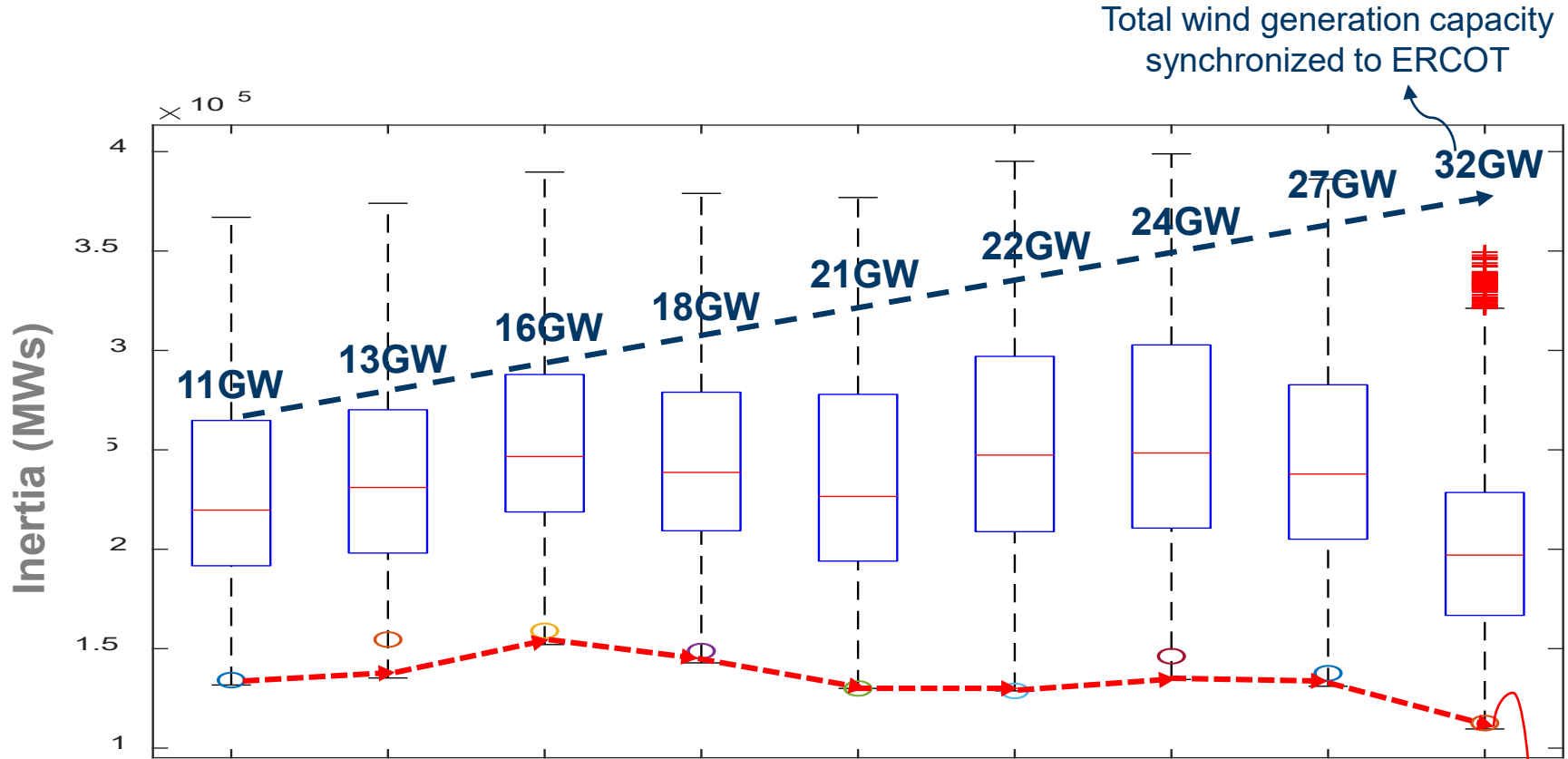




Fast Frequency Response in the Texas Power System

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ERCOT Inertia 2013-2021(Jan-Jul)



