Operational Constraints Update
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Key Updates

- *Dublin Generation and System Stability – For clarification, PBA and PBB represent operation of Poolbeg in combined cycle mode. If combined cycle mode is not available then PPA and PBB will not be considered as constraint resources if other resources are available. Reason is for provision of available reactive capability for Dublin and inertia for system stability.*
- *Operation Limit for RoCoF - Certain windfarms in NI with relays set to trip at 0.4 Hz/s RoCoF require management to maintain system security. This can result in re-dispatch of generation on the island in order to maximise priority dispatch generation while maintaining system security. This is anticipated to last until these relay settings are changed which is forecast for the end of 2017.*
- *Appendix A – List of Dispatchable Units*

- *Removal of DB1 – max limit of 245MW (overnight from 06:00 to 22:00 and weekends). as hot spot issue is being resolved.*
- *Removal of Moyle Interconnector restriction of -254< MW <257.*

Contents

1. Introduction

To enable the efficient and secure operation of the system, generation is dispatched to certain levels to prevent equipment overloading, voltages outside limits or system instability.
The software used to model the system is the Reserve Constrained Unit Commitment (RCUC).

1.1 Document Objective

The objective of the Operational Constraints Update is to present the key system and generator constraints which are included in the scheduling process (i.e. in the RCUC software). The most common operational constraints that are modelled are:

- North – South tie-line export / import constraint: MWR type
- Moyle import / export constraint: MW type
- Requirement to keep a minimum number of units on in an area: NB type
- Requirement to limit the output of the generators in an area to limit short circuit levels or overloads: MW type or NB type
- Requirement for a minimum output from the generators in an area to support the voltage or to avoid overloads: MW type or NB type
- Requirement to limit the output of stations due to fish spawning: MW type

This document comprises of: (i) **Operational Reserve Requirements**, and (ii) **System Constraints**.

1.2 List of Terms

TCG Type	
MW	Limit MW output of unit or units assigned to a TCG
MWR	Limits (the total MW + Primary Reserve - the area demand) from assigned resources
NB	Limit to the status (On/Off) of the unit or units assigned to a TCG

Limit Flag	
E	Equality Constraint (generation = load)
X	Export Constraint - limit output of a group of units <= max limit
N	Import Constraint - limit output of a group of units >= min limit
B	In-between Constraint; >= min and <= max

2. Operating Reserve Requirements

The following tables show the operating reserve requirements on an all-island basis and in each jurisdiction.

Category	All Island Requirement % Largest In-Feed	Ireland Minimum[1] (MW)	Northern Ireland Minimum (MW)
POR[2]	75%	130 / 95	50
SOR	75%	130 / 95	50
TOR 1	100%	130 / 95	50
TOR 2	100%	130 / 95	50

1. Ireland Lower values apply from 00:00 - 07:00 inclusive
2. Minimum values of POR in each jurisdiction must be supplied by dynamic sources

Note: Minimum operating reserve in Ireland increased from 110 MW to 130 MW from 07:00 to 00:00 and from 75 MW to 95 MW from 00:00 to 07:00 due to ongoing outage of Turlough Hill station.

2.1 Operating Reserve Definitions

Category	Delivered By	Maintained Until
Primary (POR)	5 seconds	15 seconds
Secondary (SOR)	15 seconds	90 seconds
Tertiary 1 (TOR1)	90 seconds	5 minutes
Tertiary 2 (TOR2)	5 minutes	20 minutes

2.2 Source of Reserve

	Ireland	Northern Ireland
Dynamic Reserve	Synchronised Generating Units	Synchronised Generating Units and Moyle Interconnector (up to 50 MW)
Static Reserve	Turlough Hill Units when in pumping mode Interruptible Load: Standard provision: 54MW (07:00 – 00:00) EWIC Interconnector (up to 100MW)	Moyle Interconnector (up to 50MW)
Negative Reserve (Defined as the MW output of a conventional generator above its minimum load)	100MW	50MW

3. System Constraints

3.1 Tie Line Limits

Tie line flows in both directions have physical limits, the maximum flow that can be sustained without breaching system security rules (line overloads, voltage limits etc.) after a credible transmission or generation event. The limits are referred to as the Total Transfer Capacity (TTC) comprising of two values: N-S and S-N. When determining minimum system cost, RCUC respects the TTC values by not allowing the sum of a) the tie line flow into a jurisdiction and b) the reserve requirement of the largest single infeed in that jurisdiction and c) a percentage of the reserve holding in that jurisdiction to exceed the TTC i.e. TTC > a + b + c.

