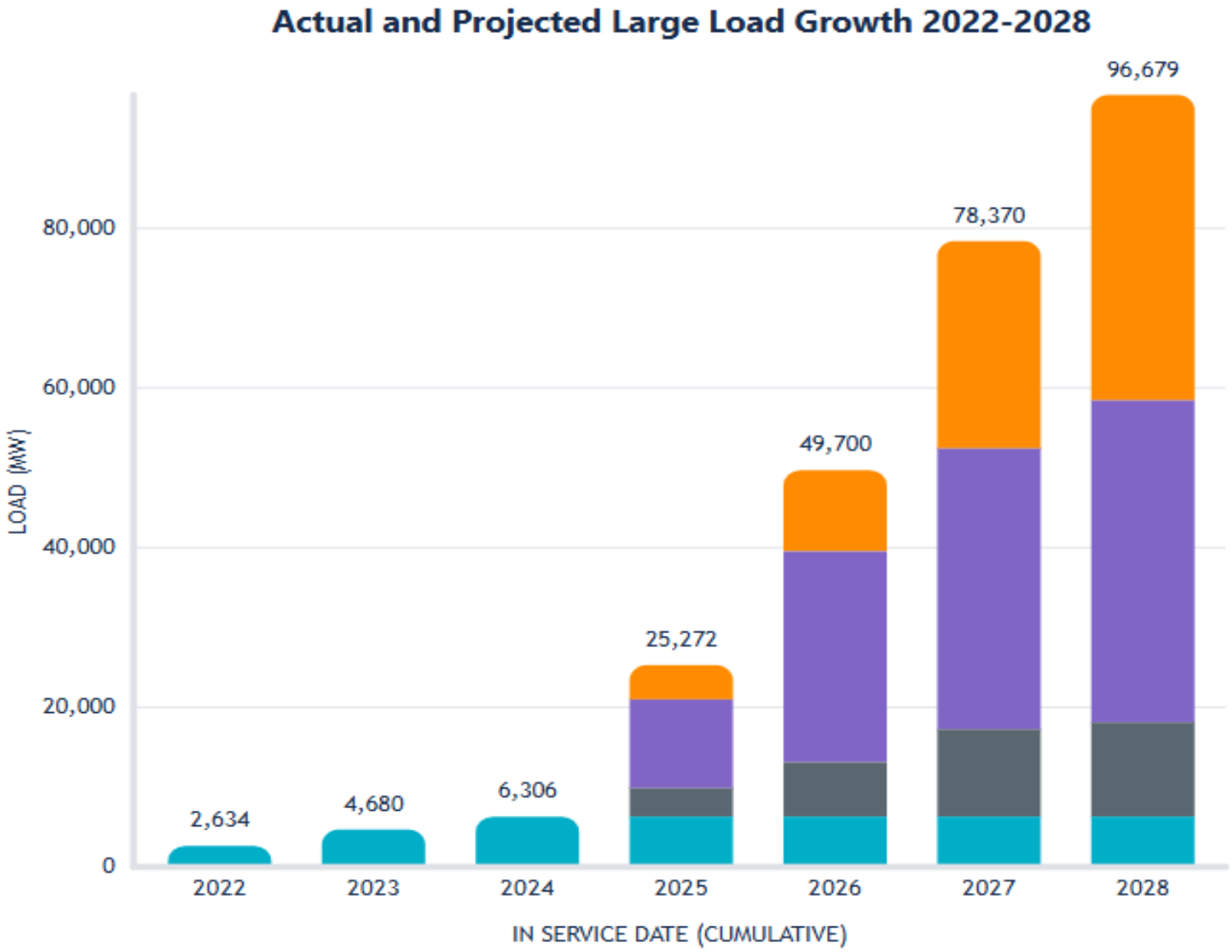
Energy Systems Integration Group (ESIG) Spring Technical Workshop

