

TEXAS FREEZE DISASTER

February 12-19, 2021

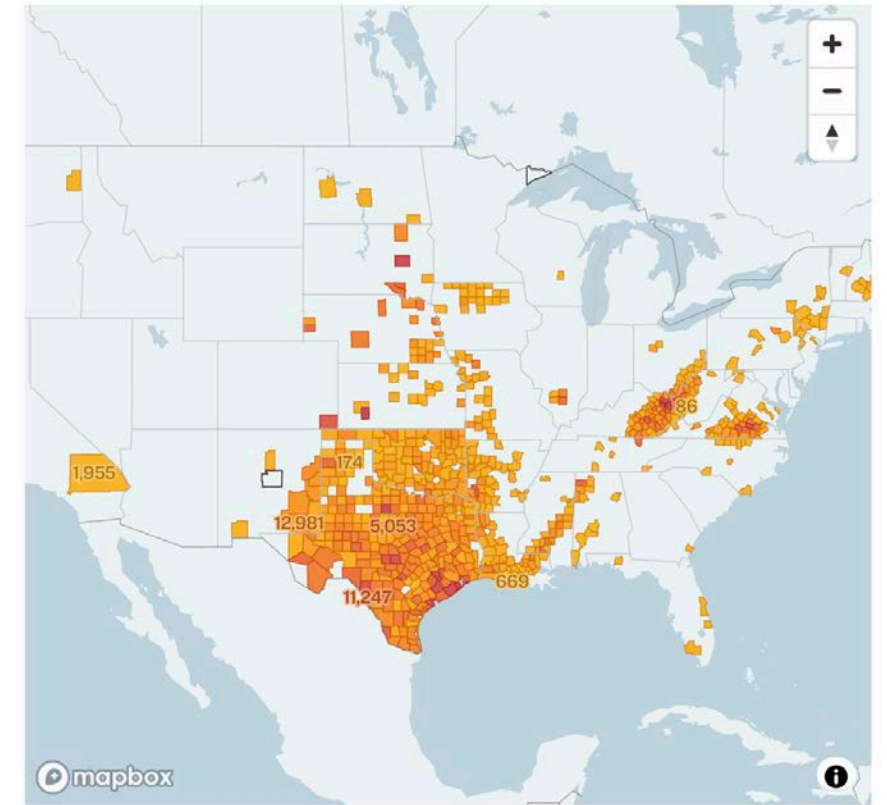
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IEAA Webinar
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NOTE – data from public sources, based on non-exhaustive search, as of March 8, 2021

Texas freeze and blackout introduction

- Ice storm across much of Texas 2/11-12; unprecedented winter storm covers entire state & southern Midwest on 2/14, stays very cold across TX through Friday morning 2/19
- 48.6% of ERCOT nameplate capacity lost/unavailable
- 20,000 MW load shed – 4.5 million customers, most down Monday 1:30am through Thursday or Friday; little or no rotation of outages
- ERCOT says, 4 min 37 secs away from cascading grid collapse and months until full system restoration
- Bad weather, extended power outages and icy roads led to widespread hunger, cold, discomfort, life interruption, 50+ deaths, pipe and water system freezes, zero or unsafe water for >20 million Texans, extensive home and building destruction from frozen water pipes

The Peak of Texas's Power Outages



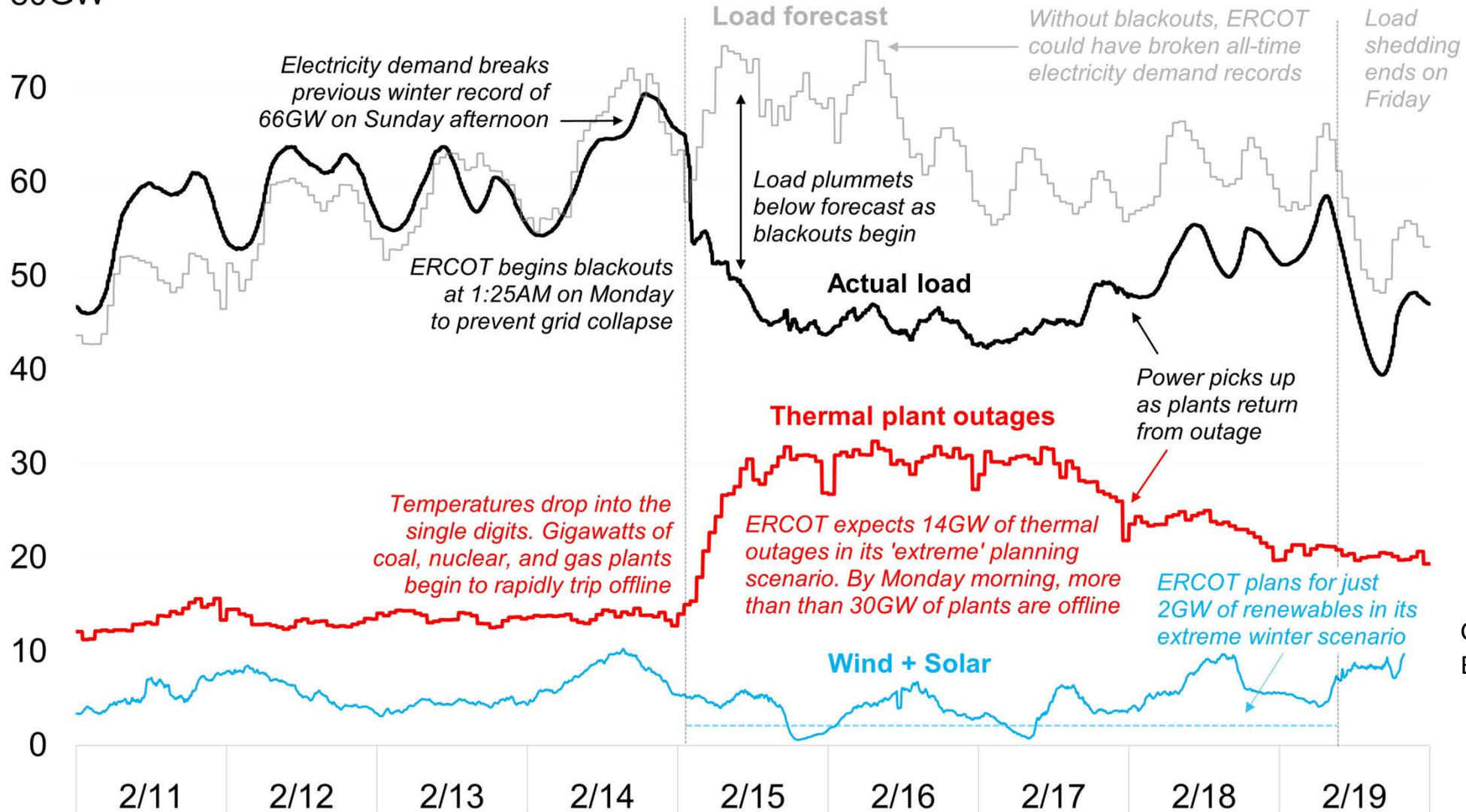
More than 4.5 million customers in Texas were without power during the peak of outages in the state this week, as freezing temperatures hit parts of the country. This map shows activity at 10 a.m. on February 16, 2021.

