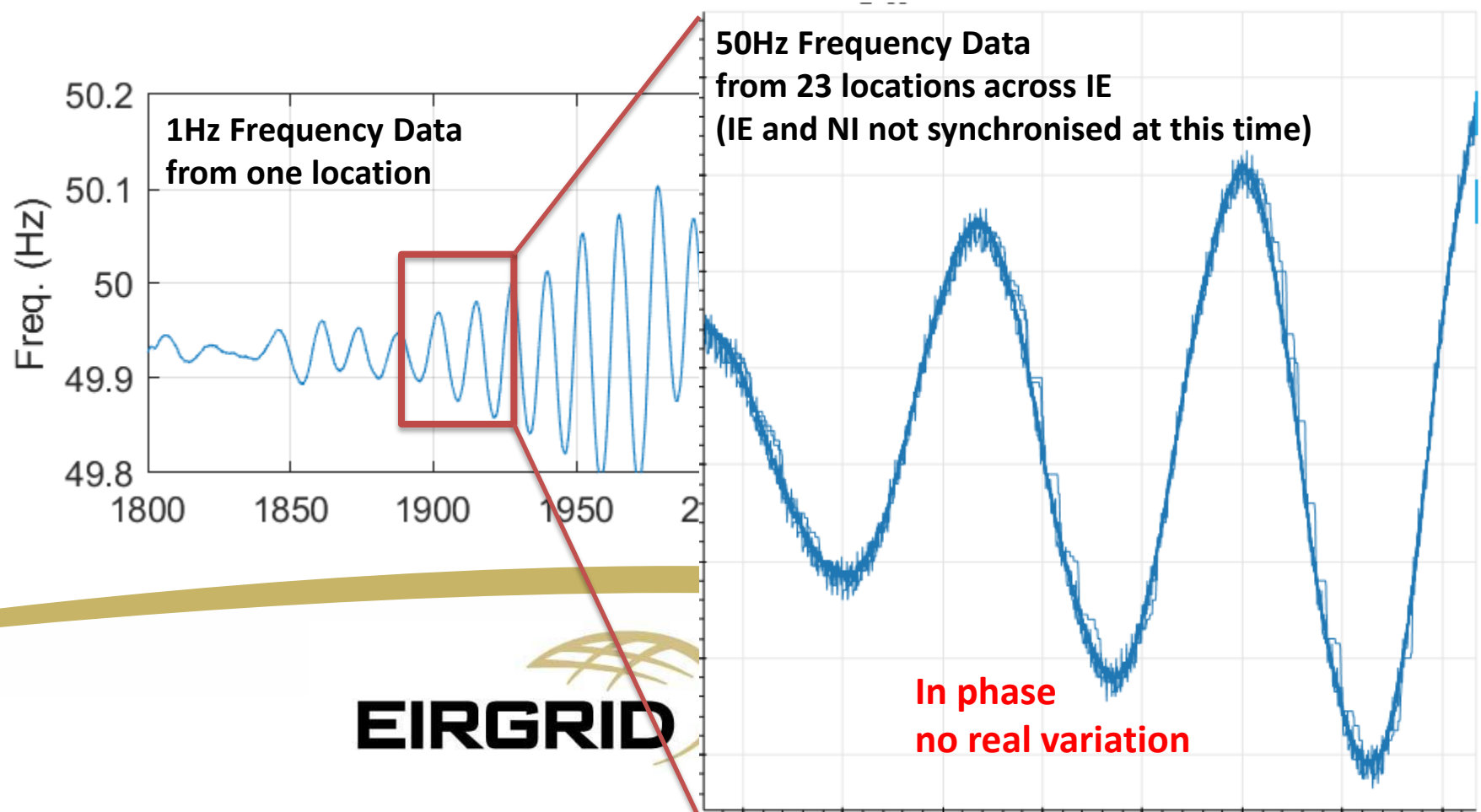
VLF Oscillation

- Common Mode Oscillation



Outcomes of Past Work

What do we know so far?

