Ensuring Grid Reliability and Operational Preparedness

October 7, 2021

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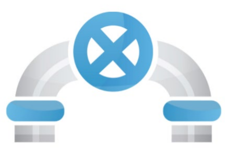
AESO Stakeholder Engagement Framework

Agenda: what we are discussing today

- Purpose and session objectives
- Overview of recent system events
  - Impact of generation pullback and distributed energy resources (DERs) loss during events
- Plans to ensure grid reliability and operational preparedness
  - Short, medium, and long-term plans
  - Achievements and work in progress
- Frequency response capability next steps
- Most Severe Single Contingency (MSSC) implications
- Q & A

Key takeaways

- Changing supply mix creating frequency response capability challenges on our system
- Increasing importance of consistent, predictable and expected frequency response
- Generation pullback and loss of distributed energy resources during frequency events exacerbating the challenge
- AESO has taken—and is planning—more action to improve frequency response capability across the key time horizons

Overview of Recent System Events

Recent System Events in Alberta

June 7, 2020
- AB-BC Intertie Trip
- Frequency dropped to 59.15 Hz
- Under-Frequency Load Shed (UFLS) activated (235 MW)
- Load Shed Service for imports (LSSi) activated (188 MW)

October 16, 2020
- Islanded Mode of Operation, Internal Generation (267 MW) trip
- Frequency dropped to 59.57 Hz for such a small disturbance
- No UFLS or LSSi triggered

February 21, 2021
- AB-BC Intertie Trip
- Frequency dropped to 59.44 Hz
- UFLS activated (125 MW)
- No LSSi activated

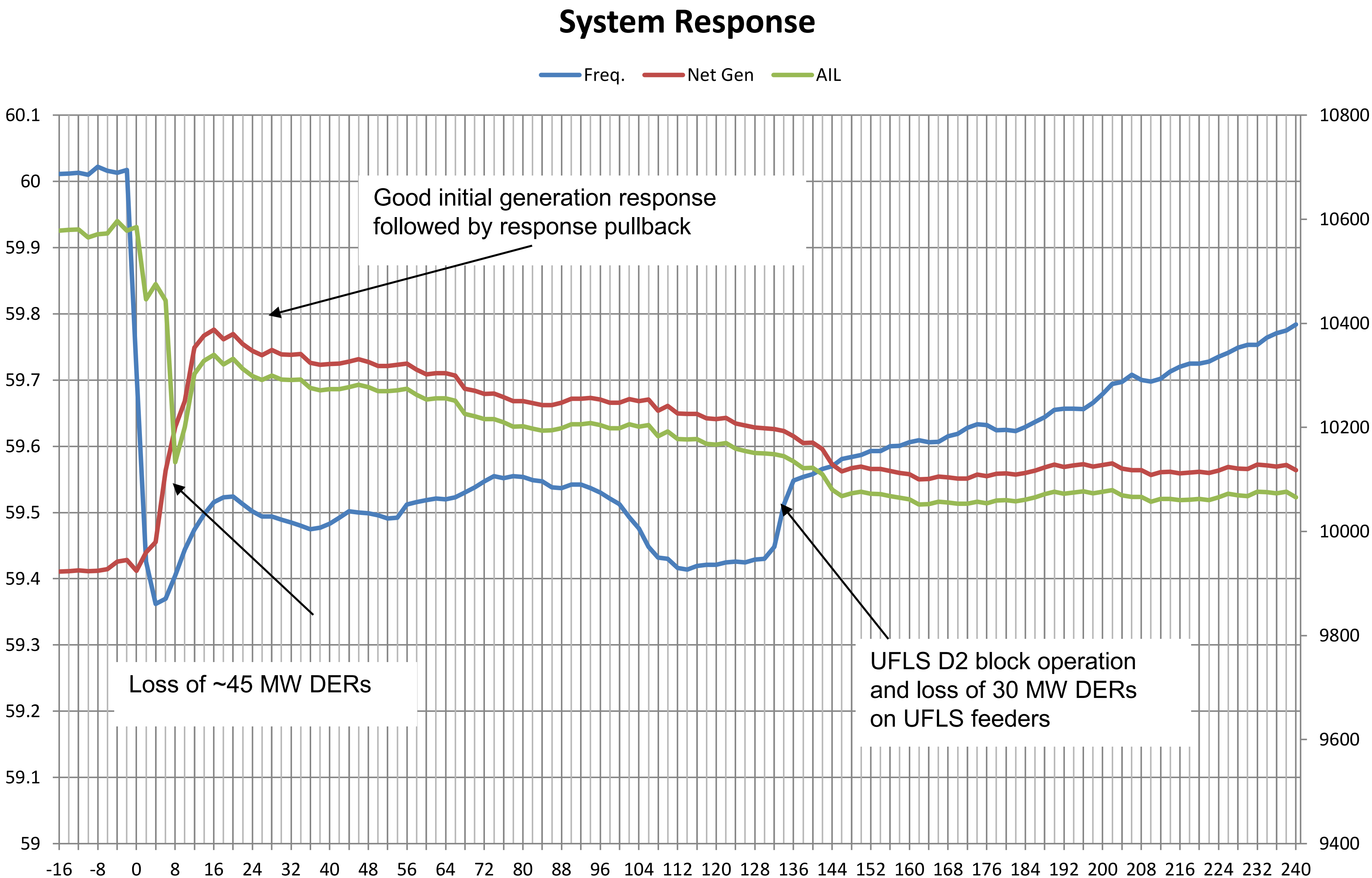
February 22, 2021
- AB-BC Intertie Trip
- Frequency dropped to 59.48 Hz
- No UFLS activated
- LSSi activated (208 MW)