3.2 Non-Synchronous Generation

To ensure the secure, stable operation of the power system, it is necessary to limit the level of non-synchronous generation of the system. The System Non-Synchronous Penetration (SNSP) is a measure of the non-synchronous generation on the system at an instant in time i.e. the non-synchronous generation and net interconnector imports as a percentage of the demand and net interconnector exports (where "Demand" includes pump storage consumption when in pumping mode).

3.3 Permanent System Constraint Tables

The following tables set out the system constraints:

- Active System Wide Constraints;
- Active Northern Ireland Constraints, and
- Active Ireland Constraints.

Note that the limits specified in each table represent the normal intact transmission network limit. These limits may vary from time to time due to changing system conditions.

3.3.1 Active System Wide Constraints

Name	TCG Type	Limit Type	Limit	Resources	Description
Inter-Area Flow	MWR	X:<=	400 MW (There is a margin of 20MW on this limit for system safety)	Ireland and Northern Ireland Power Systems	Ensures that the total MW transferred between Ireland and Northern Ireland does not exceed the limitations of the North-South tie line. It takes into account the rescue/reserve flows that could occur immediately post fault inclusive of operating reserve requirements. This is required to ensure the limits of the existing North South tie line are respected.
Inter-Area Flow	MWR	X:<=	450 MW (There is a margin of 20MW on this limit for system safety)	Ireland and Northern Ireland Power Systems	Ensures that the total MW transferred between Northern Ireland and Ireland does not exceed the limitations of the North-South tie line. It takes into account the rescue/reserve flows that could occur immediately post fault inclusive of operating reserve requirements. This is required to ensure the limits of the existing North South tie line are respected.
Non-Synchronous Generation		X:<=	60%	Wind, Moyle Interconnector EWIC Interconnector	Ensures that the SNSP is kept below 60%.
Operational Limit for RoCoF		X:<=	0.5 Hz/s*	Ireland and Northern Ireland Power Systems	Ensures that RoCoF does not exceed 0.5 Hz/s. * Certain windfarms in NI with relays set to trip at 0.4 Hz/s RoCoF require management to maintain system

					security. This can result in re-dispatch of generation on the island in order to maximise priority dispatch generation while maintaining system security. This is anticipated to last until these relay settings are changed which is forecast for the end of 2017.
Operational Limit for Inertia		N:>=	20,000MWs	Ireland and Northern Ireland Power Systems	Ensures that all island Inertia does not fall below 20,000 MWs.

3.3.2 Active Northern Ireland Constraints

Name	TCG Type	Limit Type	Limit	Resources	Description
System Stability	NB	N:>=	3 Units at all times	B4, B5, B10, B31, B32, C30, K1, K2	There must be at least 3 machines on-load at all times in Northern Ireland. Required for dynamic stability.
Replacement Reserve	MW	X:<=	275 MW	BGT1, BGT2, CGA, CGT8, EMPOWER , iPOWER, KGT1, KGT2, KGT3, KGT4	Combined MW output of OCGTs and AGUs must be less than 275 MW (out of a total of 400 MW) in Northern Ireland at all times. 125 MW Required for replacement reserve
North West Generation	NB	N:>=	0 or 1 Unit depending on NI system demand	C30	Coolkeeragh must be on load when the NI system demand is at or above 1260 MW. This operational constraint is required to ensure voltage stability in the northwest of Northern Ireland and to prevent possible system voltage collapse above the indicated system demand.
Kilroot Generation	NB	N:>=	1 or 2 Units depending on NI system demand	K1, K2	There must be at least one Kilroot unit on load when the NI system demand exceeds 1400 MW and 2 units are required above 1550 MW. This operational constraint is required to ensure voltage stability in the Belfast area and to prevent the requirement for an inter area flow reduction in a post fault scenario.
Moyle Interconnecto	MW	B	-300 <MW <442	Moyle Interconnector	This applies to all units registered as Moyle Interconnector units. It ensures that all flows do not exceed an import of 442MW to Northern Ireland and an export of 300MW to Scotland (values taken from NI). This is required to ensure that the limits are respected.

