# Inertia Management on the Power Systems of Ireland and Northern Ireland

G-PST Future of Inertia Summit

11-12 March 2024

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# All-Island Power System Overview

## System

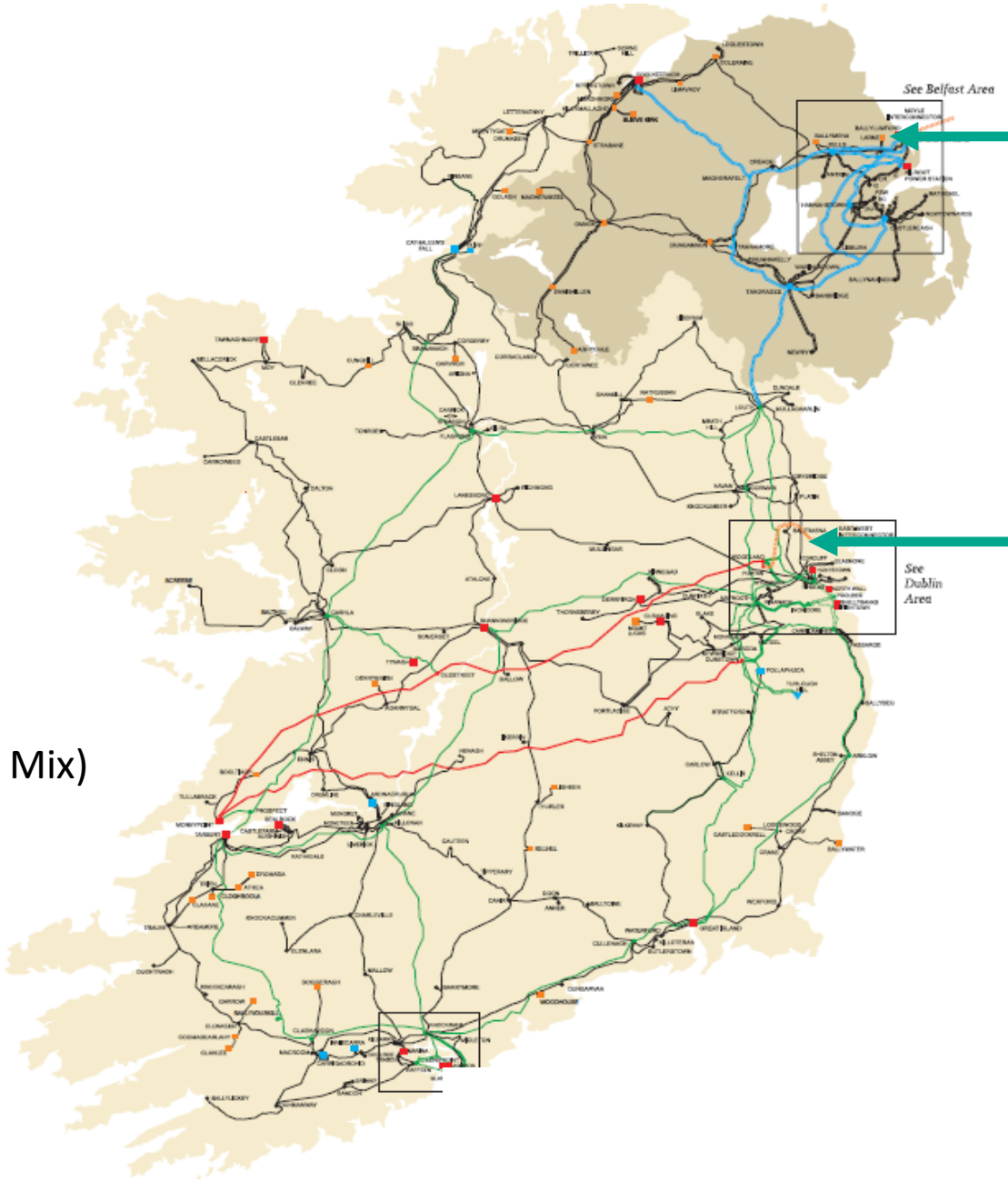
- Two Jurisdictions / Two TSOs
- Single Synchronous Area & Market
- Transmission: 110/220/275/400kV
- Jurisdictional Transmission Control
- All-Island Scheduling and Dispatch