ERCOT Perspective on Large Load Modeling Needs

José Conto,
ERCOT Principal, Dynamic Studies System Planning

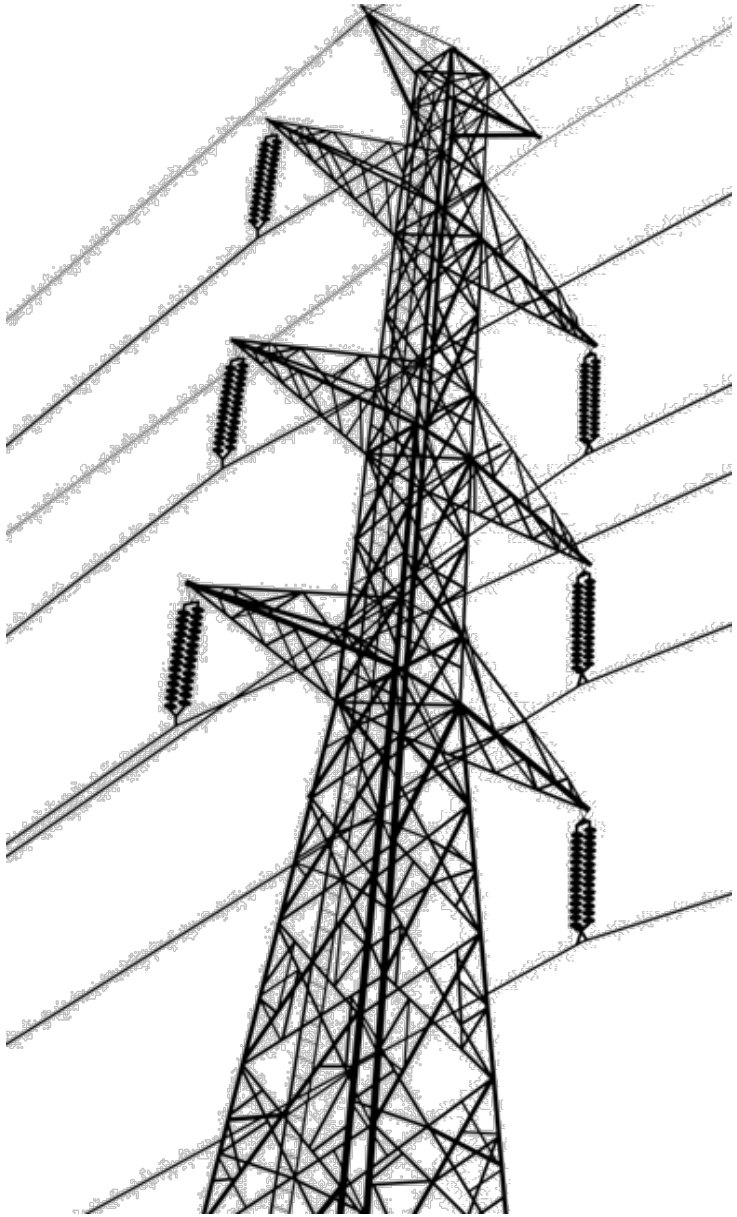
March 20, 2025

Large Load Growth



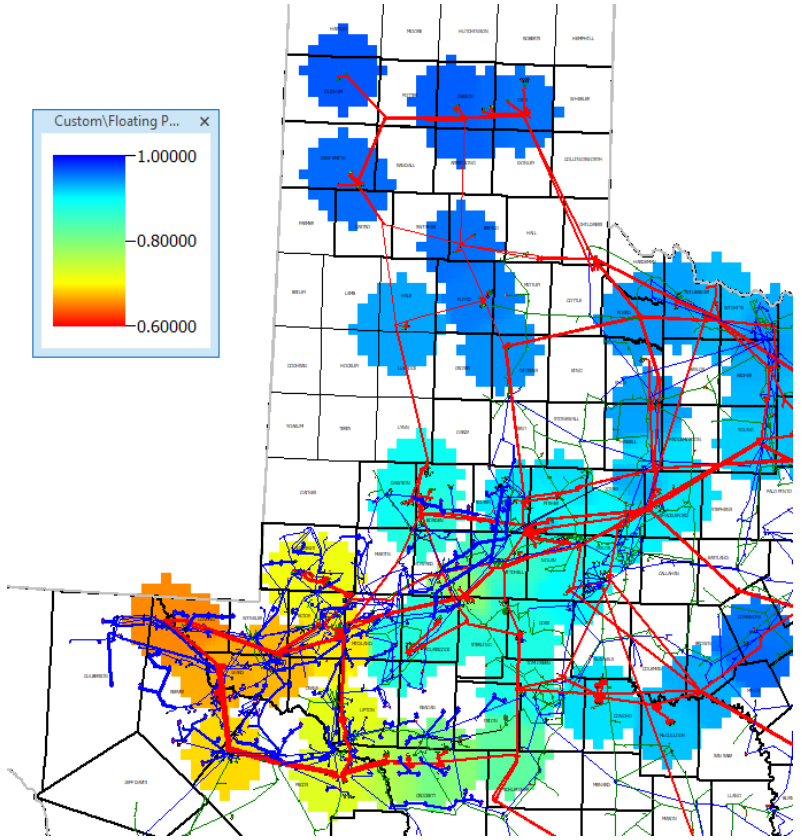
Large Load Loss Event

- December 7, 2022, at 3:50 a.m., multiple related faults on 138-kV lines near Odessa, Texas
- Reduction in load of about 1,600 MW
  - 10 large Power Electronic Loads (PELs) reduced a combined ~162 MW (39% of consumption)
  - Largest load reduction from oil and gas production, processing, and delivery facilities (~420 MW from 24 loads)
  - Two thermal generators tripped during event, totaling 112 MW
  - System frequency spiked to 60.235 Hz
  - Returned to 60 Hz in 12 minutes 30 seconds



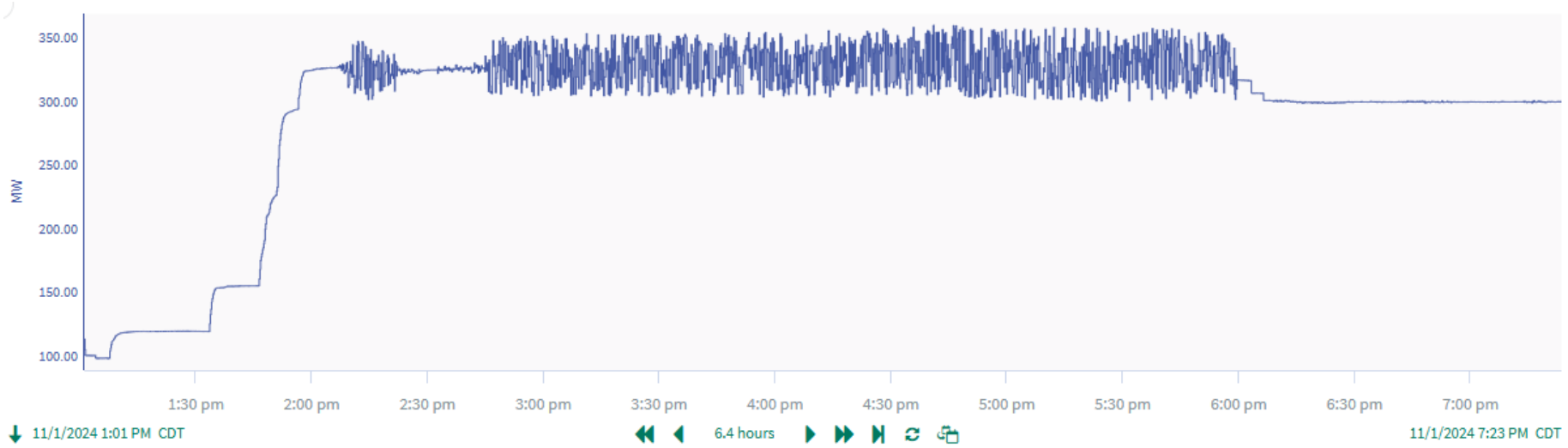
Ride-Through

- A variety of disturbances may impact the performance of a power system
- For a fault event, the voltage in the area may remain depressed until the protection systems clear the fault
- Generators and large loads in the area need to ride through this voltage dip and continue to produce power, support voltage, and stay in sync with the grid frequency
- At present, there is no ride-through requirement for large loads



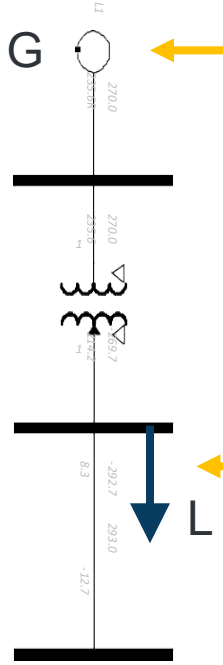
Large Load Induced Oscillation

- Oscillation with ~40 MW swings in the telemetry of a large load
- Phasor Measurement Unit data showed voltage was stable; oscillation seen in the current signals
- Digital Fault Recorders data at 20 sample/cycle showed a ~23 Hz oscillation
- Below 320 MW consumption, no oscillations observed
- Older firmware versions on certain equipment was root problem; after firmware upgrade, large load operated at full consumption



