Large Load Power Variation Requirement Consideration

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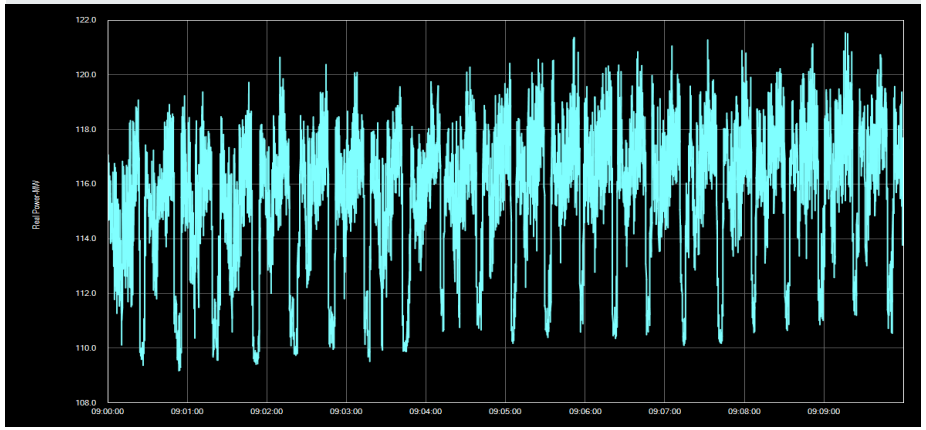
Recap

- ERCOT discussed the impact of Large Load active power variation on synchronous generators in July 2025 LLWG Large-Load-SSO-Primer.pptx
- ERCOT worked with Electranix to demonstrate the impact, develop technical framework and requirements. Regular status updates were provided to LLWG
  - Investigation into Vulnerability of Synchronous Machines to Large Load Subsynchronous Active Power Variation (October 2025)
  - Progress Update LEL SSO and Power Variation Criteria (January 2026)