## Demand

- Peak Demand: 7.0 GW
- Minimum Demand: 2.5 GW

## Generation

- 55% Gas/Coal/Oil, 36 % Wind (2020 Fuel Mix)
- Installed Wind: 6.0 GW
- Peak Wind: 4.7 GW (Dec 2023)




Moyle
+/- 500 MW
HVDC (LCC)
to Great Britain

EWIC
+/- 500 MW
HVDC (VSC)
to Great Britain

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# Current Operational Approach to Inertia Management

| Key Operational Stability Metrics | Requirement (March '24) |
|---|---|
| **Minimum Synchronous Area Inertia** | **23,000 MVA.s** |
| Maximum Rate of Change of Frequency (RoCoF) | +/- 1.0 Hz/s |
| Frequency Nadir / Zenith limits | 49.0 Hz / 51.0 Hz |
| Minimum number of large synchronous units that must be synchronised | 7 (currently under trial) |
| System Non-Synchronous Penetration limit | 75 % |

- The minimum inertia requirement is reflected as a constraint in our market scheduling tools – this generally results in a requirement for at least 7 large synchronous units (generators / synchronous condenser).
- Inertia is monitored in real time by summing the inertial contribution (Unit MVA rating x H constant) of all on-line synchronous units (generators and synchronous condensers)
- The current inertia floor allows us to maintain the theoretical RoCoF below 0.6 Hz/s for loss of the largest generation infeed (which is approx. 450 MW / 4000 MVA.s)

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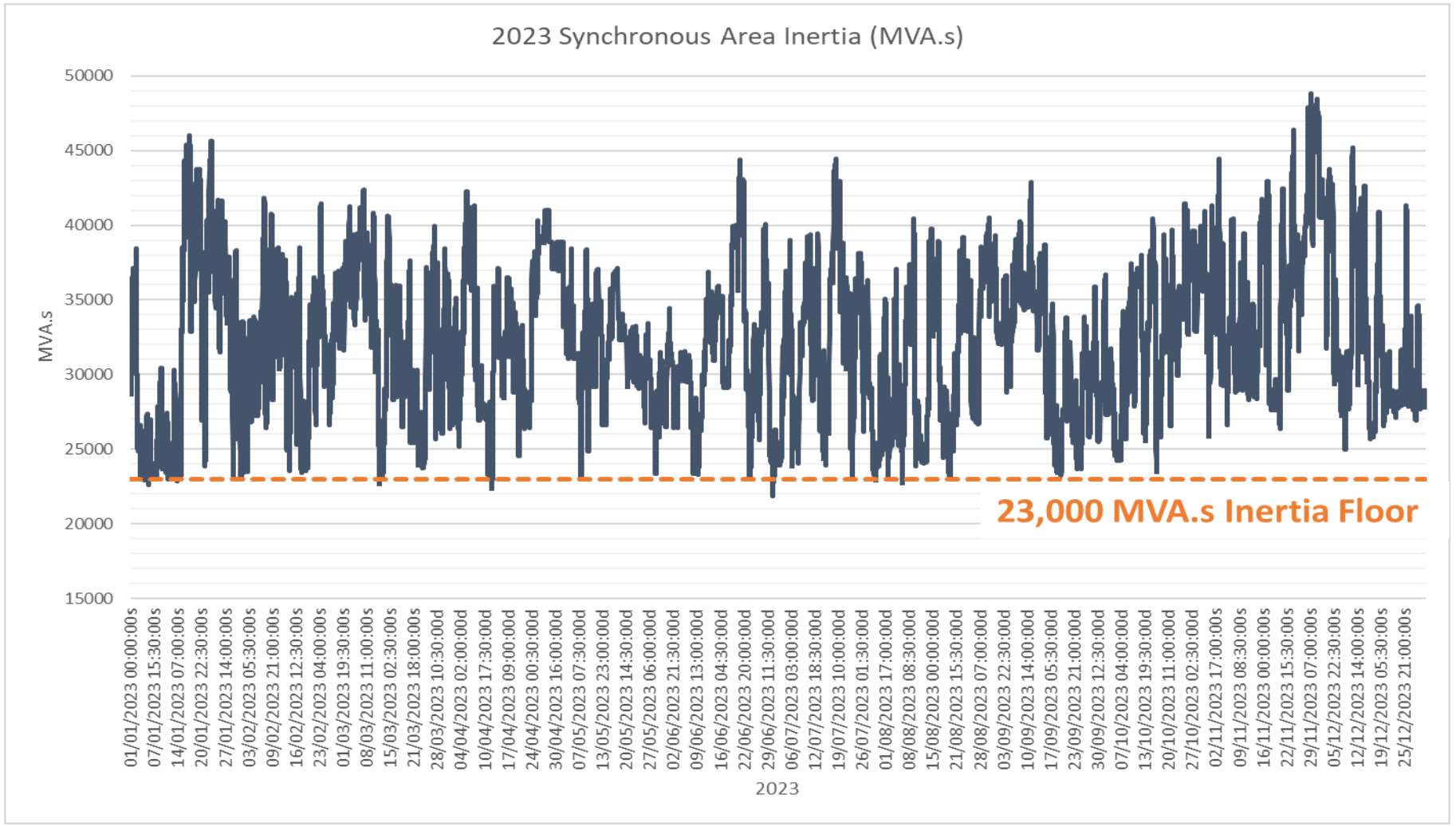
$$RoCoF = \frac{f * \Delta P}{2(Ksys - Klost)}$$