Outcomes of Past Work

- No significant system level correlation
- Occurs in clear sensitised blocks not continuously
- Strongly linked to generator governor behaviour
- Unlikely to be linked to a single unit or small set of units
- Likely driven by specific unit commitments and dispatches
- Occurs within generator deadband of +/- 15mHz
- Wind following behaviour of turbines may be sensitising the system to the oscillation (very low frequency noise)

Conjecture

- Oscillations are linked to specific unit commitments and dispatches
  - i.e. if certain combinations of units are on and running in a certain way then oscillations will occur
  - Some of these will give rise to more severe oscillations than others
  - Likely that there are units that help supress the oscillation
- The severity of any oscillation is a combination of
  - The severity of the root cause conditions (mode stability margin)
  - The size of any system event (excitation)
  - The amount of inertia and regulation on the system (mitigation)

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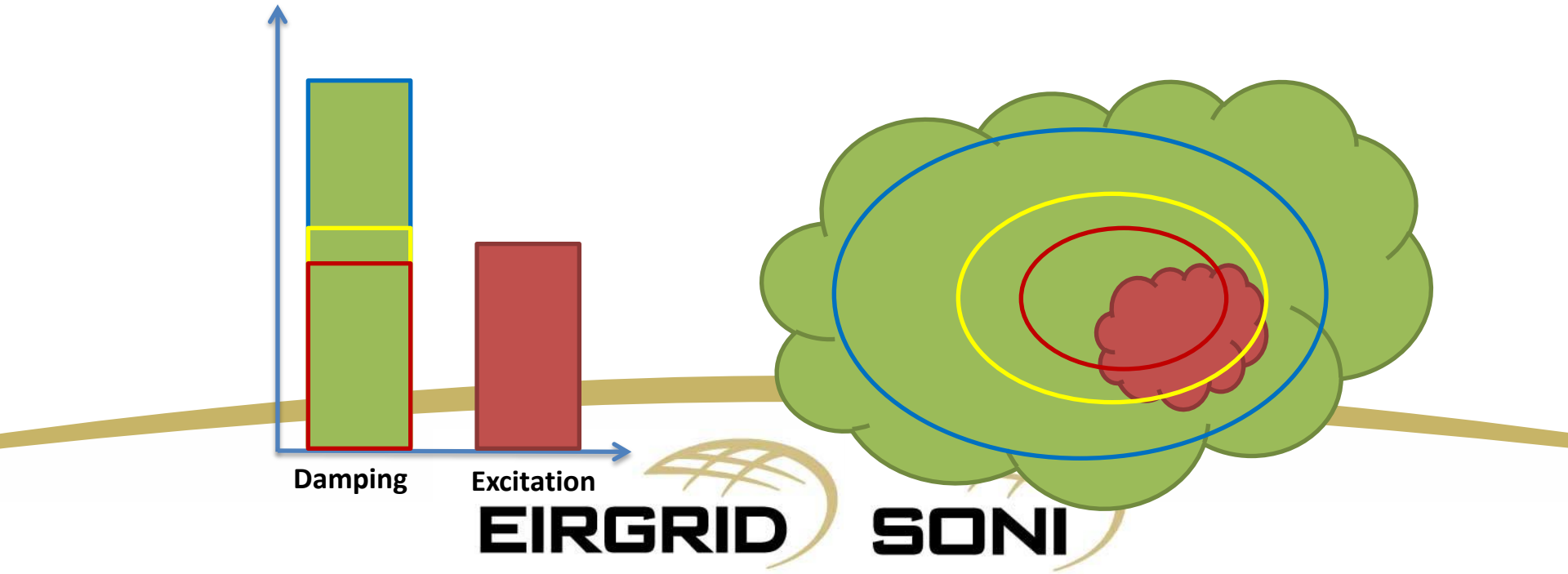
VLF as a Feature of the System

- This VLF issue may be a feature of operating a very low inertia system and not due to new control issues
  - Using fewer synch gen at more extreme operating points may be exposing a long standing issue



Next Steps for VLF Management

Defining the Root Cause and Mitigating it

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Workstreams

1. Ongoing monitoring based on signal processing
   - Tools for ongoing analysis and historical review

Almost Complete

2. Detailed correlation to system operation
   - Learning machine based correlation of events to unit commitment and dispatch

In Progress

3. Detailed Model based studies
   - Remodel system to enable small signal analysis and accurate time domain study of events with multi-minute duration

Just Started

Target completion late 2020

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Ongoing Monitoring

Is VLF getting worse?

