ELECTRIC POWER RESEARCH INSTITUTE

Implications of reduced inertia levels

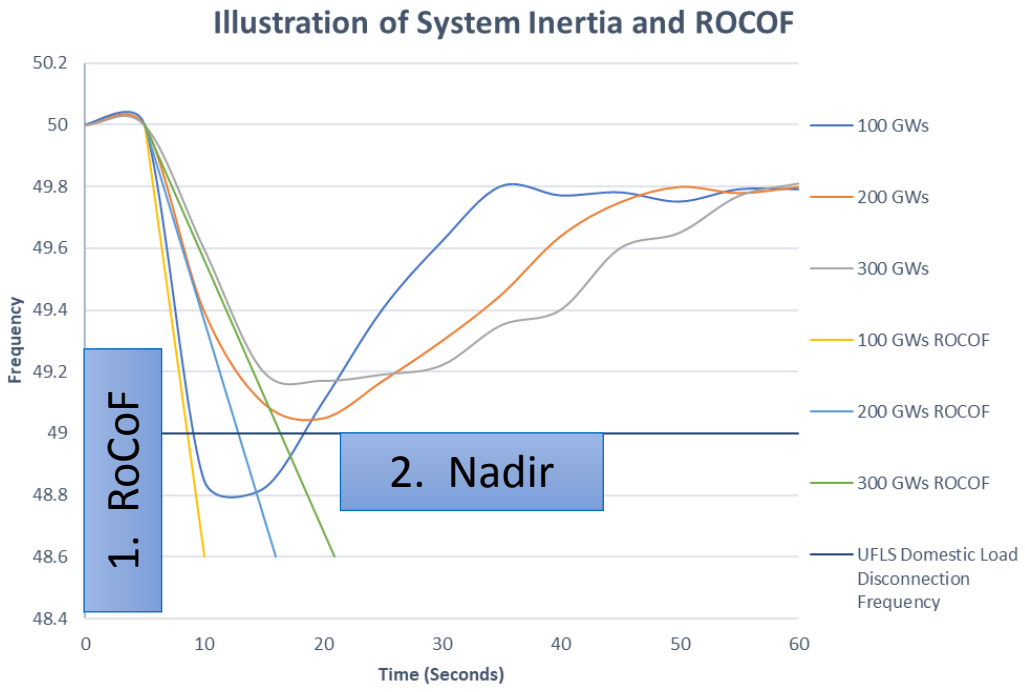
FFR in Europe

Papiya Dattaray
Eamonn Lannoye
Aidan Tuohy
pdattaray@epri.com

IEA Webcast
25th March, 2020

© 2020 Electric Power Research Institute, Inc. All rights reserved.

Reduced Inertia and Frequency Security



Nadir is a concern :

- Operational Security Standards
- Customer Load Shedding

Frequency Containment

- FFR < 2s
- FCR < 10s

RoCoF is a concern :

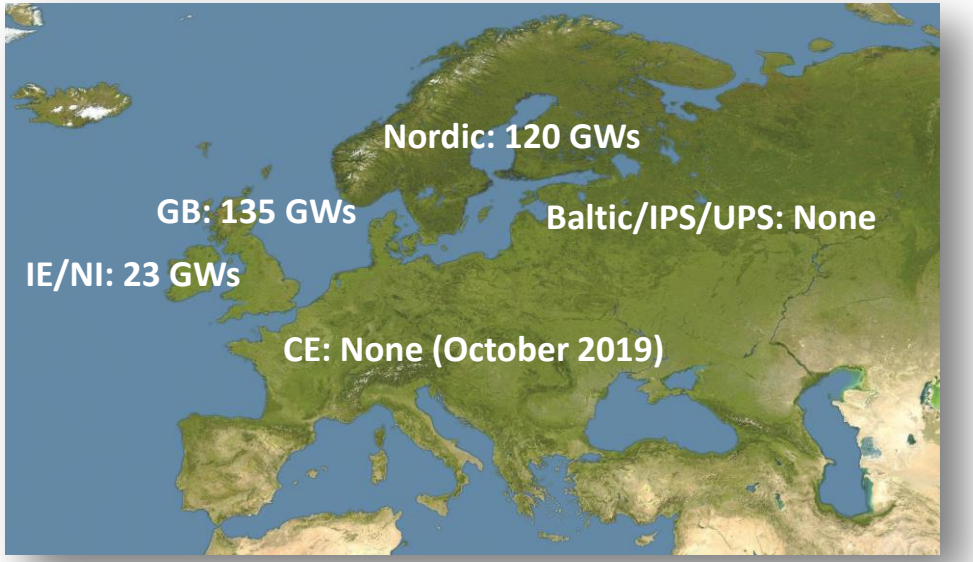
- Loss of Mains operation
- Generation withstand