# 2023 Synchronous Area Inertia

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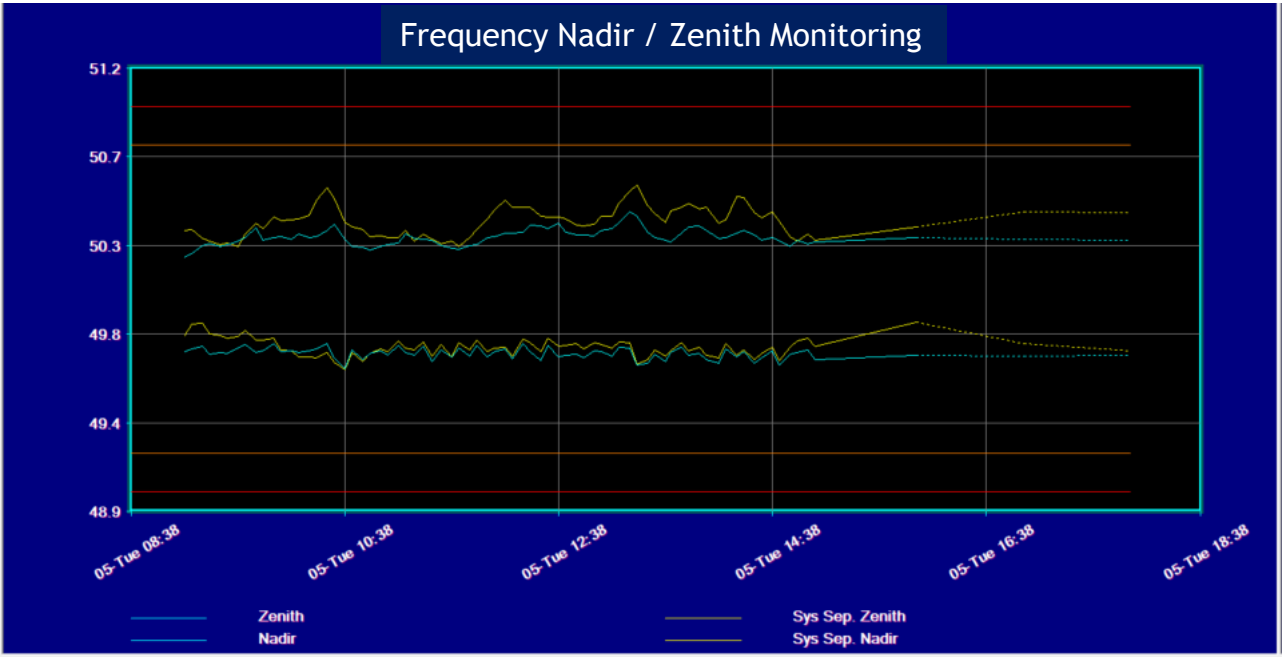
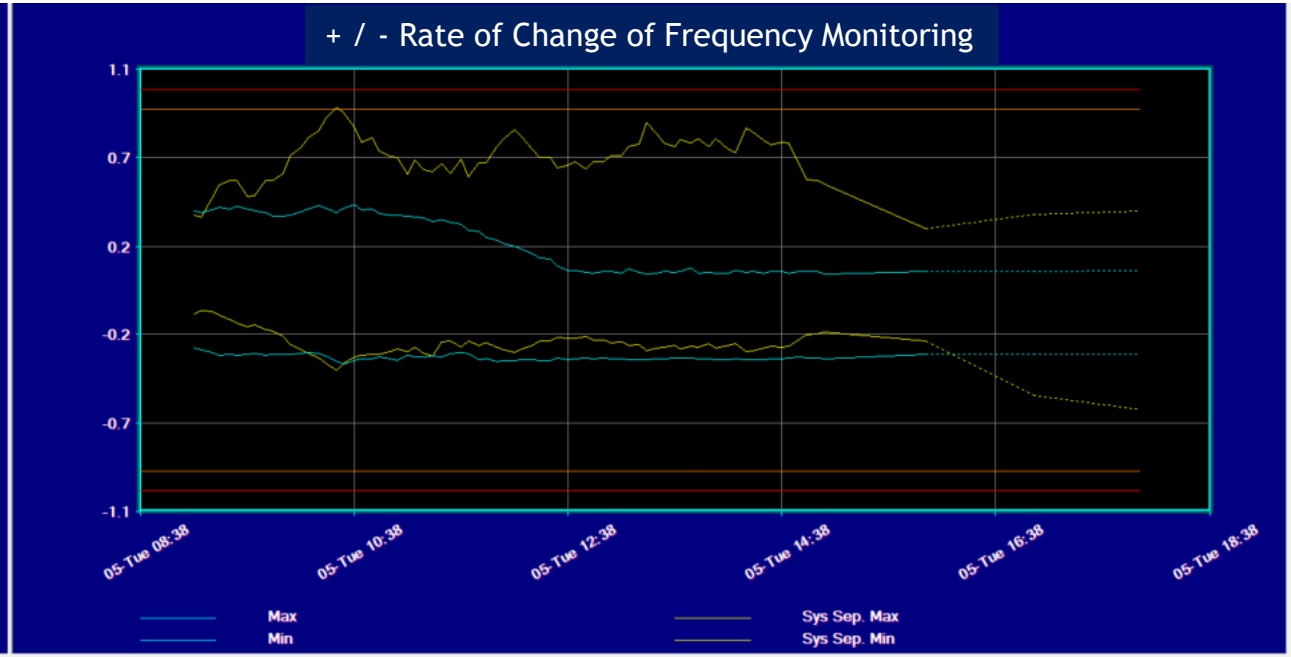
# Real Time Monitoring