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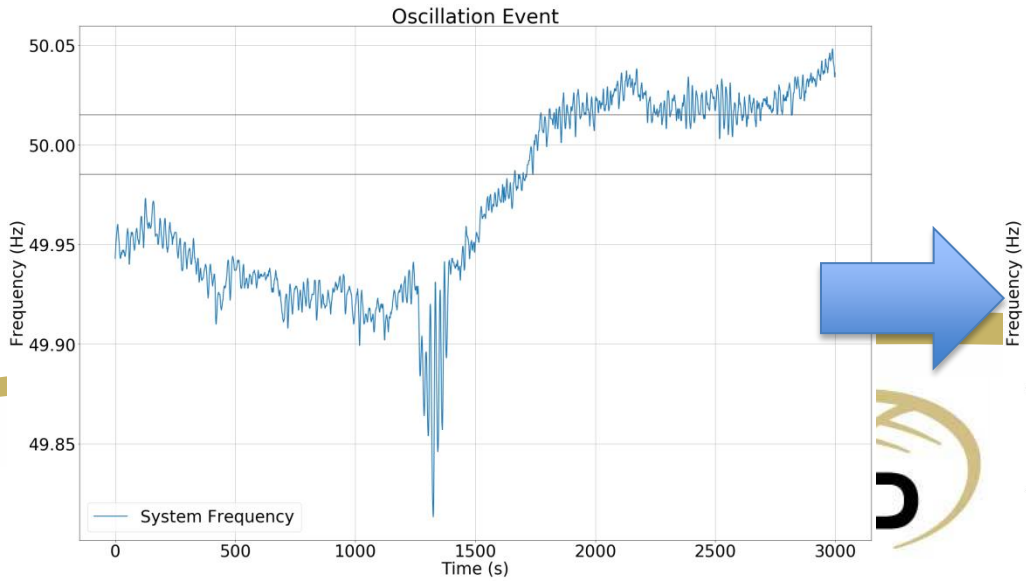
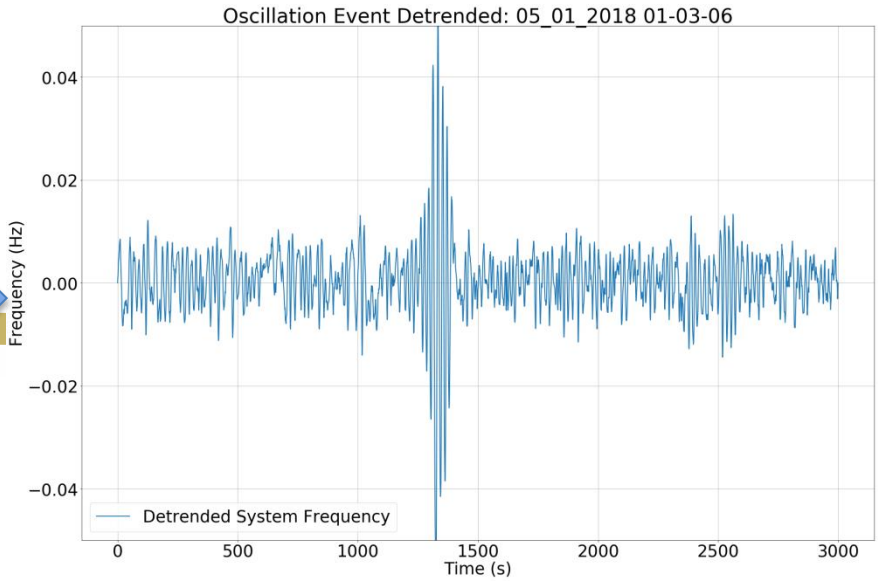
Ongoing Monitoring Tools