Negative Reserve	NB	>50 MW	Varies	B10, B31, B32, BGT1, BGT2, B4, B5, C30, CGT8, K1, K2, KGT1, KGT2, KGT3, KGT4	Number of units on above minimum load for negative reserve.

3.3.3 Active Ireland Constraints

* Note A: PBA and PBB represent operation of Poolbeg in combined cycle mode. If combined cycle mode is not available then PPA and PBB will not be considered as constraint resouces if other resources are available.

Name	TCG Type	Limit Type	Limit	Resources	Description
System Stability	NB	N:>=	5 Units	AD1, AD2, DB1, GI4, HNC, HN2, MP1, MP2, MP3, PBA*, PBB*, TB3, TB4, TYC, WG1	There must be at least 5 machines on-load at all times in Ireland. Required for dynamic stability. * See Note A
Replacement Reserve	MW	X:<=	473 MW	AT1, AT2, AT4, ED3, ED5, MRC, NW5, RP1, RP2, TP1, TP3	Combined MW output of OCGTs must be less than 473MW (out of a total of 798MW) in Ireland at all times. Required for replacement reserve. The MW values are subject to change as availability of the units change.
Dublin Generation	NB	N:>=	1 Units	DB1, HNC, HN2	There must be at least 1 large generator on-load at all times in the Dublin area. Required for voltage control.
Dublin Generation	NB	N:>=	2 Units	DB1, HNC, HN2, PBA*, PBB*	There must be at least 2 large generators on-load at all times in the Dublin area. Required for voltage control. This assumes EWIC is operational. * See Note A Note that during an outage of EWIC there must be at least 3 large generators on-load at all times in the Dublin area.
Dublin Generation	NB	N:>=	1 Unit if Ireland System Demand >4200 MW	HNC, PBA*, PBB*,	Requirement for HNC, PBA, or PBB to be on load when Ireland System Demand is greater than 4200 MW. This operational constraint is required for load flow control in the Dublin area. * See Note A

Dublin Generation	NB	N:>=	1 Unit if Ireland System Demand > 4600 MW	PBA*, PBB*	Requirement for PBA or PBB to be on load when Ireland System Demand is greater than 4600 MW. This operational constraint is required for load flow control in the Dublin area. * See Note A
Dublin North Generation	NB	N:>=	1 Unit	HNC, HN2, PBA*, PBB*	Requirement for generation in North Dublin (for load flow and voltage control). * See Note A
Dublin South Generation	NB	N:>=	1 Unit	DB1, PBA*, PBB*	Requirement for generation in South Dublin (for load flow and voltage control). * See Note A
South Generation	NB	N:>=	1 Unit if Ireland System Demand > 1500 MW	AD1, AD2, AT1, AT2, AT4, MRC, SK3, SK4, WG1	Requirement for at least one Unit to be on load when Ireland System Demand is greater than 1500 MW. This operational constraint is required for voltage stability in the South.
	NB	N:>=	2 Units if Ireland System Demand > 2500 MW	AD1, AD2, AT1, AT2, AT4, GI4, MRC, SK3, SK4, WG1	Requirement for at least two Units to be on load when Ireland System Demand is greater than 2500 MW. This operational constraint is required for voltage stability in the South.
	NB	N:>=	3 Units if Ireland System Demand > 3500 MW	AD1, AD2, AT1, AT2, AT4, GI4, MRC, SK3, SK4, WG1	Requirement for at least three Units to be on load when Ireland System Demand is greater than 3500 MW. This operational constraint is required for voltage stability in the South. Note that when Ireland wind is less than 500 MW one of these Units must be AD1, AD2, AT11, AT12, AT14, MRC, WG1.