## Look-Ahead Security Assessment Tool - LSAT

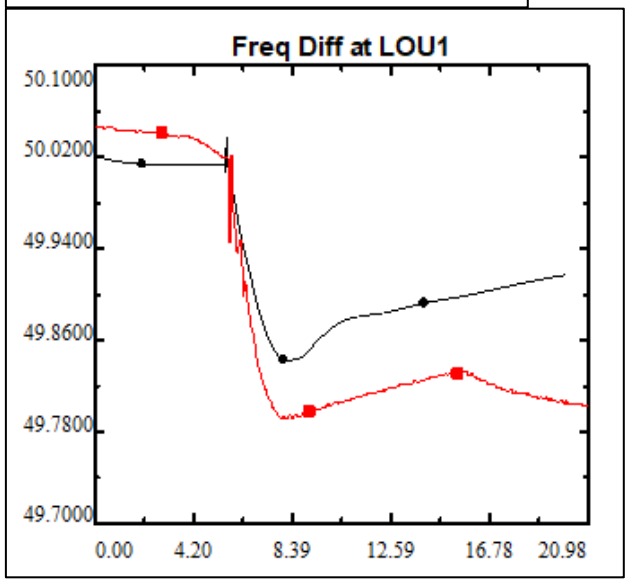
- Transient frequency (Nadir, Zenith and RoCoF) and voltage analysis.
- Real-time - running every 5 minutes.
- Forward-looking - analysis based on forecasted system conditions – running every hour, looking ahead 8 hours (configurable).