June 3, 2021
- AB-BC Intertie Trip
- Frequency dropped to 59.42 Hz
- UFLS activated (177 MW)
- LSSi activated (93 MW)
- 60 MW of DERs tripped

Event Overview – June 3, 2021

- Prior to the event:
  - Alberta Internal Load (AIL): 10,577 MW
  - Scheduled BC&MT flow: 660 MW
  - Actual BC&MT import prior to the trip: 708 MW
  - Wind generation: 1,025 MW
  - Solar generation: 259 MW
  - System Inertia: 55.3 GVA.S
  - 103 MW dispatched LSSi per the normal LSSi table
- Post event:
  - Total load of 270 MW shed including 93 MW LSSi response
  - UFLS Block D2 was activated
  - Gen response (A-B period): 78 MW/0.1Hz
  - Load Response (A-B period): 38.1 MW/0.1 Hz (2.16% damping)

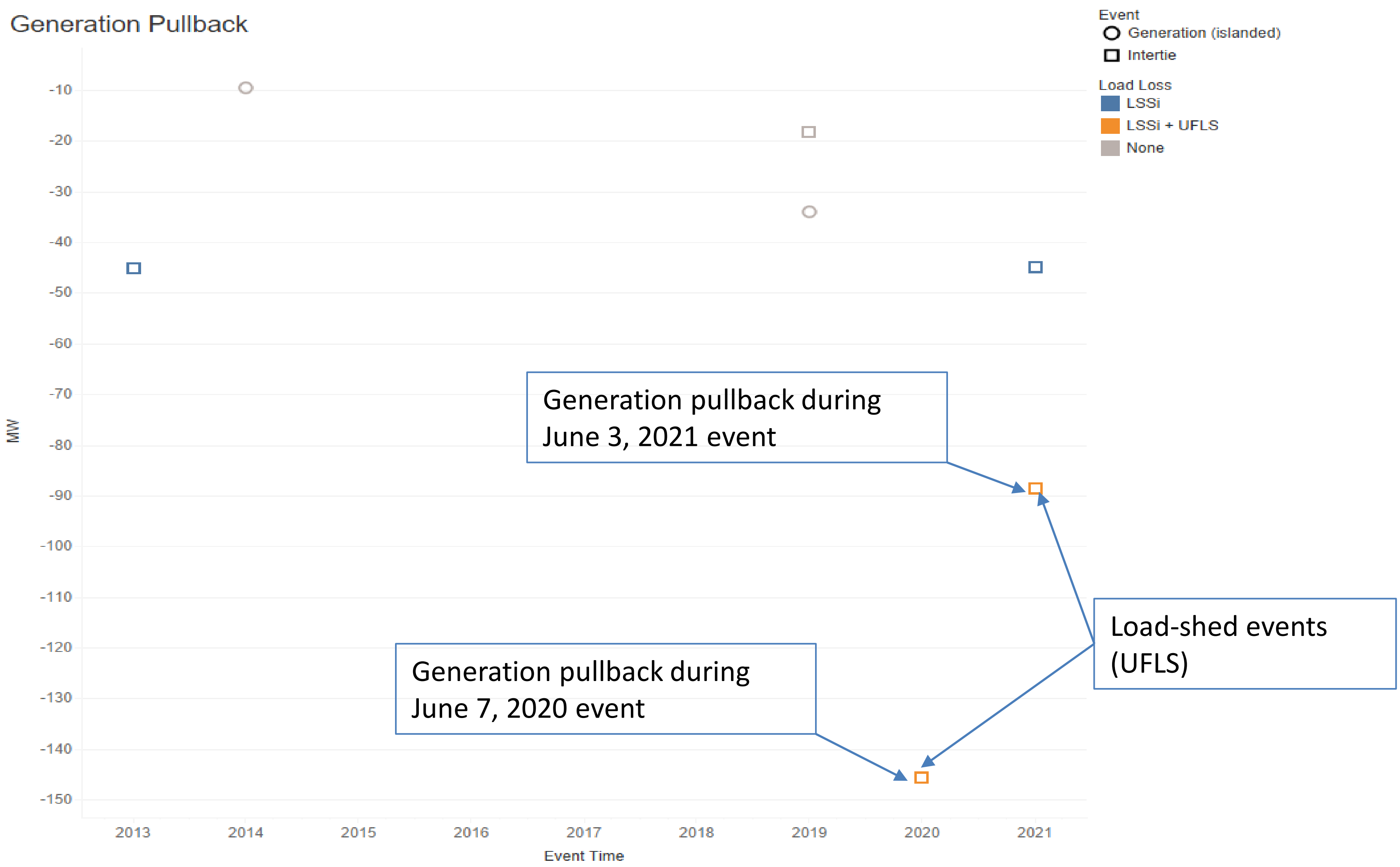
System Response – June 3, 2021



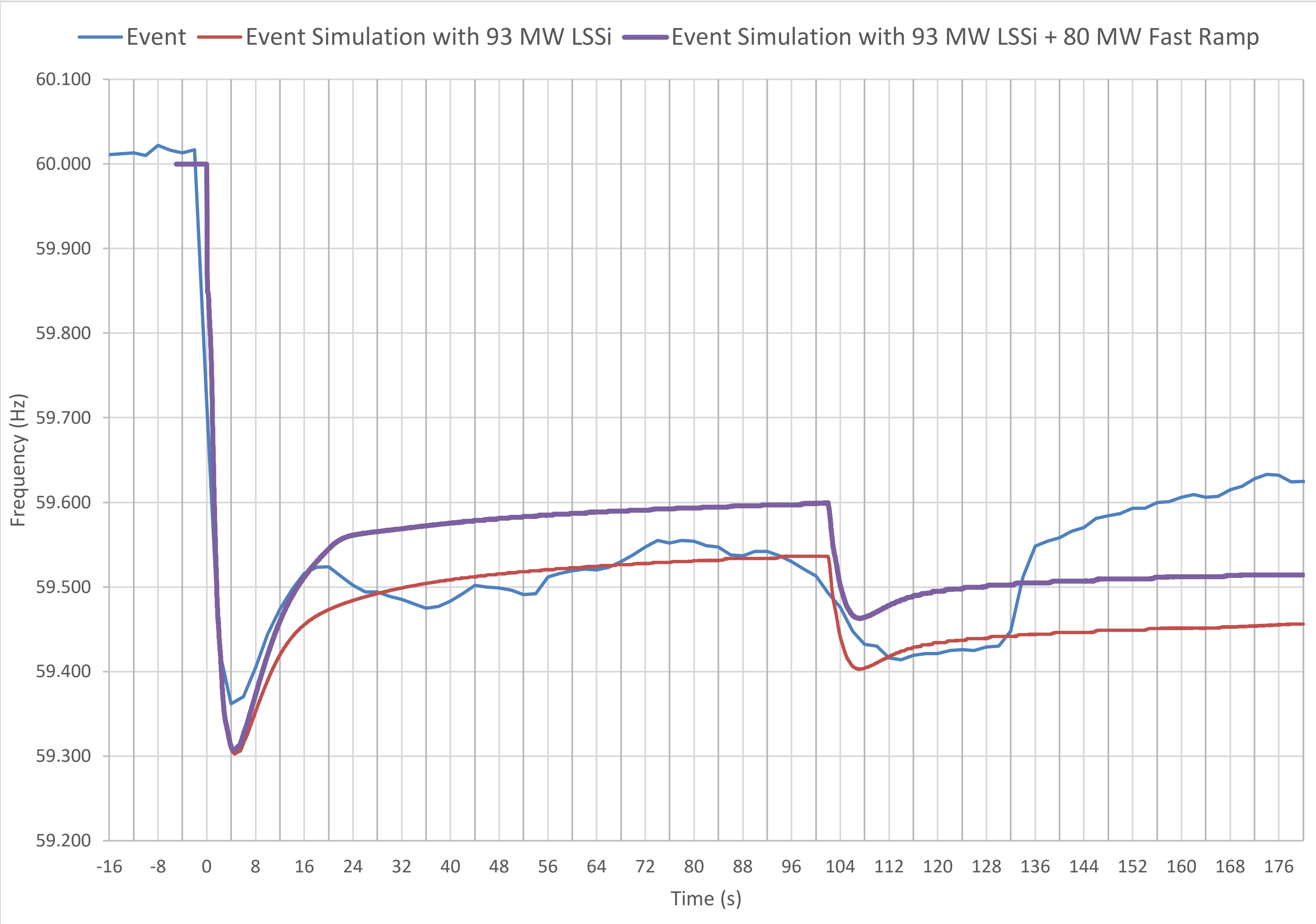
Impact of DERs on frequency response capability