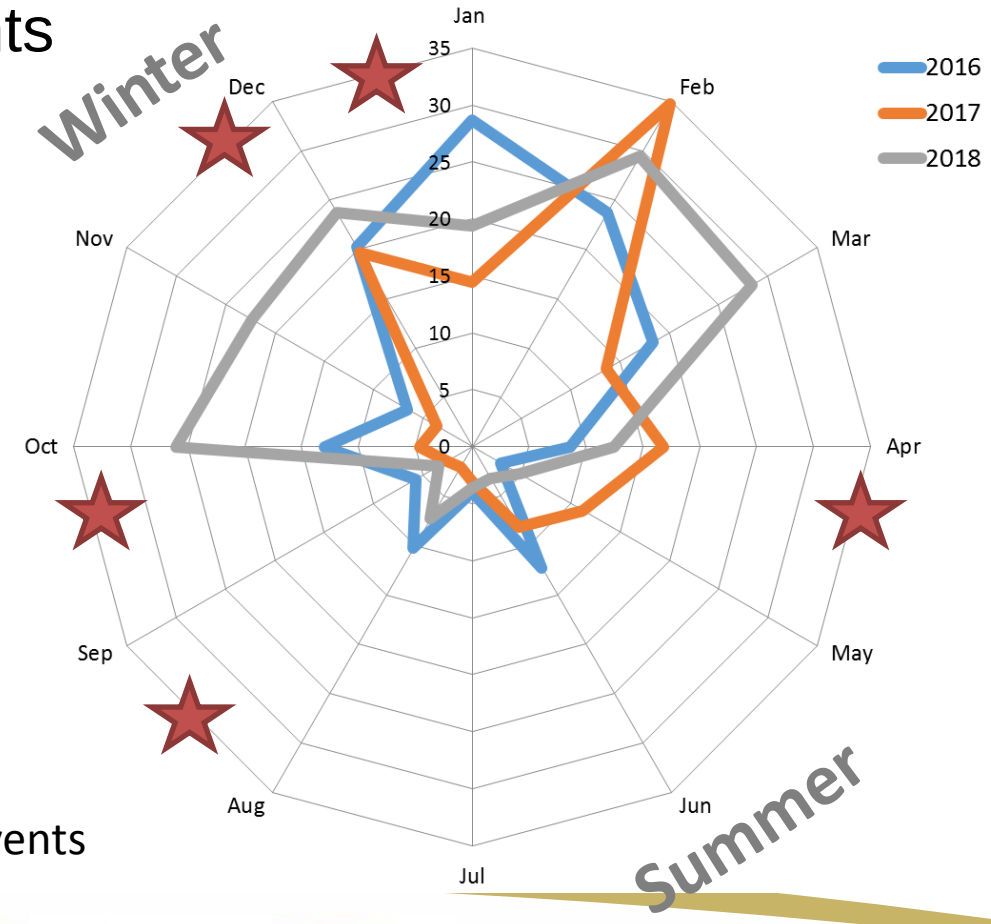
- Create tools to allow the monitoring and trending of the oscillation over time
  - Developing effective automatic magnitude estimation was focus
- Signal processing of 1Hz data
  - Tool uses a detrending process developed at UCC to identify oscillations from the data and determine their magnitude





Ongoing Monitoring

- Review of background events
  - Plot shows % of month oscillation observed for
  - Appearing more often
  - More frequent in winter
  - Occurrences not a good indicator of severity