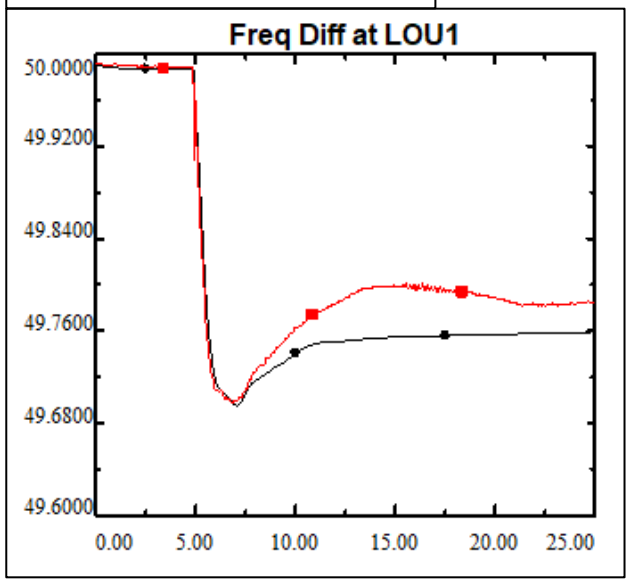



# Validation of LSAT Dynamic Models

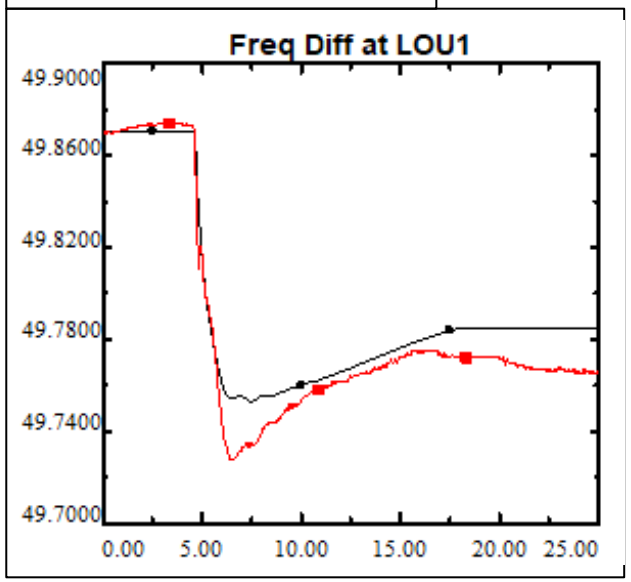
Event: 220kV Transmission fault 07-01-2022