	NB	N:>=	3 Units if Ireland System Demand > 4200 MW	AD1, AD2, AT1, AT2, AT4, GI4, MRC, SK3, SK4, WG1	Requirement for at least three Units to be on load when Ireland System Demand is greater than 4200 MW. This operational constraint is required for voltage stability in the South. Note that when Ireland wind is less than 500 MW one of these Units must be AD1, AD2, AT11, AT12, AT14, MRC, WG1. When Ireland System Demand is greater than 4200 MW one of these Units must be AD1, AD2, GI4, WG1.
Cork Generation	MW	B	0 MW <MW< 1100 MW	AD1, AD2, AT1, AT2, AT4, WG1	Generation restriction in the Cork area determined week ahead by Grid Operations NearTime.
South Generation	MW	B	0 MW <MW< 1800 MW	AD1, AD2, AT1, AT2, AT4, GI4, MRC, WG1	Generation restriction in the Southern Region. This will be determined week ahead by Grid Operations NearTime.
Moneypoint	NB	N:>=	1 Unit	MP1, MP2, MP3	There must be at least one Moneypoint unit on load at all times. Required to support the 400kV network.
Hydro Smolt Protocol	NB	N/A	Varies	ER1, ER2, ER3, ER4, LE1, LE2, LE3	Over the spring and early summer period as the water temperature in the rivers and lakes change, the hydro stations have to be dispatched in a very specific way to allow fish to move safely. This affects the generators in Erne and Lee.

EWIC Interconnector	MW	B	-526 <MW< 504 Current restriction is -300* < MW < 504	EWIC Interconnector	This applies to all units registered as EWIC Interconnector units. It ensures that all flows do not exceed an import of 504MW to Ireland and an export of 526MW to GB (values taken from Portan). This is required to ensure that the limits are respected. Current restriction is to mitigate against impact of a high frequency event on the island in the event of a trip on EWIC. * The trial to remove the operational export limit on EWIC for all system conditions is ongoing.
Turlough Hill Generation	MW	B	>0 MW by day, <0 MW by night	TH1, TH2, TH3, TH4	To ensure required MW running of Turlough Hill.
Negative Reserve	NB	>100 MW	Varies	AD1, AD2, AT1, AT2, AT4, DB1, ED3, ED5, GI4, HN2, HNC, MP1, MP2, MP3, MRC, NW5, PBA*, PBB*, RP1, RP2, SK3, SK4, TP1, TP3, TYC, WG1	Number of units on above minimum load for negative reserve. * See Note A

Appendix A – List of Dispatchable Units

Fully Dispatchable Units (Ireland)	
Aghada	AD1
	AD2
	AT1
	AT2
	AT4
Dublin Bay	DB1
Edenderry	ED1
Edenderry OCGT	ED3
	ED5
Great Island CCGT	GI4
Huntstown	HNC
	HN2
Indaver Waste	IW1
Lough Ree	LR4
Marina CC	MRC
Moneypoint	MP1
	MP2
	MP3
North Wall CT	NW5
Poolbeg CC	PBA
	PBB
Rhode	RP1
	RP2
Sealrock	SK3
	SK4
Tarbert	TB1
	TB2
	TB3
	TB4
Tawnaghmore	TP1
	TP3
Tynagh	TYC
West Offaly	WO4
Whitegate	WG1
Ardnacrusha	AA1, AA2, AA3, AA4
Erne	ER1, ER2, ER3, ER4
Lee	LE1, LE2, LE3
Liffey	LI1, LI2, LI4, LI5
Turlough Hill	TH1, TH2, TH3, TH4
EWIC Interconnector	EWIC Interconnector
Dublin Waste	Dublin Waste

Fully Dispatchable Units (Northern Ireland)	
Ballylumford	B4
	B5
	B10
	B31
	B32
	BGT1
	BGT2
Kilroot	K1
	K2
	KGT1
	KGT2
	KGT3
	KGT4
Coolkeeragh	CGT8
	C30
Moyle Interconnector	Moyle Interconnector
Lisahally	Lisahally
Bombardier	Bombardier
Contour Global (AGU)	CGA
iPower (AGU)	iPower
Empower (AGU)	Empower