



Aggregated DERs and the ERCOT Wholesale Markets

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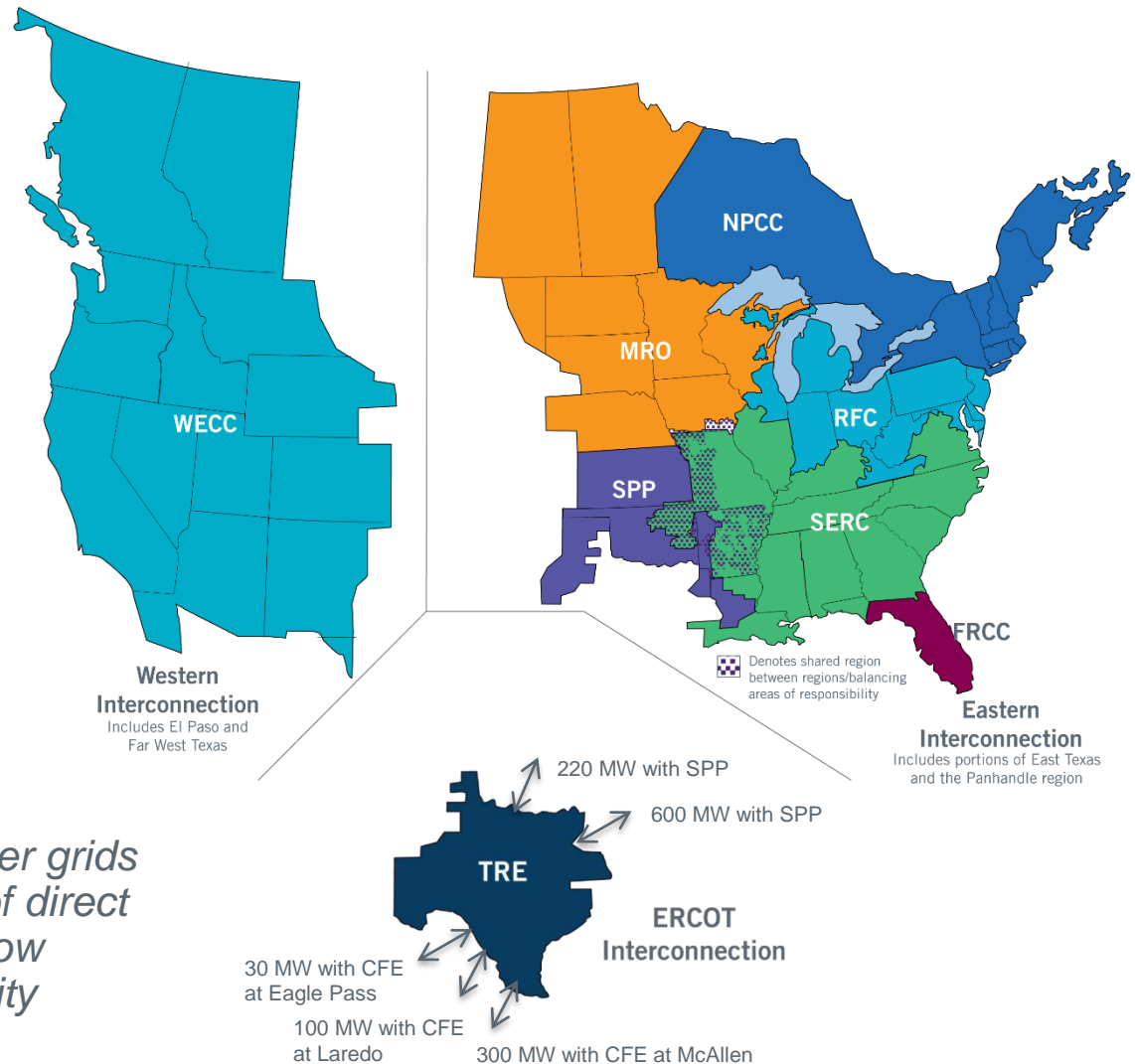
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The ERCOT Region

The interconnected electrical system serving most of Texas, with limited external connections