Unrestricted Load Variation



Could cause

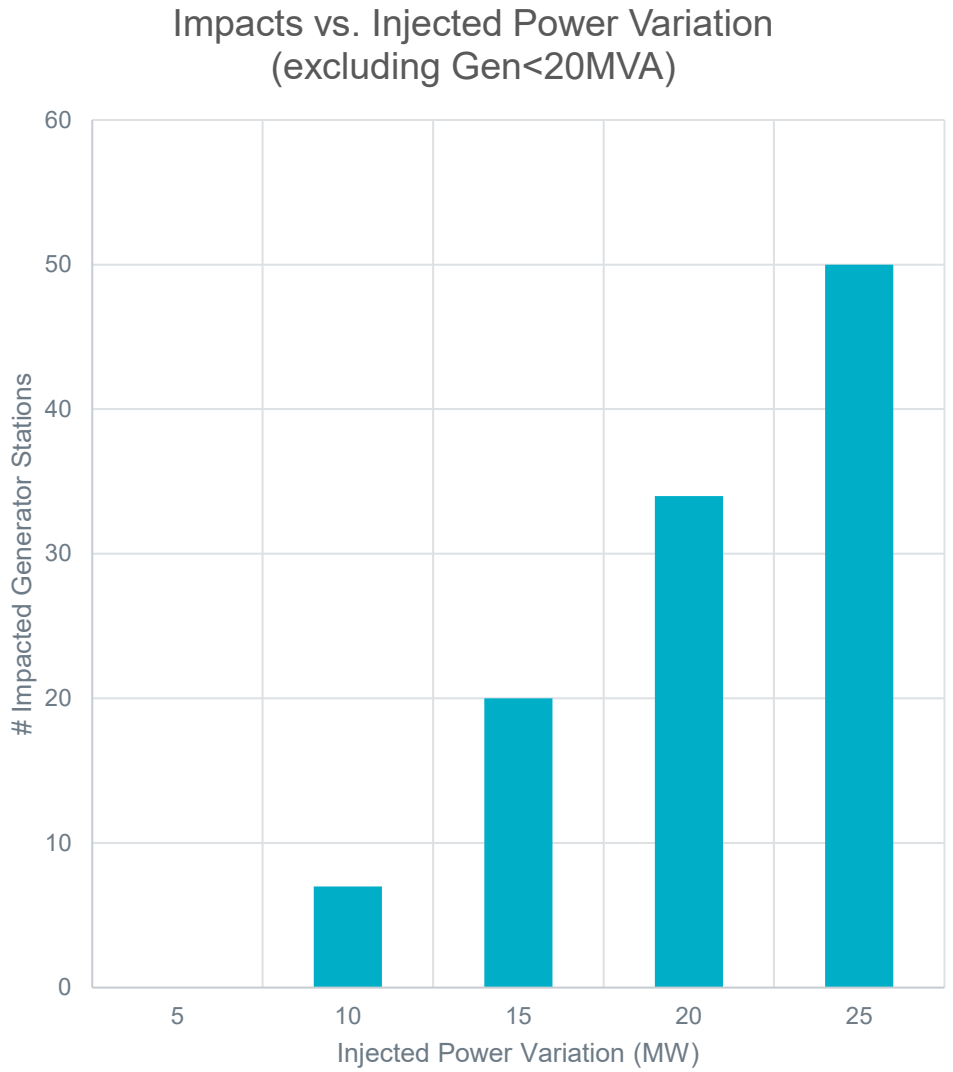
Catastrophic generator damage

Preliminary Impact Assessment

- ERCOT performed a screening assessment
  - Tested power variations at each ERCOT bus (≥100 kV) for impact on existing synchronous generators
  - Checked for MCTV violation (*Maximum Continuous Terminal Variation* corresponding to endurance limits)
  - Evaluated system wide impacts

- Observations
  - As the load MW variation increases, the affected synchronous generators increases significantly

Key Takeaway: Active power variation by Large Loads needs to be managed to minimize the impact to synchronous generators



Note: In this screening assessment, an MCTV of 0.01 was assumed, limiting generator terminal power variation to 1% of MVA rating to avoid torque violations

