Inertia Management on the Power Systems of Ireland and Northern Ireland

G-PST Future of Inertia Summit
11-12 March 2024

Simon Tweed - EirGrid
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)
## Current Operational Approach to Inertia Management

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

- 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)

\[
RoCoF = \frac{f \ast \Delta P}{2(K_{sys} - K_{lost})}
\]
2023 Synchronous Area Inertia

2023 Synchronous Area Inertia (MVA.s)

23,000 MVA.s Inertia Floor
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).

[Images of charts showing frequency nadir/zenith and rate of change of frequency monitoring]
Validation of LSAT Dynamic Models

Event: 220kV Transmission fault 07-01-2022

Event: Generator trip 07-01-2022

Event: Generator trip 23-03-2023

Event: HVDC Interconnector trip 09-08-2022

Event: Generator trip 26-08-2022

Event: HVDC Interconnector trip 29-08-2022

Frequency (HZ)

Simulation Hz
- Measured Hz
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

<table>
<thead>
<tr>
<th>Service</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>SSRP</td>
<td>Steady-State Reactive Power</td>
</tr>
<tr>
<td>POR</td>
<td>Primary Operating Reserve</td>
</tr>
<tr>
<td>SOR</td>
<td>Secondary Operating Reserve</td>
</tr>
<tr>
<td>TOR1</td>
<td>Tertiary Operating Reserve 1</td>
</tr>
<tr>
<td>TOR2</td>
<td>Tertiary Operating Reserve 2</td>
</tr>
<tr>
<td>RR</td>
<td>Replacement Reserve De-Synchronised</td>
</tr>
<tr>
<td>RRD</td>
<td>Replacement Reserve Synchronised</td>
</tr>
<tr>
<td>FFR</td>
<td>Fast Frequency Response</td>
</tr>
<tr>
<td>SIR</td>
<td>Synchronous Inertia Response</td>
</tr>
<tr>
<td>RM1</td>
<td>Ramping Margin 1</td>
</tr>
<tr>
<td>RM3</td>
<td>Ramping Margin 3</td>
</tr>
<tr>
<td>RM8</td>
<td>Ramping Margin 8</td>
</tr>
<tr>
<td>DRR</td>
<td>Dynamic Reactive Response</td>
</tr>
<tr>
<td>FPFAPR</td>
<td>Fast Post Fault Active Power Recovery</td>
</tr>
</tbody>
</table>

0 sec SIR, POR, TOR1, RR | 16 hrs RM1, RM3, RM8 |
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.