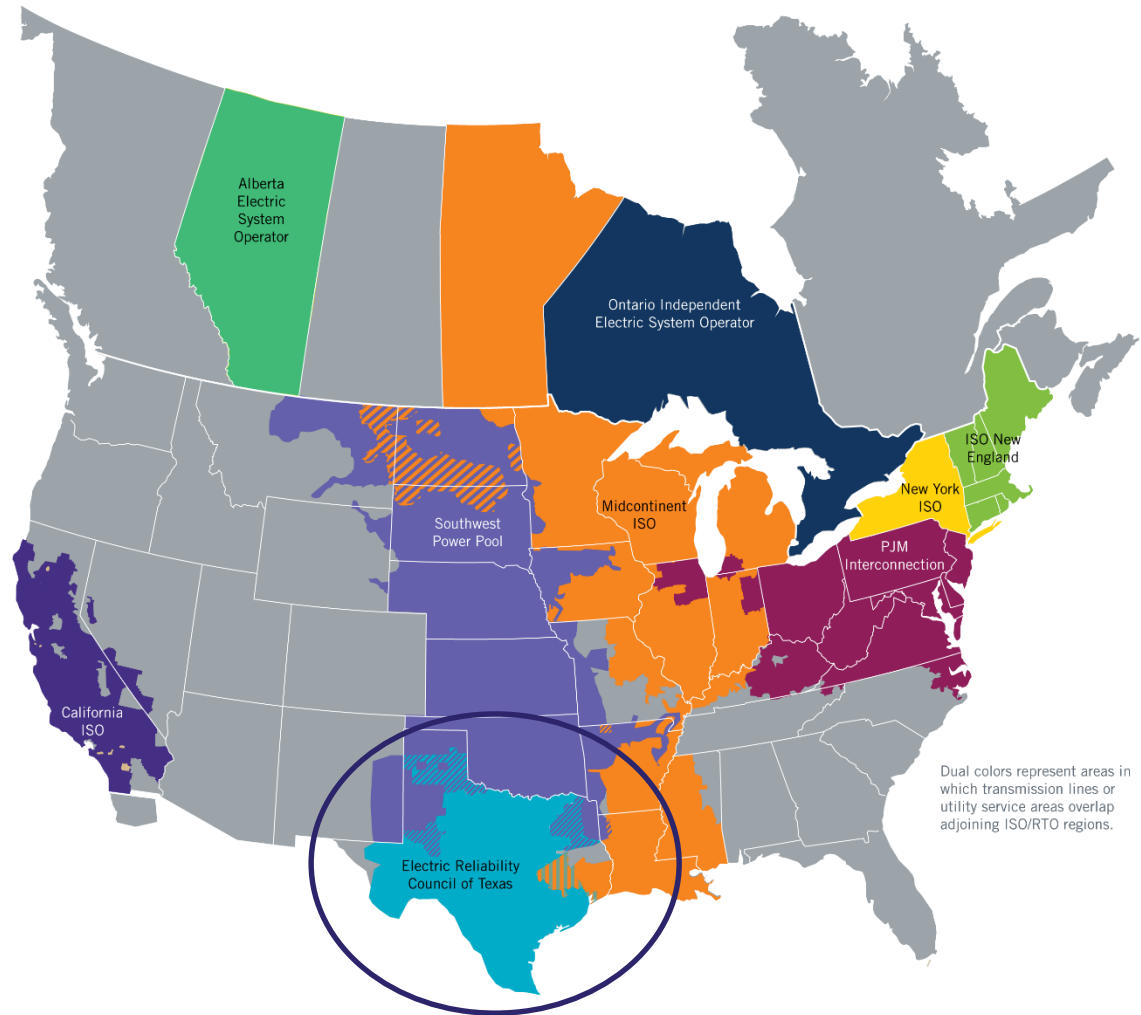
- 90% of Texas electric load; 75% of Texas land
- 71,110 MW peak, August 11, 2016
- More than 46,500 miles of transmission lines
- 570+ generation units

ERCOT connections to other grids are limited to ~1,250 MW of direct current (DC) ties, which allow control over flow of electricity



U.S.-Canadian ISOs and RTOs

Independent System Operators and Regional Transmission Organizations are the 'air traffic controllers' of the bulk electric power grids.
(69kV and up)



ERCOT Markets

Service	Eligible Resource Types	Aggregations?	Telemetry?
Responsive Reserves*	Generators, Load Resources (LRs) on under-frequency relay	Needs work	Yes
Regulation-Up* Regulation-Down*	Generators, Controllable LRs (CLRs)	Needs work	Yes
➤ Fast Responding Reg-Up/Down (FRRS)*	Fast-acting, limited-duration resources	Needs work	Yes
Non-spin*	Generators, SCED-qualified CLRs	Yes	Yes
Security-Constrained Economic Dispatch (SCED) energy	Generators, CLRs	Yes	Yes
Emergency Response Service (ERS)	Demand response, distributed generation	Yes	No

- Minimum capacity offer in ERCOT's markets is 100 kW
 - Exception is Weather-Sensitive ERS (500kW)