- 2021 Long Term Outlook (LTO) - DERs:
  - 2,500 MW in the Reference case
  - 4,500 MW in the Clean-Tech scenario
- Tripping of DERs during system events can exacerbate the impact of an event on grid reliability
  - About 60 MW of DERs tripped during the June 3, 2021 event
  - Working with impacted DERs and distribution facility owners (DFOs) in the province to enable the implementation of the reliability standard (IEEE 1547) – frequency and voltage ride-through requirements
- Tripping of DERs as part of the province's UFLS service is a concern
  - Working with DFOs on identifying DERs on UFLS feeders and the potential of employing strategies such as sectionalizing

Two UFLS events due to larger generation pullback



80 MW of fast supply would have mitigated June 3, 2021 load shed event



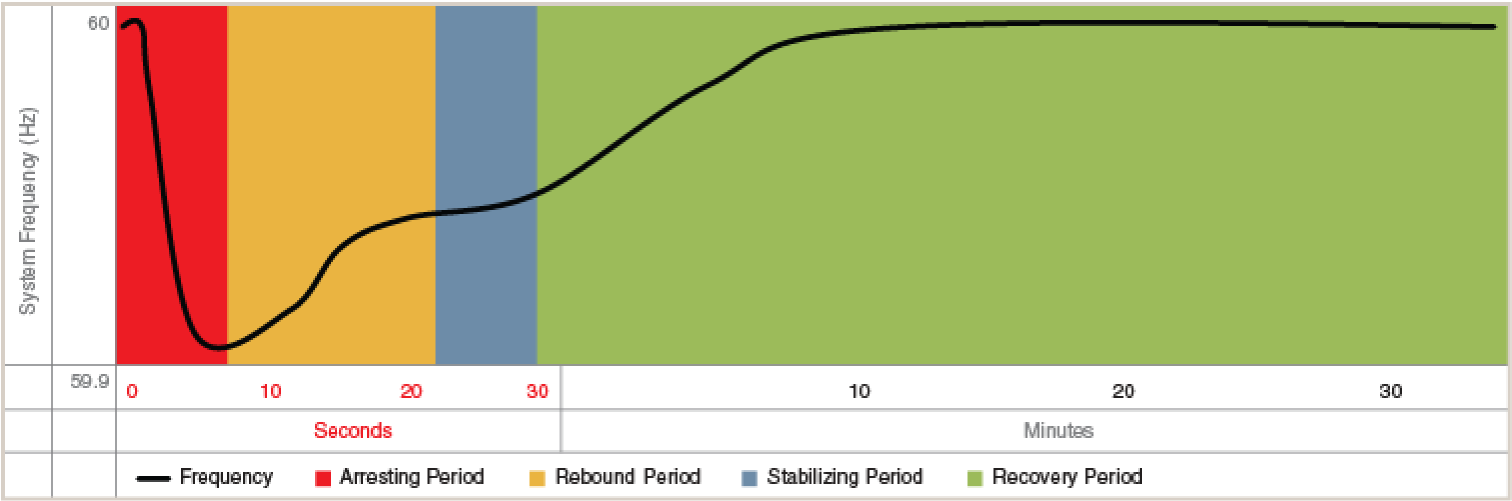
Key drivers impacting frequency response capability from recent events