Date	2013	2014	2015	2016	2017	2018	2019	2020	2021
Min synch. Inertia (GW*s)	132	135	152	143	130	128.8	134.5	131.1	109
System load at min. synch. Inertia (GW)	24.7	24.6	27.2	27.8	28.4	28.4	29.9	30.7	32.6
Non-synch. Gen. in % of System Load	31	34	42	47	54	53	50	57	65



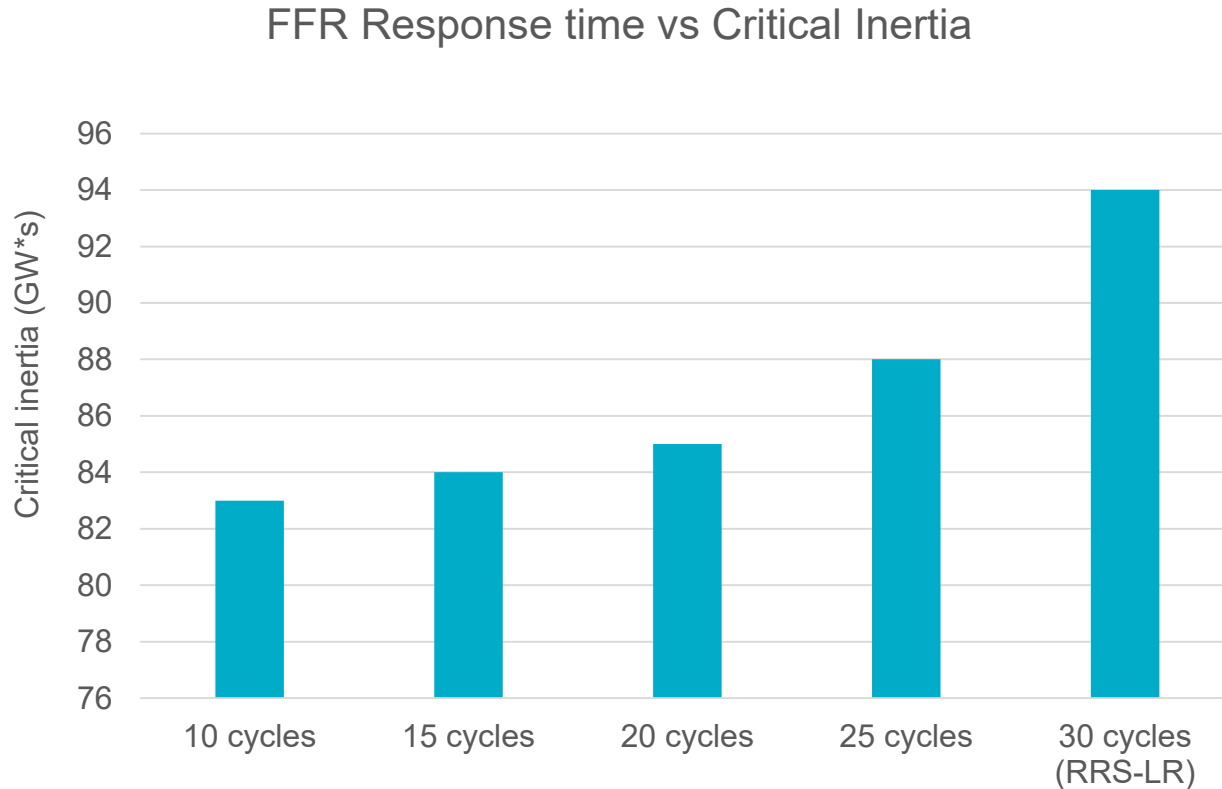
Introduction to Responsive Reserve Service

- In ERCOT, **Responsive Reserve Service (RRS)** is an Ancillary Service that provides operating reserves for frequency containment after large generation contingency events.
- RRS may be provided by:
 - Resources providing **Primary Frequency Response (RRS-PFR)** - e.g., Gen Resources, Controllable Load Resources, 17 mHz deadband, 5% droop
 - **Load Resources** controlled by high-set under-frequency relays (RRS-UFR), full response to 59.7 Hz trigger within 0.5 second.
 - Resources capable of providing **Fast Frequency Response (RRS-FFR)**. **NEW**
- RRS is procured to ensure that the sufficient capacity is available to respond to frequency excursions once a unit trips (2805 MW).
- Amount of RRS procured depends on expected inertia and participation of fast responding resources (RRS-UFR and RRS-FFR)