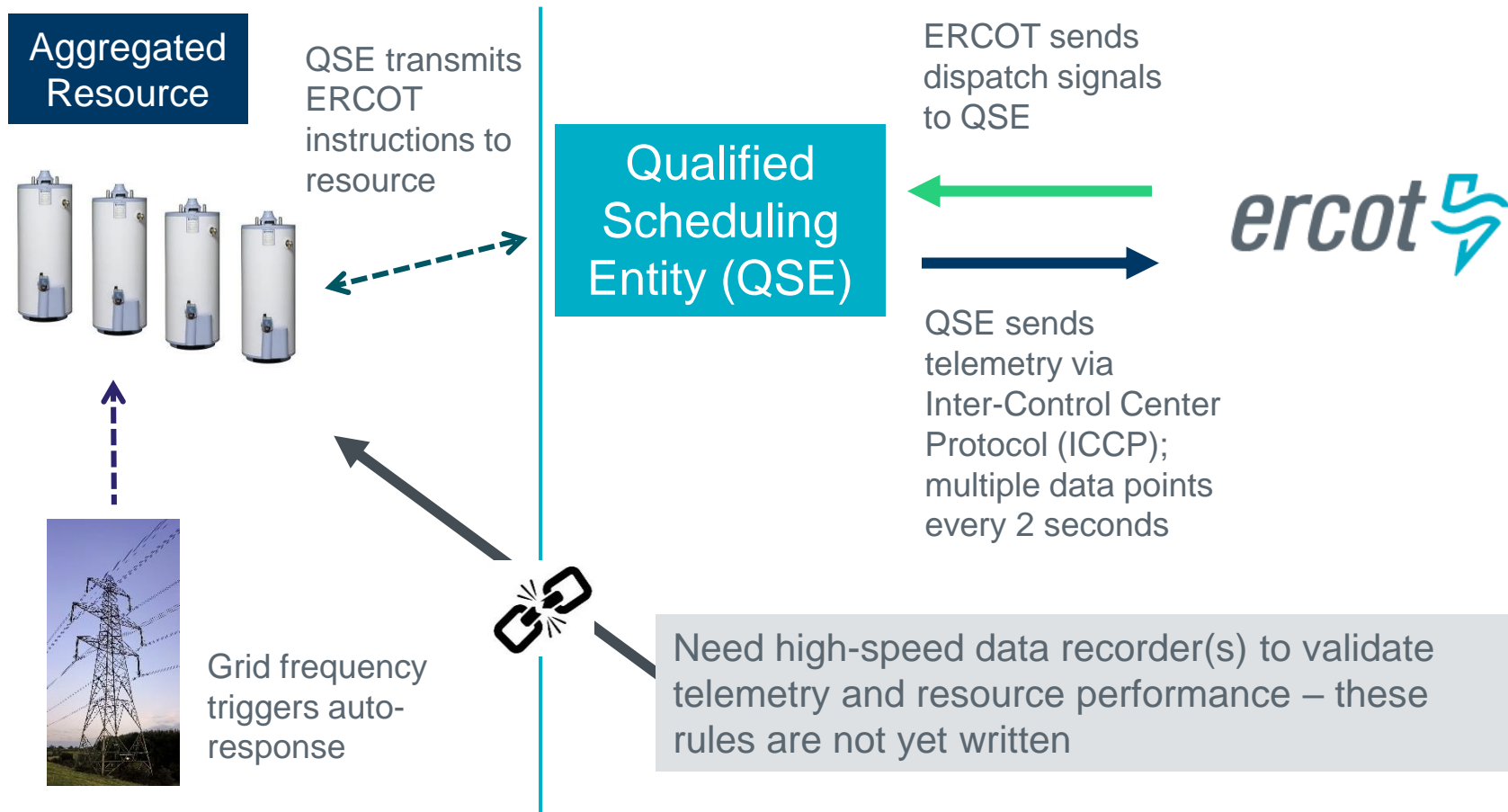
Aggregation Experience to Date

- ERS was created by PUC Rule as an operational backstop for emergency conditions
 - Not an Ancillary Service, intentionally open to aggregations, no telemetry requirement
- In the Ancillary markets, rules are in place for Aggregated Load Resources (ALRs) to provide Non-spin and participate in SCED
 - Non-spin has a 30-minute deployment requirement
 - SCED issues base point instructions every 5 minutes
 - Market participants agreed to accept 15-minute advanced meter data as basis for performance evaluation
 - No resources have qualified or participated to date

Potential Aggregations in FRRS

- Fast Responding Regulation Service
 - Qualification test requires 8-minute performance instead of full hour for conventional Reg
 - Must perform within 60 cycles (1 second)
 - ERCOT dispatches specified MWs when frequency falls outside of $\pm 0.025\text{Hz}$ band
 - Automatic full response if frequency $\leq 59.91\text{Hz}$ or $\geq 60.09\text{Hz}$
 - High-speed data recorder required at resource site
 - Distribution-connected resources are eligible (several are currently in progress)
 - Aggregated DERs in FRRS will require more work
 - For example, rules not yet written for telemetry and performance validation

Hypothetical Aggregated Resource in FRRS



Questions?