Event: Generator trip 07-01-2022



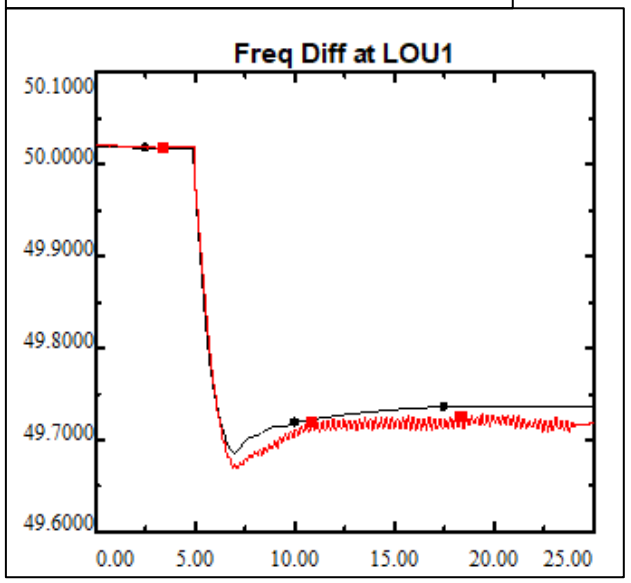

Event: Generator trip 23-03-2023



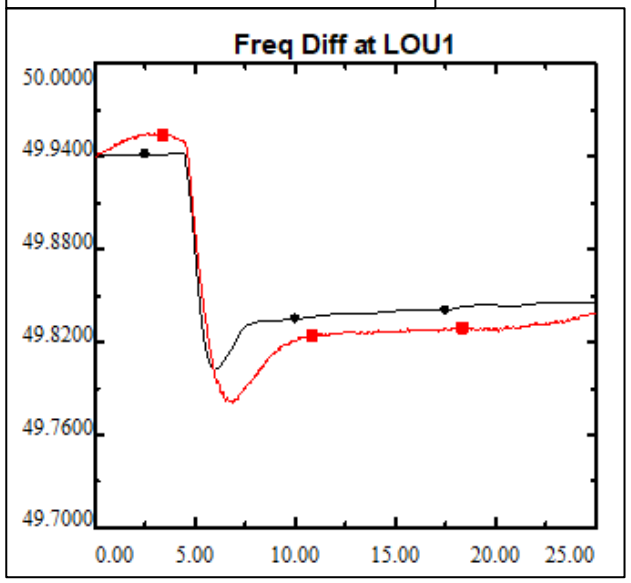

Simulation Hz

Measured Hz

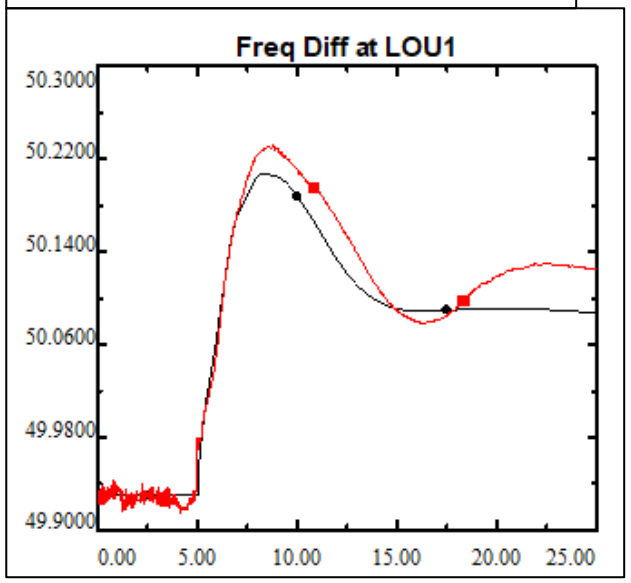
Event: HVDC Interconnector trip 09-08-2022




Event: Generator trip 26-08-2022

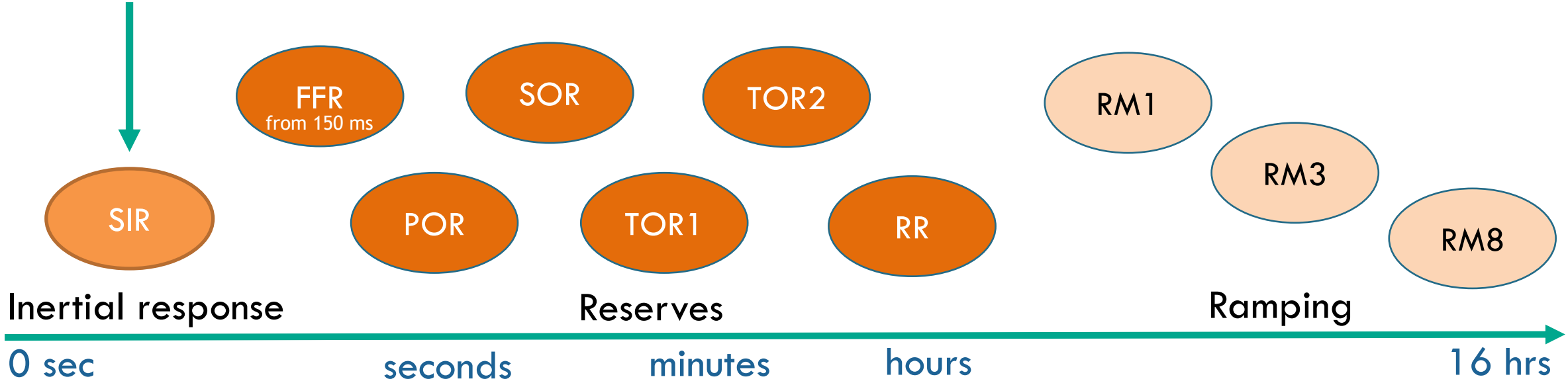



Event: HVDC Interconnector trip 29-08-2022



# Contracting for Inertia

- Synchronous Inertial Response (SIR) is one of a suite of inertia/reserve/ramping System Services that we contract for.
- SIR is a function of the inertia of the unit and its minimum generation level – this has incentivised a reduction in the minimum generation level of synchronous generators.