What is FFR

- To be qualified for the provision of FFR, a resource should be automatically deployed and provide its full response within 15 cycles after the frequency meets or drops below a preset threshold (59.85 Hz).
- FFR resources must sustain a full response for at least 15 minutes once deployed.
- When a resource providing FFR is deployed, it shall not recall its capacity until the frequency is greater than 59.98 Hz or deployment lasted for over 15 minutes.
- Once recalled, the resources providing FFR must restore their full FFR responsibility within 15 minutes after the cessation of deployment.

FFR Response Time vs Critical Inertia



With faster FFR, critical inertia or inertia floor can be kept at lower level.

Advantage: Less commitment of synchronous generation just for inertia.

1 cycle = 16.667 ms for 60 Hz system

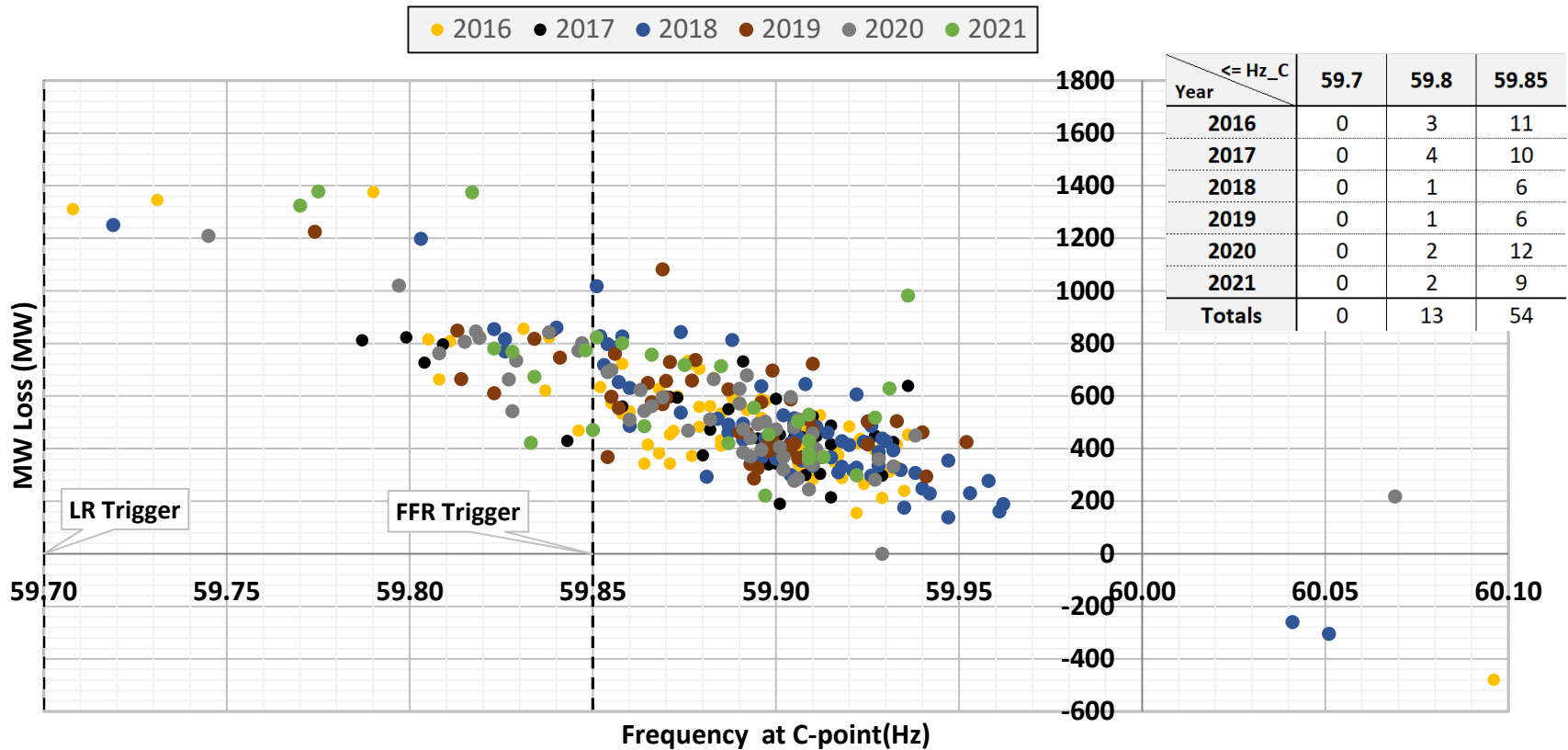
RRS-FFR vs RRS-LR – Trigger Frequency

Resource providing FFR

- Support frequency at 59.85 Hz.

Load Resource providing RRS

- Support frequency at 59.7 Hz.



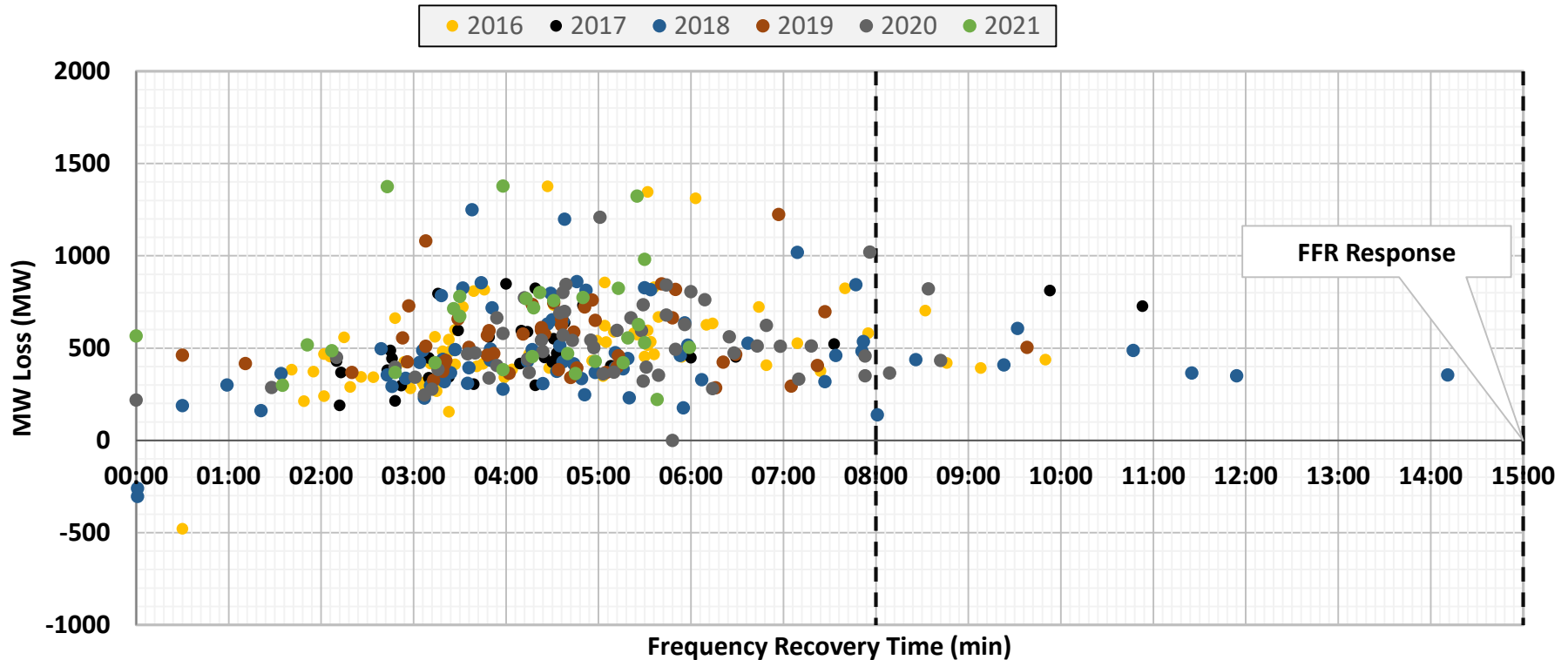
RRS-FFR vs RRS-LR – Max Response Duration

Resource providing FFR

- Sustain full response for 15 minutes or until ERCOT recalls deployment, whichever occurs first.