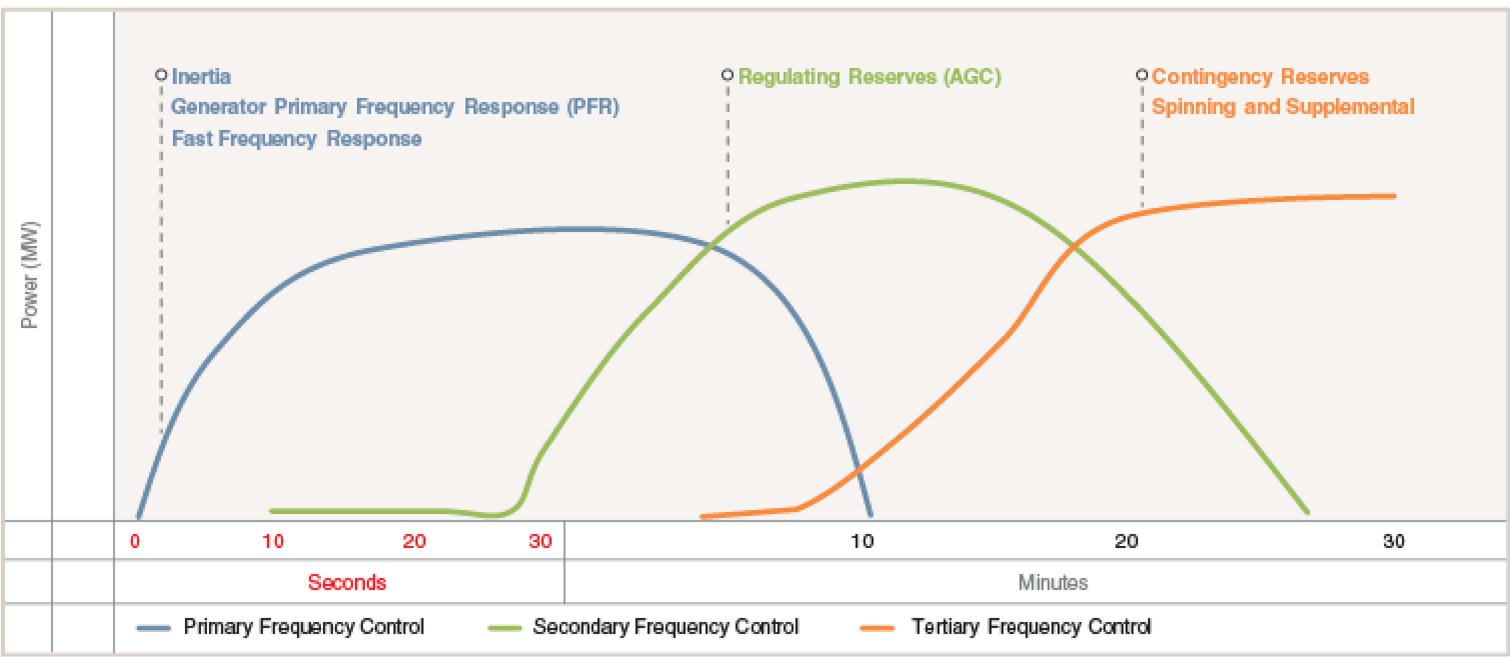
- Declining system inertia
  - Low system inertia during high imports and high renewable resources
- Declining primary frequency response from generators
  - Inconsistency in performance during events
  - Generation pull-back after initial response (lack of sustained response)
- Limited interconnection with WECC to access intertie support during system events
- Increasing penetration of renewable resources
  - Do not currently contribute to system inertia or frequency response

Plans to Ensure Grid Reliability and Operational Preparedness

AESO Approach

Assessing action plans across the frequency control spectrum





Targeted action plans for each mode of control

Control	Type of Response	Timeframe
Primary Control	• Inertia • Fast Frequency Response • Governor and Load Response	Milliseconds – 60 seconds
Secondary Control	Regulation / Automatic Generation Control (AGC)	1 – 10 minutes
Tertiary Control	Contingency Reserves Activation and dispatch of the energy market merit order (EMMO) for system rebalancing	10 minutes - hour

Primary Frequency Control – Inertia

Short Term 2021

Medium Term 2021 - 2022

Long Term 2021 - 2023

- ✓ Use of real-time system inertia and severe weather parameters on the AB-BC tie-line in determining allowable power flows
- ✓ Use of system inertia as a third parameter to develop arming tables for fast frequency response

- ➢ Assess feasibility and effectiveness of Synthetic inertia for inverter-based resources (IBRs)
- • Stakeholder engagement based on Synthetic Inertia studies and outcomes

- • If need determined, implement Synthetic Inertia for IBRs

✓ Action completed
➢ Work in progress
• Work yet to be started

Primary Frequency Control – Fast Frequency Response (FFR)

Short Term — 2021

Medium Term — 2021 - 2022

Long Term — 2021 - 2023

✓ Work with current LSSi, a FFR product, to improve compliance to system events

✓ Develop technical rules for participation of energy storage resources (ESRs)

✓ Pilot project for FFR to enable participation of new technologies such as energy storage resources (ESRs)

➢ Develop and implement ISO rules to enable technology-agnostic participation in FFR services

- ✓ Action completed
- ➢ Work in progress
- • Work yet to be started

Primary Frequency Control – Generator Primary Frequency Response (PFR)

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Short Term — 2021

Medium Term — 2021 - 2022

Long Term — 2021 - 2023

✓Analyze the impact of generator characteristics, ambient temperature and lack of headroom on system performance

✓Work collaboratively with Generation Facility Owners (GFOs) to help improve PFR from their assets

✓Situational awareness in the control room on expected PFR (in MW/0.1Hz)

➢Provide clarity on PFR expectation from generators during system events, through an information document (ID)

✓Continue collaborative approach with GFOs including ensuring outer control loops and AGC controls do not impede PFR from generators

➢Assess need and approach to mitigate risks associated with generation pull-back

✓Modify AESO modeling and operating assumptions

➢Develop and engage stakeholders in modifications to generator interconnection standards

• Implement ISO rule changes to address qualification standards and performance metrics

✓ Action completed
➢ Work in progress
• Work yet to be started

Secondary Frequency Control – Automatic Generation Control (AGC)

Short Term 2021

Medium Term 2021 - 2022

Long Term 2021 - 2023

- ✓ Analyze the contribution of resources on AGC during system events
- ➢ Provide clarity on role of AGC during system events through an information document (ID)

- ✓ Work with GFOs to ensure AGC controls do not impede natural frequency response of generators
- ➢ Enable AGC blocking during system events to ensure recovery and grid reliability