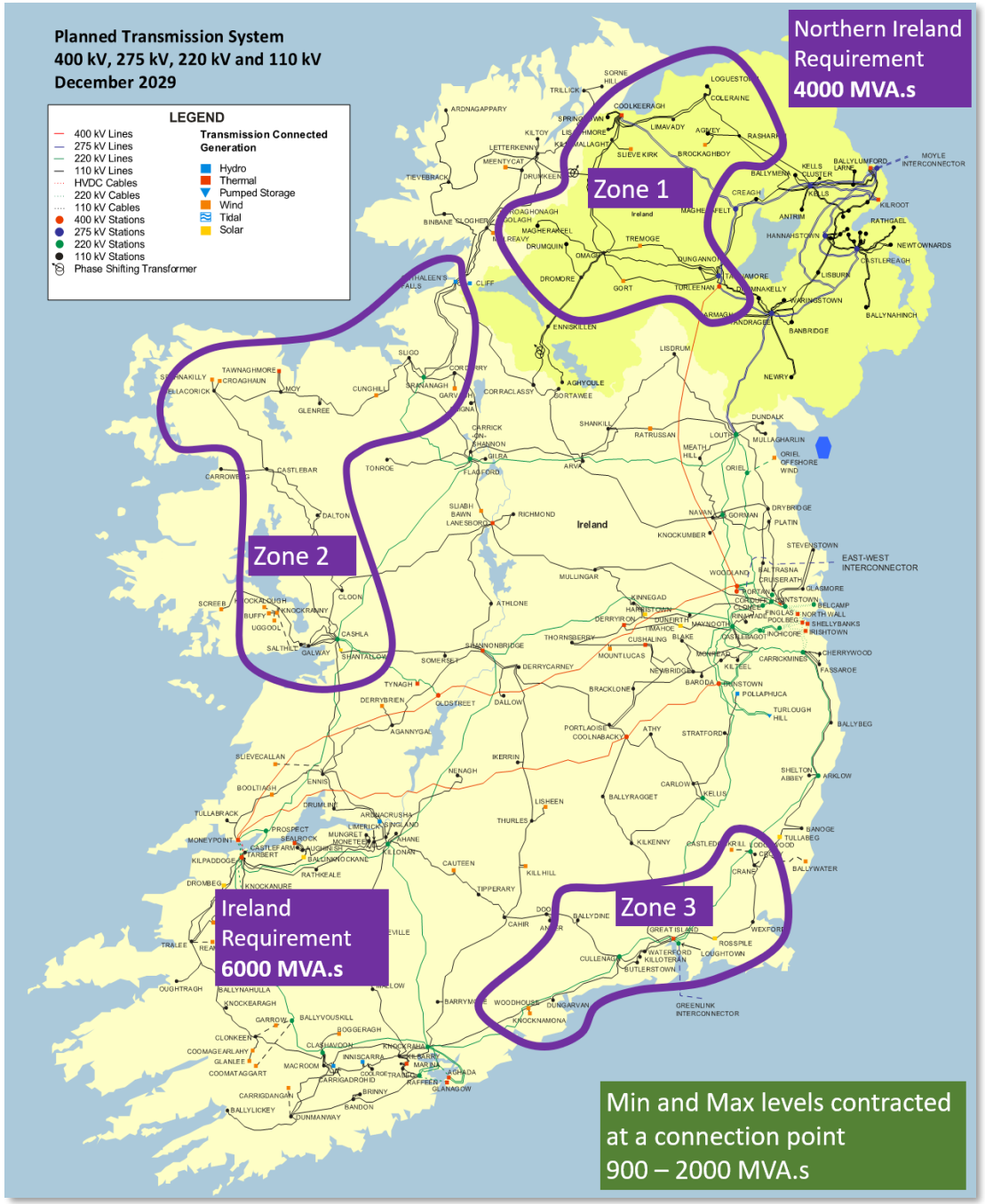



| System Services | | | |
|---|---|---|---|
| **SSRP** | Steady-State Reactive Power | **SIR** | Synchronous Inertia Response |
| **POR** | Primary Operating Reserve | **FFR** | Fast Frequency Response |
| **SOR** | Secondary Operating Reserve | **RM1** | Ramping Margin 1 |
| **TOR1** | Tertiary Operating Reserve 1 | **RM3** | Ramping Margin 3 |
| **TOR2** | Tertiary Operating Reserve 2 | **RM8** | Ramping Margin 8 |
| **RRD** | Replacement Reserve De-Synchronised | **DRR** | Dynamic Reactive Response |
| **RRS** | Replacement Reserve Synchronised | **FPFAPR** | Fast Post Fault Active Power Recovery |

# Low Carbon Inertia Services

**Phase 1 of our LCIS procurement process is aimed at delivering approx. 40 % of our inertia requirements from Synchronous Condensers.**

- Competitive procurement of 10,000 MVA.s of synchronous inertia with reactive power capability and short circuit contribution.
- Individual unit contracts limited to 2,000 MVA.s.
- Locational incentives.
- 6-year contracts.
- Payment based on availability with capability and performance scalars.
- A second phase of procurement will commence in 2024 which may allow for Grid Forming capability to provide the service (subject to technical studies).



# Operational Policy Roadmap

Our Operational Policy Roadmap 2023 to 2030 was published in December 2022, link. It sets out a milestone plan for evolution of key operational policies.

## Key 'Future of Inertia' considerations:

- Inertia evolving from a single synchronous area requirement to regional requirements.
- Review of inertia floor level based on increase in the LSI/LSO (from 500 MW to 700 MW) and other drivers of high RoCoF events (e.g. system split and data centre fault response behaviour).
- Transition from conventional generation to synchronous condensers being the primary source of inertia.
- Assessment and development of a roadmap for Grid Forming technology to contribute to inertia requirements.


