
Operational Constraints Update

15/12/2017



Key Updates

- *Source of Reserve: Update to the standard interruptible load provision over the holiday period.*
- *DB1 back to normal operation from 04/12/2017.*

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Contents

| | |
|---|----|
| 1. Introduction | 4 |
| 1.1 Document Objective..... | 4 |
| 1.2 List of Terms | 4 |
| 2. Operating Reserve Requirements | 5 |
| 2.1 Operating Reserve Definitions | 5 |
| 2.2 Source of Reserve | 5 |
| 3. System Constraints | 6 |
| 3.1 Tie Line Limits..... | 6 |
| 3.2 Non-Synchronous Generation | 6 |
| 3.3 Permanent System Constraint Tables | 6 |
| 3.3.1 Active System Wide Constraints | 7 |
| 3.3.2 Active Northern Ireland Constraints | 9 |
| 3.3.3 Active Ireland Constraints | 11 |
| Appendix A – List of Dispatchable Units..... | 15 |

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 \leq max limit |
| N | Import Constraint - limit output of a group of units \geq min limit |
| B | In-between Constraint; \geq min and \leq 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% | 110 / 75 | 50 |
| SOR | 75% | 110 / 75 | 50 |
| TOR ¹ | 100% | 110 / 75 | 50 |
| TOR ² | 100% | 110 / 75 | 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

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) Between 12:00 on 22 nd December 2017 and 1 st January 2018 inclusive: 18MW (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 | <p>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.</p> <p>This is required to ensure the limits of the existing North South tie line are respected.</p> |
| 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 | <p>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.</p> <p>This is required to ensure the limits of the existing North South tie line are respected.</p> |
| Non-Synchronous Generation | | X:<= | 65% | Wind, Moyle Interconnector EWIC Interconnector | <p>Ensures that the SNSP is kept below 65%.</p> <p>Trial at 65% started on 14th November 2017</p> |
| Operational Limit for RoCoF | | X:<= | 0.5 Hz/s* | Ireland and Northern Ireland Power Systems | <p>Ensures that RoCoF does not exceed 0.5 Hz/s.</p> <p>* Certain windfarms in NI with relays set to trip at 0.4 Hz/s RoCoF require management to maintain system security. This can</p> |

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|--------------------------------------|--|------|-----------|--|--|
| | | | | | 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:>= | 23,000MWs | Ireland and Northern Ireland Power Systems | Ensures that all island Inertia does not fall below 23,000 MWs. Increased to 23,000 as part of SNSP trial |

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. *Note: Firm export limit on Moyle reduced from 295MW to 80MW from 10 th November 2017. |

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|-------------------------|----|--------|--------|--|---|
| 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 only open cycle mode is available then PBA and PBB will not be considered as constraint resources, 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 | <p>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.</p> <p>Note that when Ireland wind is less than 500 MW one of these Units must be AD1, AD2, AT11, AT12, AT14, MRC, WG1.</p> <p>When Ireland System Demand is greater than 4200 MW one of these Units must be AD1, AD2, GI4, WG1.</p> |
| 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 | 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. |
| 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 |
| Kilroot | BGT2 |
| | K1 |
| | K2 |
| | KGT1 |
| | KGT2 |
| Coolkeeragh | KGT3 |
| | KGT4 |
| | CGT8 |
| | C30 |
| Moyle Interconnector | Moyle Interconnector |
| Lisahally | Lisahally |
| Bombardier | Bombardier |
| Contour Global (AGU) | CGA |
| iPower (AGU) | iPower |
| Empower (AGU) | Empower |