- • Study the technical impacts of ESR participation and Dynamic AGC on system performance (Fast versus Slow AGC)

✓	Action completed
➢	Work in progress
•	Work yet to be started

Tertiary Frequency Control – Contingency Reserves (CR)

Short Term 2021

Medium Term 2021 - 2022

Long Term 2021 - 2023

✓ Analyze the performance impact of CR resources during system events

✓ Work with GFOs to help improve performance of CR resources during system events

➢ Identify improvements to the OR qualification process

➢ Proactively monitor performance of CR providers during system events and follow-up as required

- Develop and engage stakeholders in any proposed revisions to CR qualification requirements

- Finalize stakeholder engagement and implement revisions to ISO technical rules for CR qualification and compliance processes, as required

✓ Action completed
➢ Work in progress
• Work yet to be started

Net Demand Variability (NDV)

Short Term — 2021

Medium Term — 2021 - 2022

Long Term — 2021 - 2023

✓Optimize the volume of regulating reserves

✓Provide system controllers with daily forecast and ramp event reports to support decision making

➢Support dispatch decision making in the control room using ultra short-term forecasts (one-minute wind and solar forecasts)

➢Stakeholder engagement on ISO Rule 304.9 to help improve forecast data quality and accuracy

➢Forecast and analyze long-term NDV implications

- Implement changes to wind and solar forecast data rule (ISO Rule 304.9)

➢Continued Optimization of regulating reserves to better manage NDV

- Improve system dispatch practices to proactively manage NDV
- Initiate any required market design initiatives

✓ Action completed
➢ Work in progress
• Work yet to be started

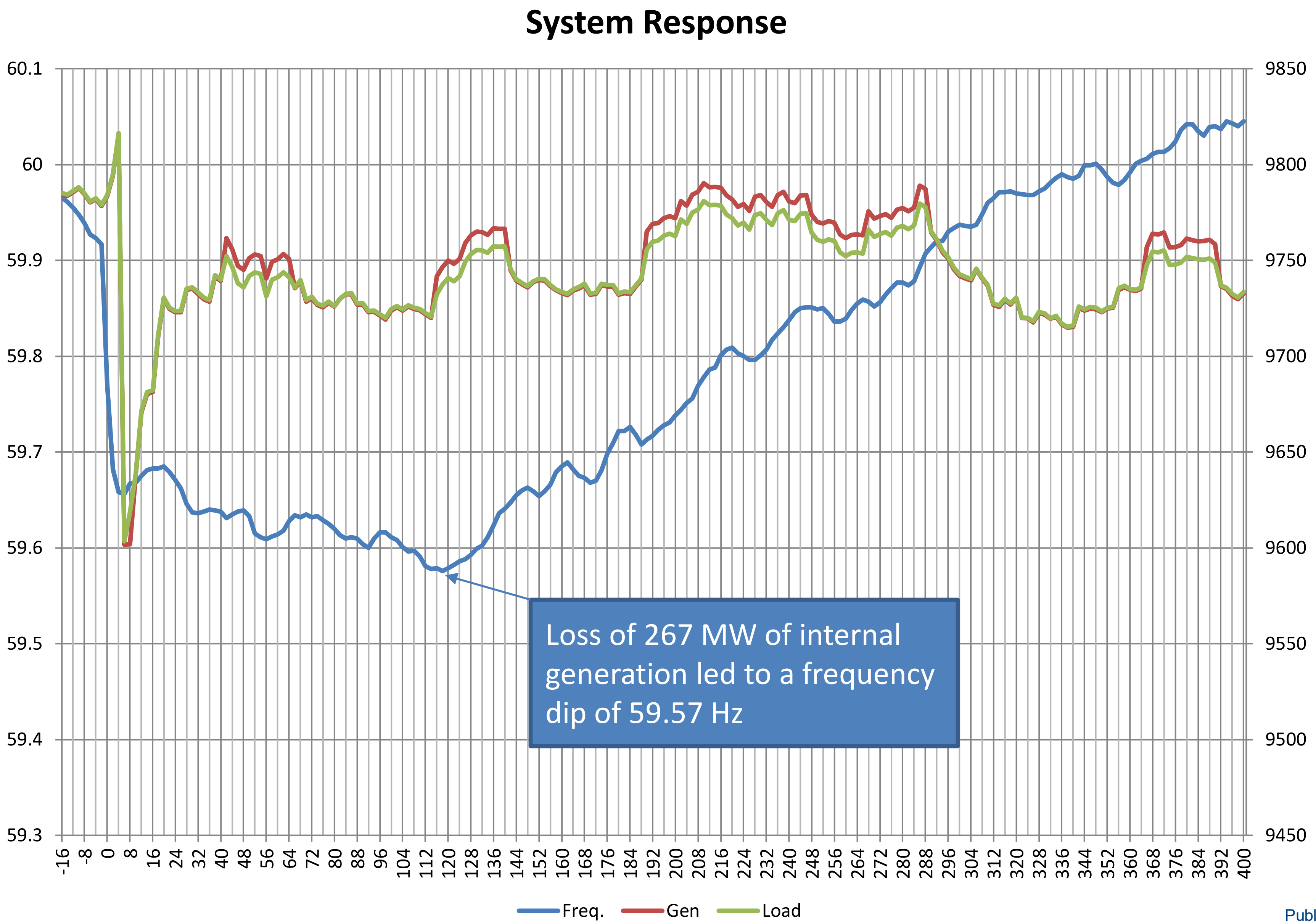
Frequency Response Capability Next Steps