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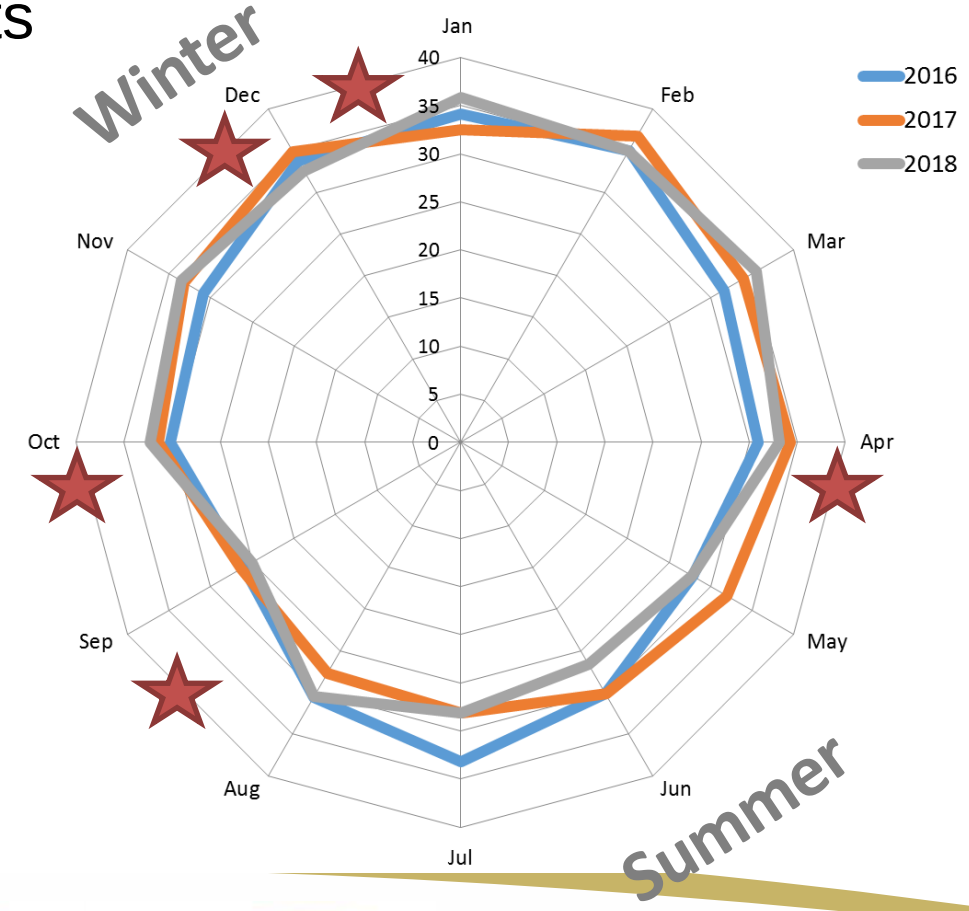
Ongoing Monitoring

- Review of background events
  - Plot shows median pk-pk magnitude in mHz
  - Very uniform magnitude
  - Occurrence not a good indicator of severity



Significant Events

Small Signal Modelling

Enable Detailed Study of VLF

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Why do we need a new model?

- WSAT model not intended for studying oscillations that take several minutes
  - Focus is steady state and dynamic security
  - So does not capture the oscillation and its drivers
- Small signal analysis is a key tool for mode stability analysis and controller tuning
- Small Signal analysis requires linearisable models and we are also attempting to model in more detail

New Information and Engagement

- Looking to engage more with generator owners (wind and synch.) on this issue
- Exact queries will be guided by initial model development and outcomes of learning machine
- Likely new information:
  - Any vulnerability to VLF
  - Frequency domain analysis of wind farm export
  - PSS on/off and when
  - Alternative modes of governor operation
  - When unit is/isn't frequency sensitive
  - Any reports or information on observed oscillations in generators

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Options for Future Management

Long Term Plan

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Options for Future Management

- Severity of future management depends heavily on quality of outcome
- Possible mitigation plans:

1. Requiring operation with a certain level of damping of the mode based on detailed understanding
2. Limiting dispatch on certain units (narrow forbidden regions) based on understanding of source
3. Avoiding certain unit commitment combinations
4. Requesting controller changes

Questions?