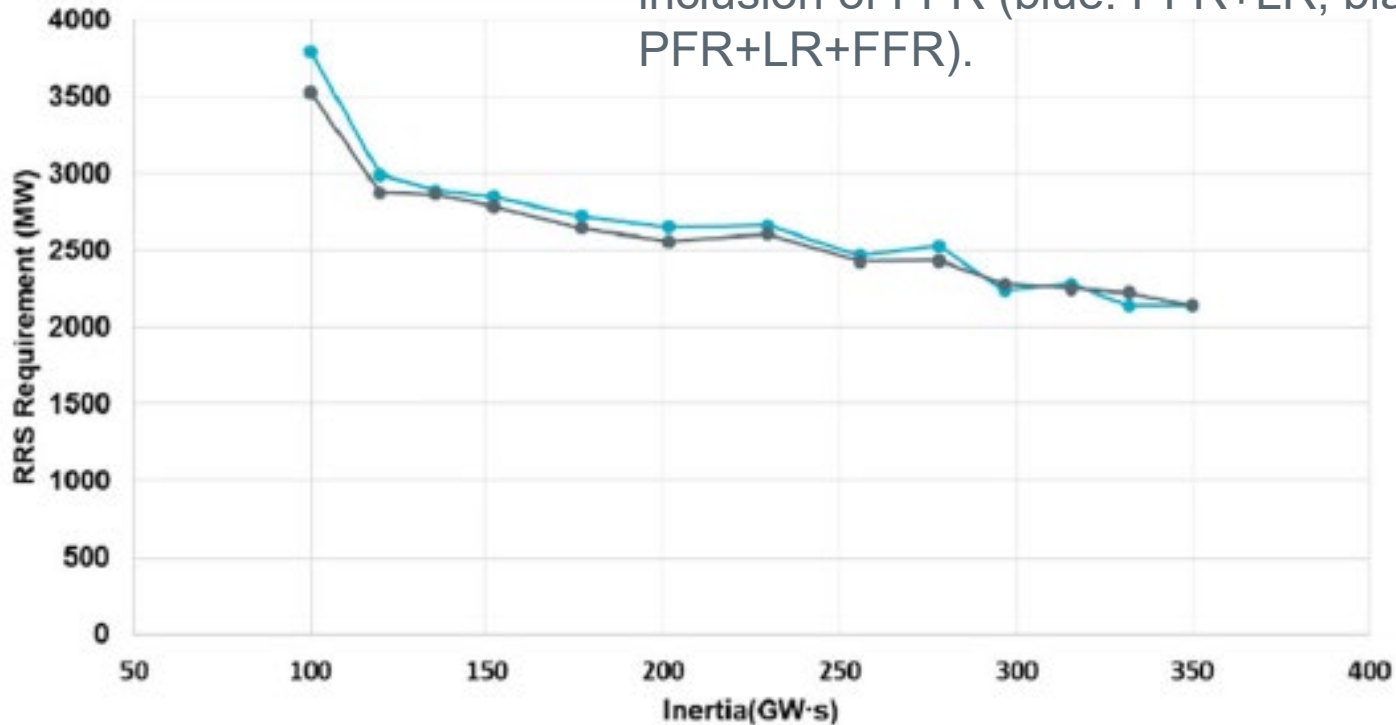
Load Resource providing RRS

- Sustain response until deployment is recalled.



Benefit of Having FFR in the RRS Mix

Reduction in RRS requirement due to inclusion of FFR (blue: PFR+LR, black: PFR+LR+FFR).