- Cascade Loss of Generation (compromise system adequacy)
- Spurious operation of under frequency protection in low inertia regions

Critical inertia floors

RoCoF Constraint

Loss of Main Relay setting changes

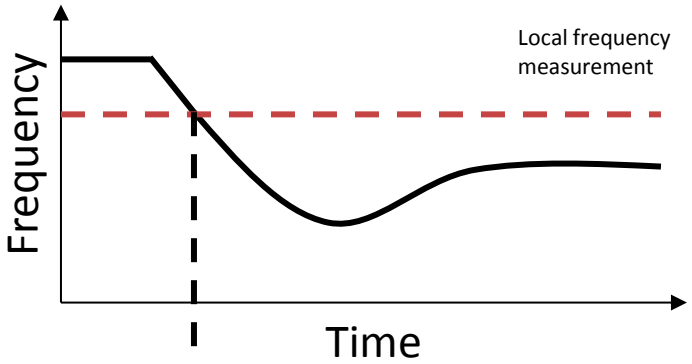


SOGL 39.3a

© 2020 Electric Power Research Institute, Inc. All rights reserved.

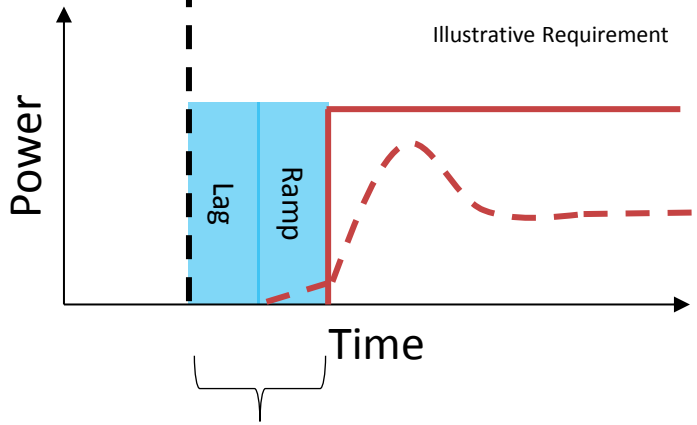
Fast Frequency Response

EirGrid define FFR as a "MW response provided from 2 to 10 seconds after start of event"



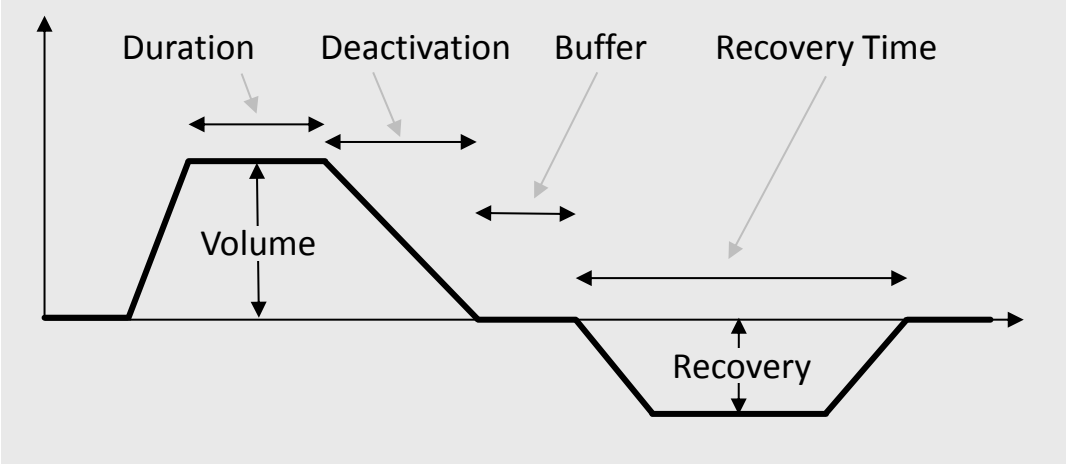
Frequency Trigger

EirGrid:	**49.985 to 49.8 Hz (dynamic)**
	49.8 to 49.3 Hz (static)
National Grid ESO[1]:	**49.9 to 49.5 Hz (dynamic)**
	49.6 Hz (static)
Nordic TSOs:	**49.5, 49.6 and 49.7 Hz (static)**



Static or Dynamic

- **Steps**
- **Volume**
  Duration
  Buffer Time
  Recovery
- **Droop**



Full Response Time
Lag Time + Ramp Time

EirGrid:	**0.1 to 2 s**
National Grid ESO[1]:	**0.5 to 1 s**
Nordic TSOs:	**1 s**

© 2020 Electric Power Research Institute, Inc. All rights reserved.