Next Steps

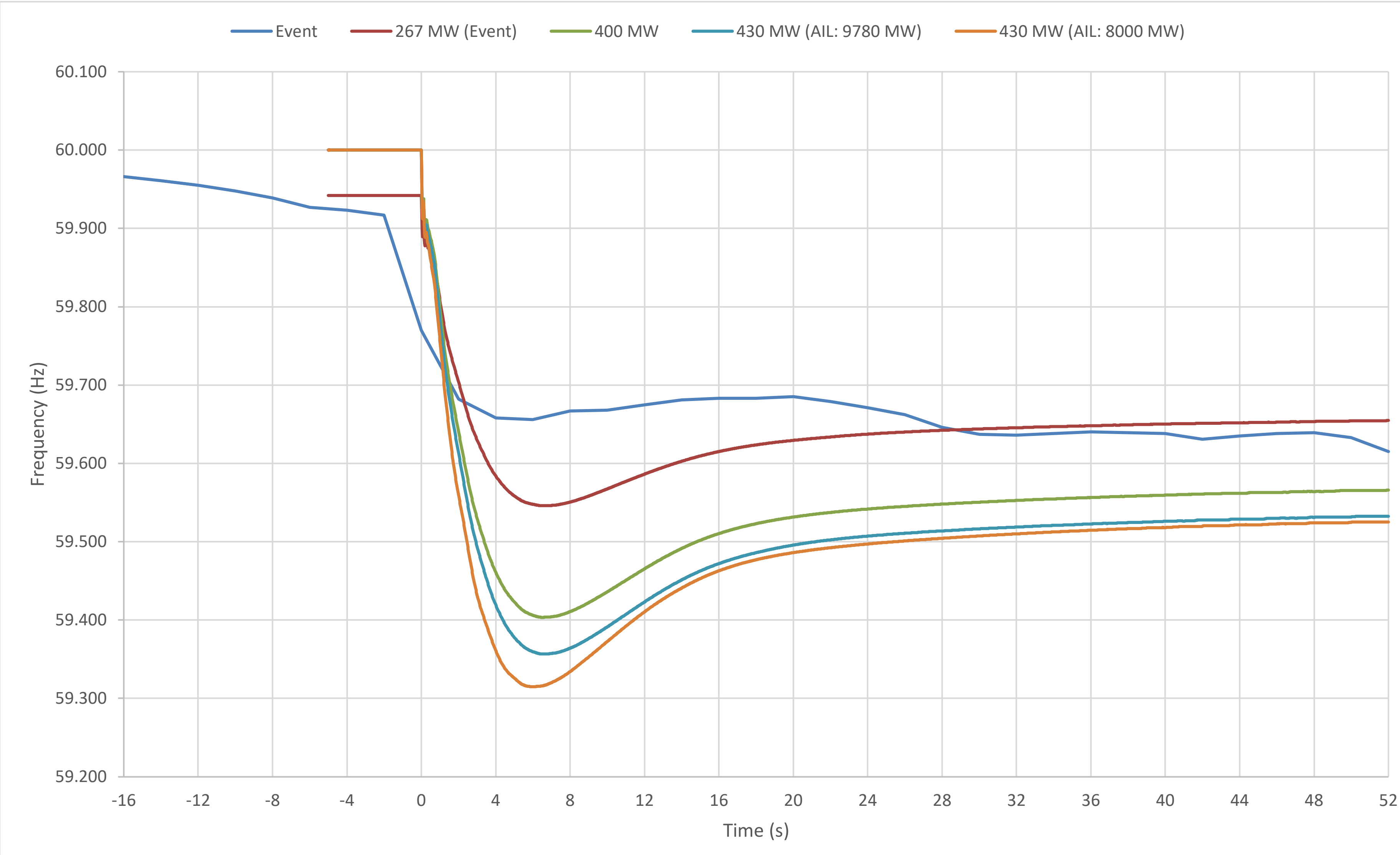
- Continued Collaboration
  - Continue to work with GFOs to improve generator response during system events
- Transparency
  - Regular updates to the industry on plans, progress, and impact of actions on improving grid reliability
- Engagement
  - Engage stakeholders proactively on identified plans to support grid reliability and operational preparedness
- Compliance
  - Proactive approach to compliance to ensure adherence to ISO technical rules and reliability standards
- Improvements
  - Implement short-term bridging solution to address generation pullback and DER tripping risk