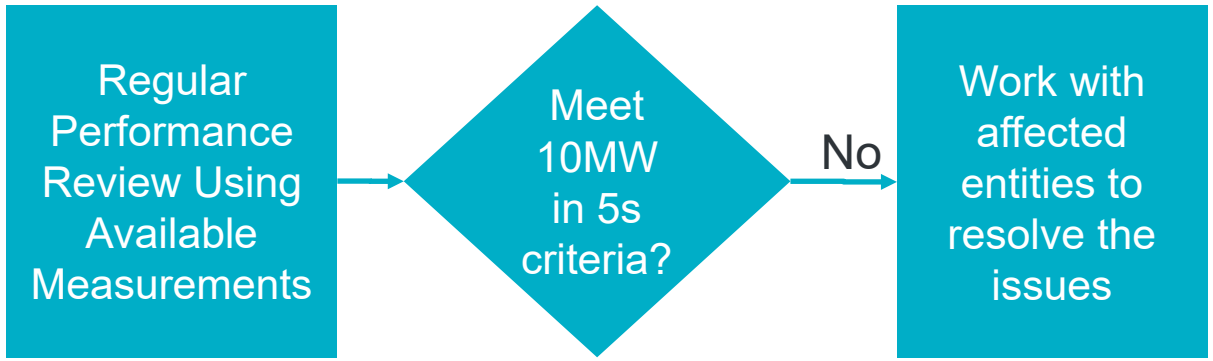
ERCOT's Proposed Requirement

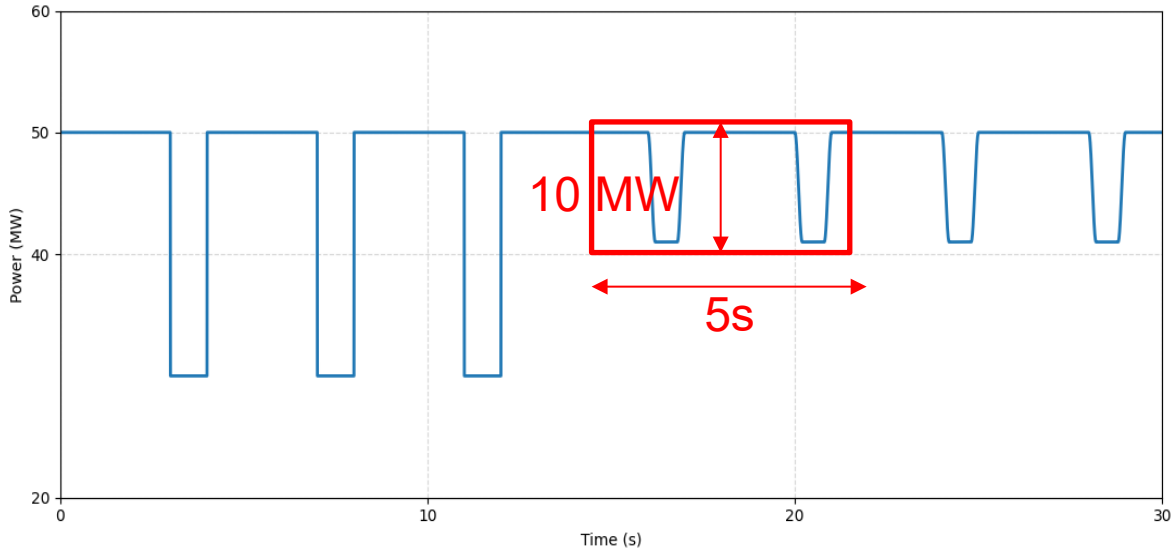
Proposed Requirement:
Load power shall not repetitively exceed 10 MW change in a sliding time window of 5 seconds

- This is selected to
  - **Maintain reliability**
    - Per previous slide, increasing this number, even modestly, *drastically* increases the "reach" where larger areas of the system and many more generators are affected by a single large load.
  - **Facilitate future interconnections**
    - A straightforward, simple criteria that addresses concerns means future large loads can avoid time-consuming generator interaction SSO studies. This is especially helpful considering that the information required for a detailed study may be very difficult to obtain.
    - Widening this requirement would quickly make process unmanageable → studies would become very large and need to consider very large areas of the system, resulting in complicated, overlapping criteria and objectives.

Image source: https://stockcake.com/i/vast-data-center_1467301_878882

Proposed Method to Evaluate Performance





- ERCOT will focus on **repetitive** power cycling behavior above 10 MW
  - (Infrequent power steps over 10 MW would not violate this criteria)
  - ERCOT will work to further define details
- High resolution measurement like PMU will be needed

Next Steps

- Submit the revision request in Q2 2026

- Welcome stakeholders' input and suggestions
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Recap from January 22 LLWG: Methodology for Gen Variation (MCTV) Limit

- **Step 1: Determine the maximum continuous terminal variation (MCTV) in active power for synchronous generators** (mechanical limit → electrical limit)
  - **Endurance Limit (EL):**
    Maximum continuous cyclic shaft torque a synchronous generator can safely tolerate
  - **Load Shape Ratio (LSR):**
    Amplification factor between terminal active-power variation and resulting shaft torque
  - **Maximum Continuous Terminal Variation (MCTV):**

    The maximum amount of continuous active power variation at the SG terminals without exceeding the given mechanical endurance capability. MCTV = LE / LSR
- **Example:**
  If EL = 0.1 pu and LSR = 10 → MCTV = 0.01 pu
  For a 100 MW generator → allowable continuous oscillatory power at SG terminal is 1 MW

- **Step 2: Calculate the maximum allowable power variation at LEL terminal**
  - Use a load-flow or impedance-based approach to calculate the Interaction Factor–Based Limit (IFBL)
    - maximum LEL power variation such that no nearby generator exceeds its MCTV
  - The most limiting generator sets the IFBL for that load location