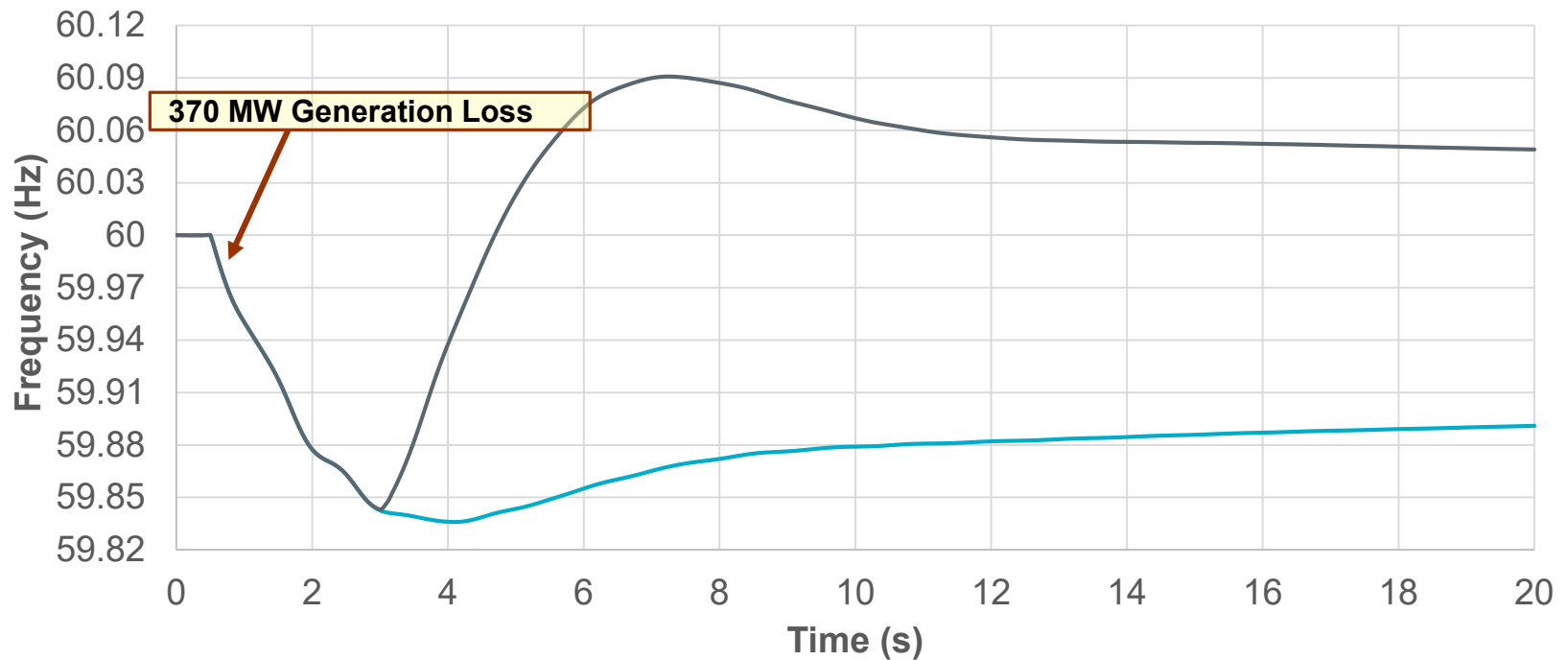


Reduction in total RRS amount is achieved by replacing a portion of LR (with 59.7 Hz trigger, 0.5 s response) with even faster response of FFR (59.85 Hz trigger, 0.25 s response).

FFR Limit Determination

Inertia :109 GW.s
1420 MW PFR, 59.85 Hz & 15 cycles FFR

— 0 MW FFR — 460 MW FFR



Conclusions

- FFR arrests frequency decay faster and therefore, Critical Inertia can be reduced – production cost savings and higher renewable deployments.
- FFR ensures RRS-LR remains available for more severe frequency events – increased reliability.
- FFR leads to reduction in overall RRS quantities: cost savings.
- Step response from FFR leads to relatively low FFR limit – limited benefits from FFR.

Thank you! Questions?



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