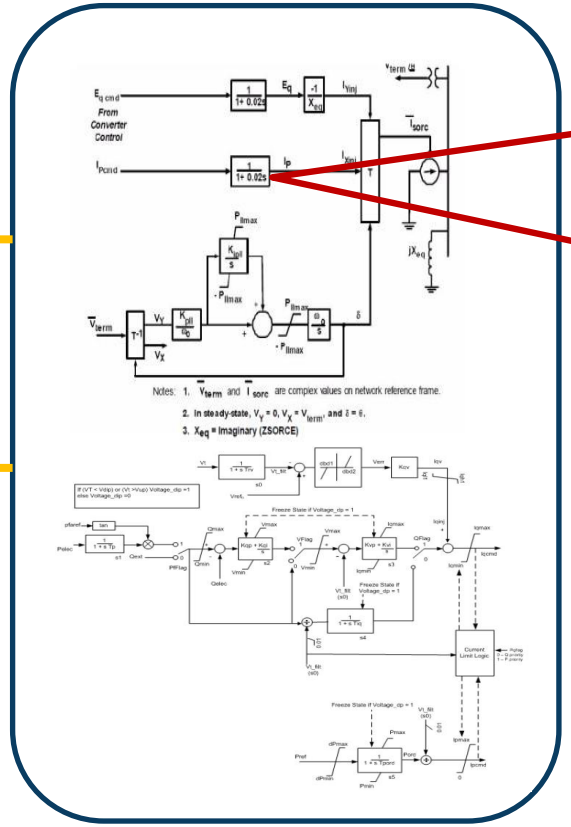
Modeling Complexity

Power System Model



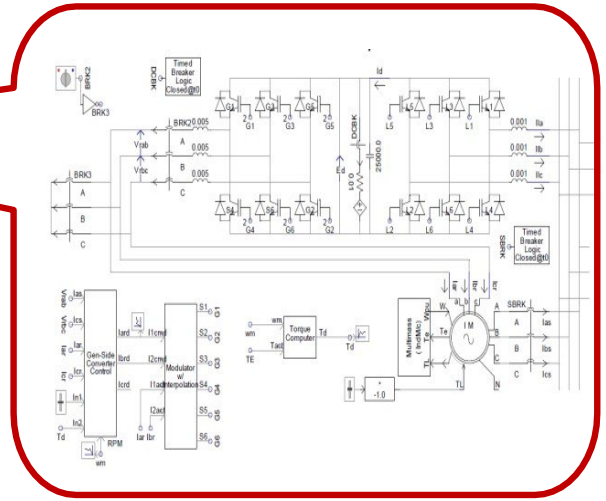
- Algebraic equation with no time step
- 60 Hz
- Positive sequence
- Balanced system
- Steady state
- Solution in < 1 sec
- Tools: PSS/e, PowerWorld, VSAT

Traditional Dynamics



- Time step of 1 ~ 4 ms
- Fundamental frequency assumption
- Positive sequence & balanced system
- Electro-mechanical machine dynamics
- Simulation time: 1 ~ 20 mins
- Tools: PSS/e, PowerWorld, TSAT

EMT



- Time step of 10 ~ 50 us
- Frequency impacts included
- Full three-phase representation
- Phase imbalances represented
- Fast dynamic controls explicitly modeled
- Need for detailed SSR analysis
- Need for high IBR penetration analysis?
- Simulation time: 10 mins ~ hours
- Tools: PSCAD

ERCOT Grid Planner Wish List

- Collect high-fidelity data from load customer
- Validate model of large load for power system simulations
- Deploy intelligent uninterruptible power supply (UPS) with ride-through to support transient response of load
- Design the dynamic characteristics of a large load operation to control ramp-down and ramp-down responses
- Energy storage devices at the load site
- Engage with Market Participants, utility companies, regulatory bodies, and research institutions to gather input and align on strategies for grid reliability

Q&A

Questions?

Jose.Conto@ercot.com