EirGrid

"Delivering a Secure Sustainable System"

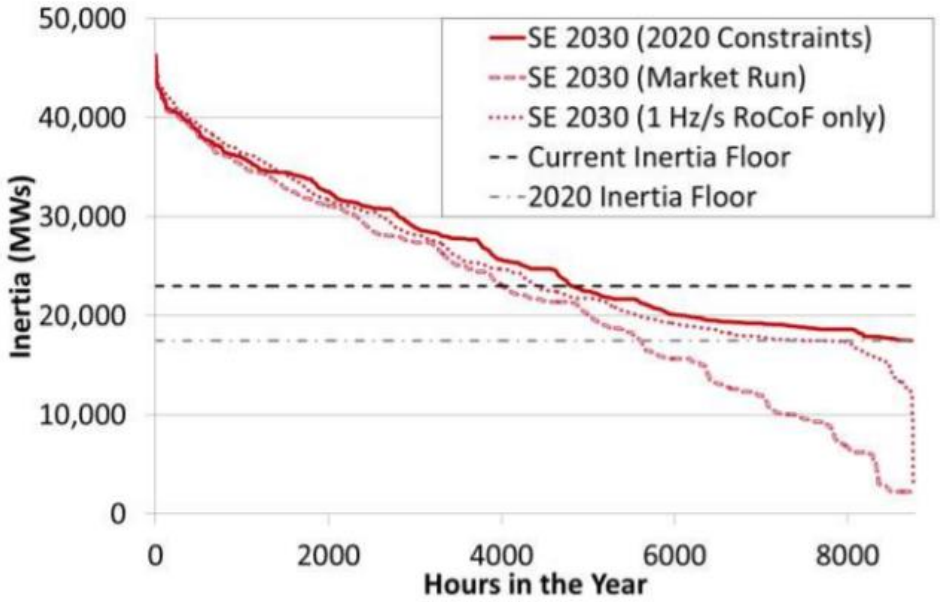
14 System Services

- Grid Code
- Performance Monitoring
- DSM
- System Services

- Frequency
- Voltage
- ROCOF
- Renewable Data

- WSAT
- Control Centre Tools
- Model Dev. & Studies

- Frequency and Voltage services.
- Range from 0.15 seconds to eight hours



- Ramping assessments
- Voltage trajectory assessment
- Real time and look ahead dynamic security assessment

Inertia: 23 GWs	**17.5 GWs**
SNSP: 50 %	**75 %**
RoCoF: 0.5 Hz/s	**1 Hz/s**

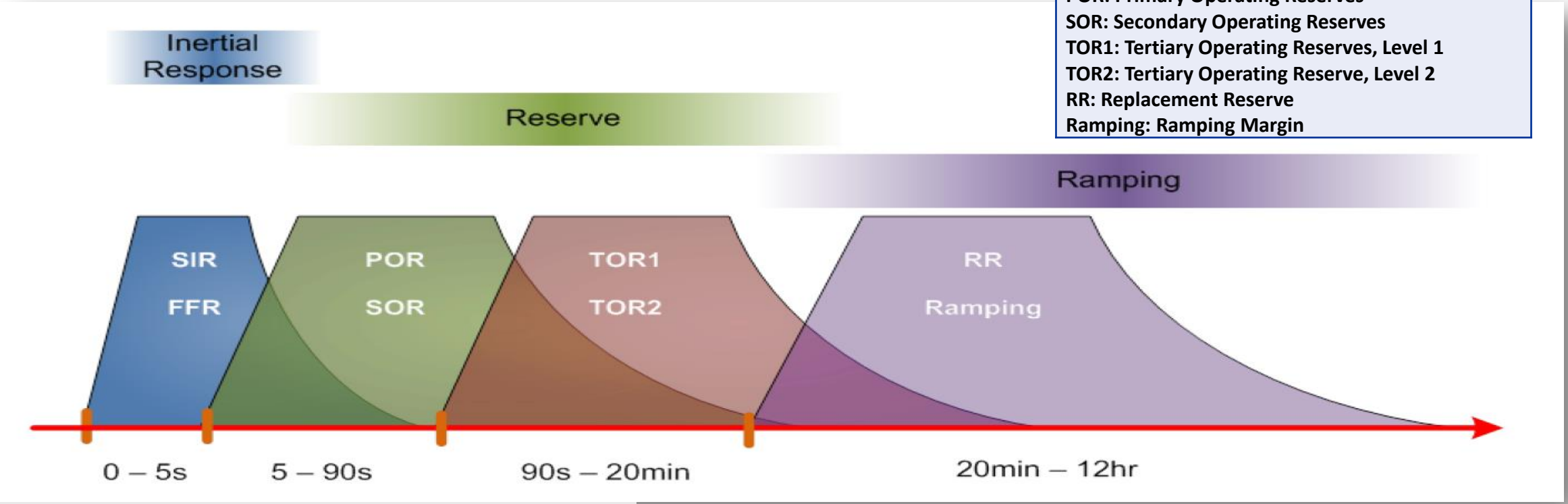
© 2020 Electric Power Research Institute, Inc. All rights reserved.