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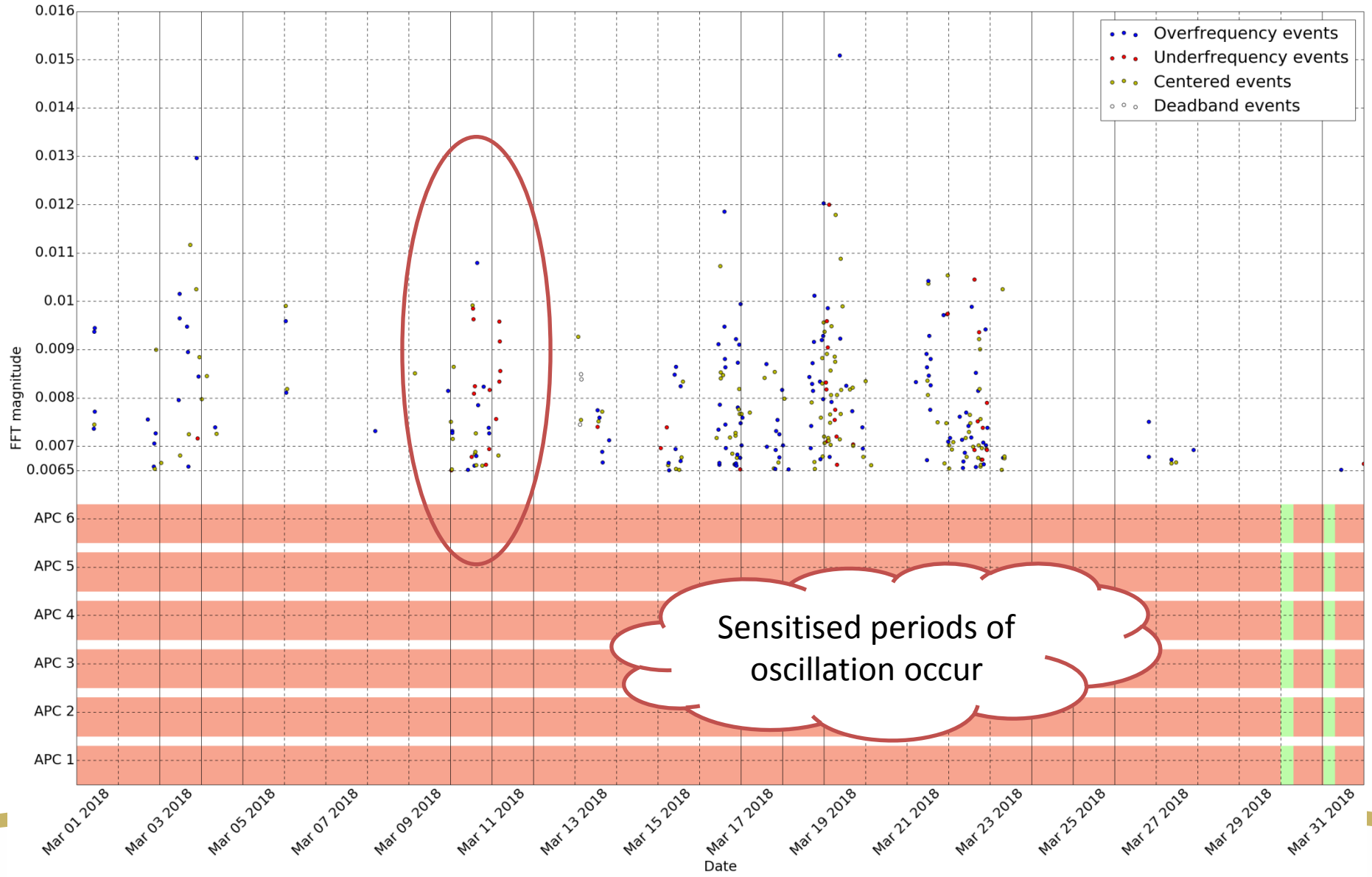
Events distributed against time – March 2018



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Our Purpose
Transform the power system for future generations
EIRGRID
SONI


EirGrid's role is to:
Develop Manage Operate
the electricity system throughout the island of Ireland. Transforming the power system for future generations.
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