### Milestones to 2030 - Dynamic Stability

| Key Changes | | | | Greenlink HVDC | | | LCIS | North South Interconnector Celtic HVDC | | | | Offshore Wind | | | | Potential Further Interconnection | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Policy** | **22H2** | **23H1** | **23H2** | **24H1** | **24H2** | **25H1** | **25H2** | **26H1** | **26H2** | **27H1** | **27H2** | **28H1** | **28H2** | **29H1** | **29H2** | **2030** |
| Inertia | 23 GWs | 20 GWs (All Island) | | 20 GWs (All Island) | | | Regional Inertia | | ~ 20 GWs (Regional or All Island) | ~ 20 GWs (Regional or All Island) | | | | | | ~ 20 GWs (Regional or All Island) |
| RoCoF | 1 Hz/s | 1 Hz/s | | | | | | | | | | | | | | 1 Hz/s |
| System Strength | | | | | | New EirGrid & SONI Policy | | | | | | | | | Updated EirGrid & SONI Policy | Enduring System Strength Policy |
| SNSP | 75% | | | ~ 80% | ~ 80 % | | | Constraint Relaxed ~ 85% | Constraint Removed | | | ~ 90% | | | | ~ 95% |
| MUON | 8 (5 in IE, 3 in NI) | 7 (All Island) | | 7 (All Island) | | | | | Constraint Relaxed ~ 6 | Constraint Removed ~6 | ~ 5 (All Island) | | ~ 4 (All Island) | | | ~ 3 (All Island) |

Key: Information gathering → Analysis System Studies → Operational trial → Trial Review Policy Update → Ongoing monitoring

**Notes**

1. The ~ symbolises that the exact figure will be determined as part of extensive studies. The numbers quoted are our targets as viewed at the end of 2022.
2. For inertia, post the connection of the second North-South Interconnector, a determination will be made to maintain a regional inertia model, or revert to the all-island model.
3. RoCoF requirements may change for new generators connecting before 2030, which must comply with the EU network codes: Requirements for Generators (RfG)
4. Proposed new System Strength policy to define requirements and limits to ensure safe and secure system operation with high penetration of IBR.
5. The intention with SNSP and MUON is to relax the application of the constraints before removing them but to maintain monitoring of both through 2030.

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