Interaction Between Synchronous Inertia, FFR, FCR, RR

In Ireland, new inertial response measures have been added to EirGrid's reserve planning scheme, as part of the coordinated plan to increase the penetration of renewable resources.

EirGrid: Frequency Response System Services

SIR: Synchronous Inertial Response
FFR: Fast Frequency Response
POR: Primary Operating Reserves
SOR: Secondary Operating Reserves
TOR1: Tertiary Operating Reserves, Level 1
TOR2: Tertiary Operating Reserve, Level 2
RR: Replacement Reserve
Ramping: Ramping Margin

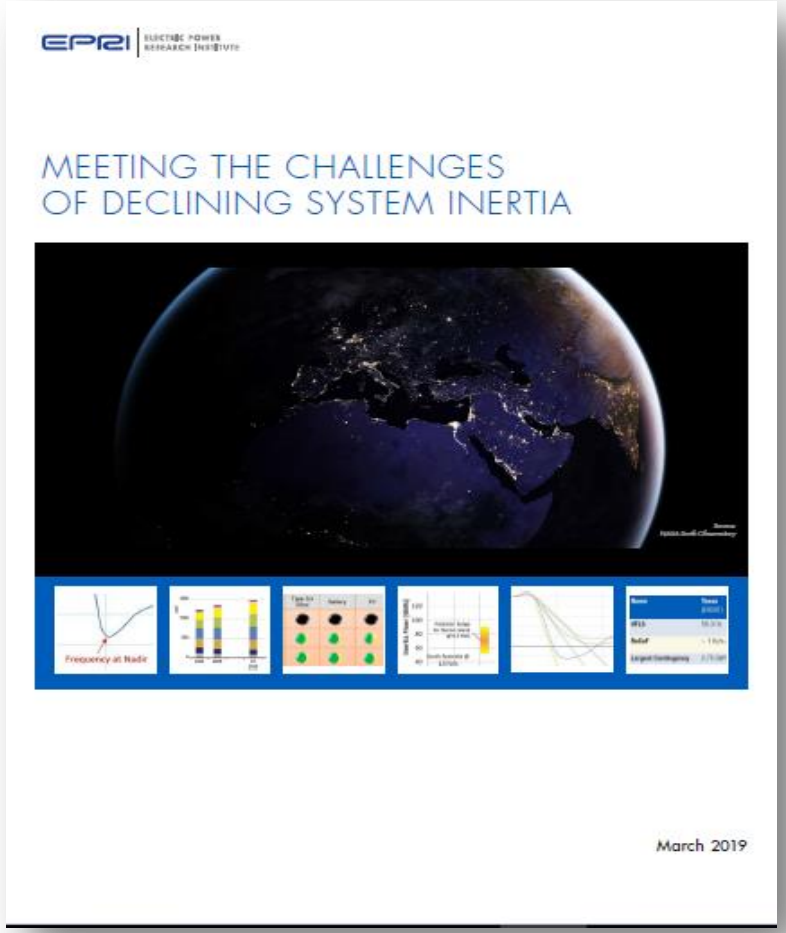