Most Severe Single Contingency (MSSC) Implications

Islanded operation event on Oct. 16, 2020



Oct. 16, 2020 event and simulation results for reduced MSSC levels



Frequency Response capability implications on MSSC limits

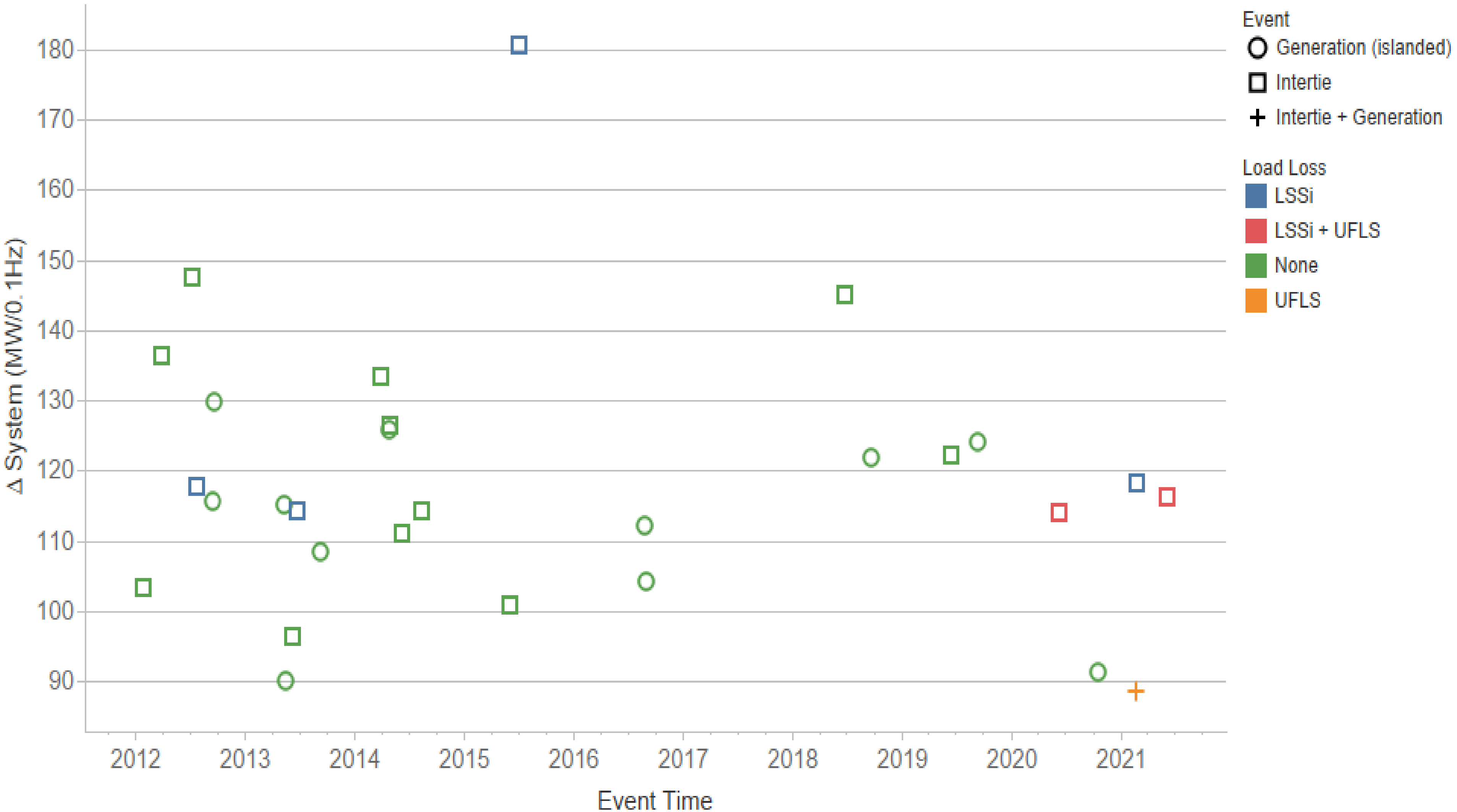
- Islanded operation event indicates system currently challenged to handle 466 MW MSSC loss
- Studies indicated 425 MW is the MSSC limit while islanded
- Any increase in MSSC will only exacerbate the reliability risk of customer load shed
- Assessing reliability risk increases at higher MSSC levels
- Assessing costs of additional reliability services required to enable higher MSSC levels
- Assessing benefits to increasing MSSC levels in Alberta
- MSSC-specific session will be planned for late October/early November to share results and engage stakeholders

Questions

Thank you

Appendix

Historical Events – System Response



Historical Events – Rate of Change of Frequency (RoCoF)