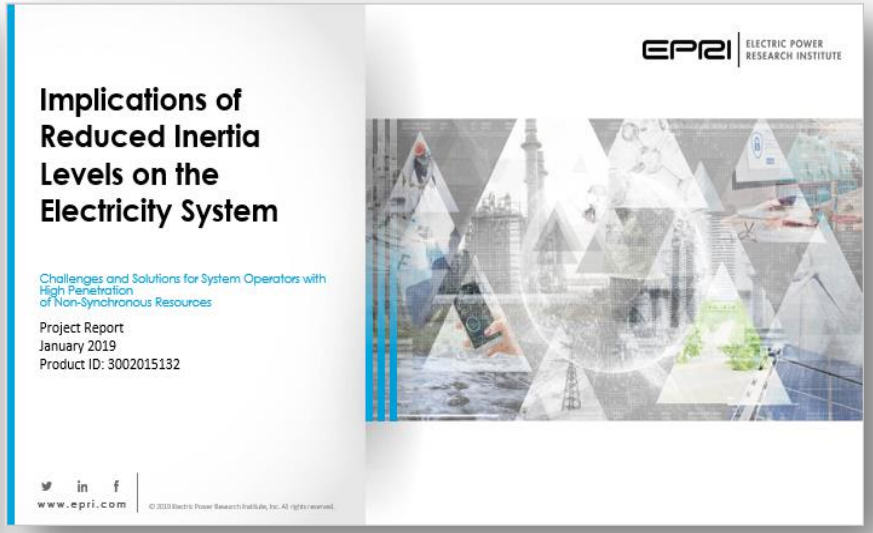
SIR - Synchronous Inertial Response

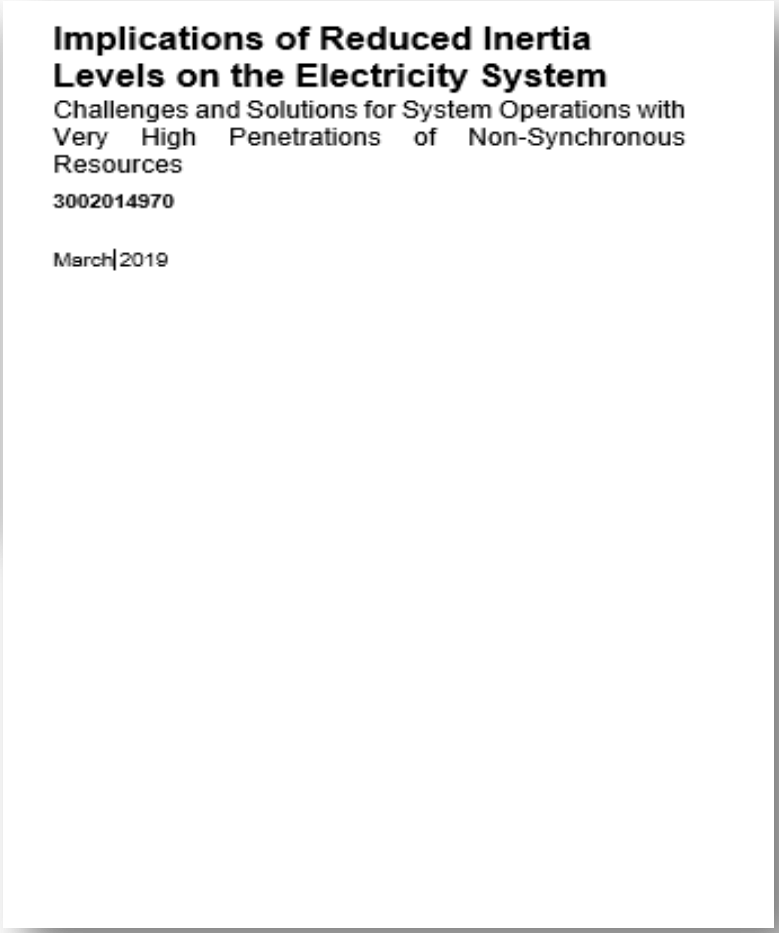
- Places value on inertia, tariff arrangement
- Incentivizes lower minimum stable generation

© 2020 Electric Power Research Institute, Inc. All rights reserved.

EPRI Project on Operation With Decreasing Inertia Levels







All reports are freely downloadable. Click images for links

Lead Funding Member

IBERDROLA

© 2020 Electric Power Research Institute, Inc. All rights reserved.

Together…Shaping the Future of Electricity

© 2020 Electric Power Research Institute, Inc. All rights reserved.