Source: poweroutage.us

Extreme Weather, Extreme Outages Pushed Texas into Blackouts

ERCOT electric load, load forecasts, thermal plant outages, and renewables

80GW



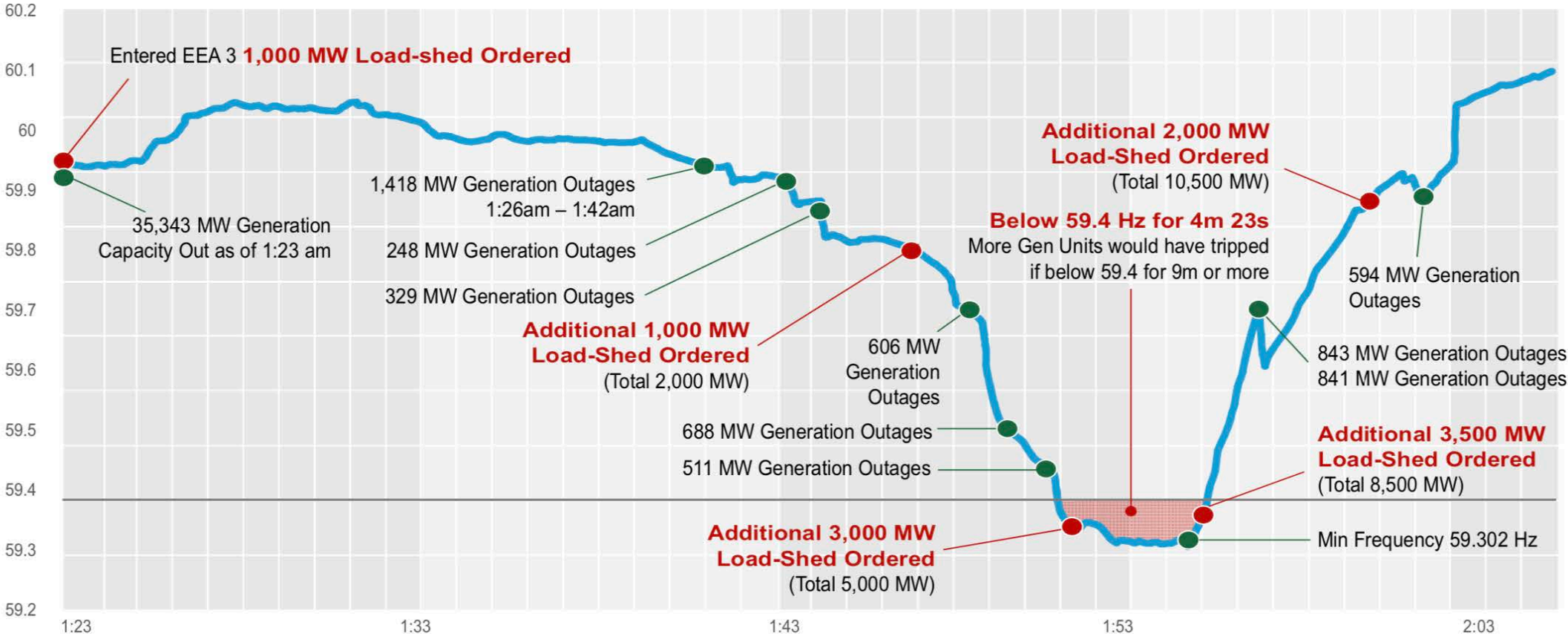
Data source: ERCOT

Note: 'Thermal plant outages' is non-renewable generator outages reported by ERCOT

Graphic by Brian Bartholomew

Grid view from ERCOT control room, Feb 15 1:23-2:03 am

Rapid Decrease in Generation Causes Frequency Drop

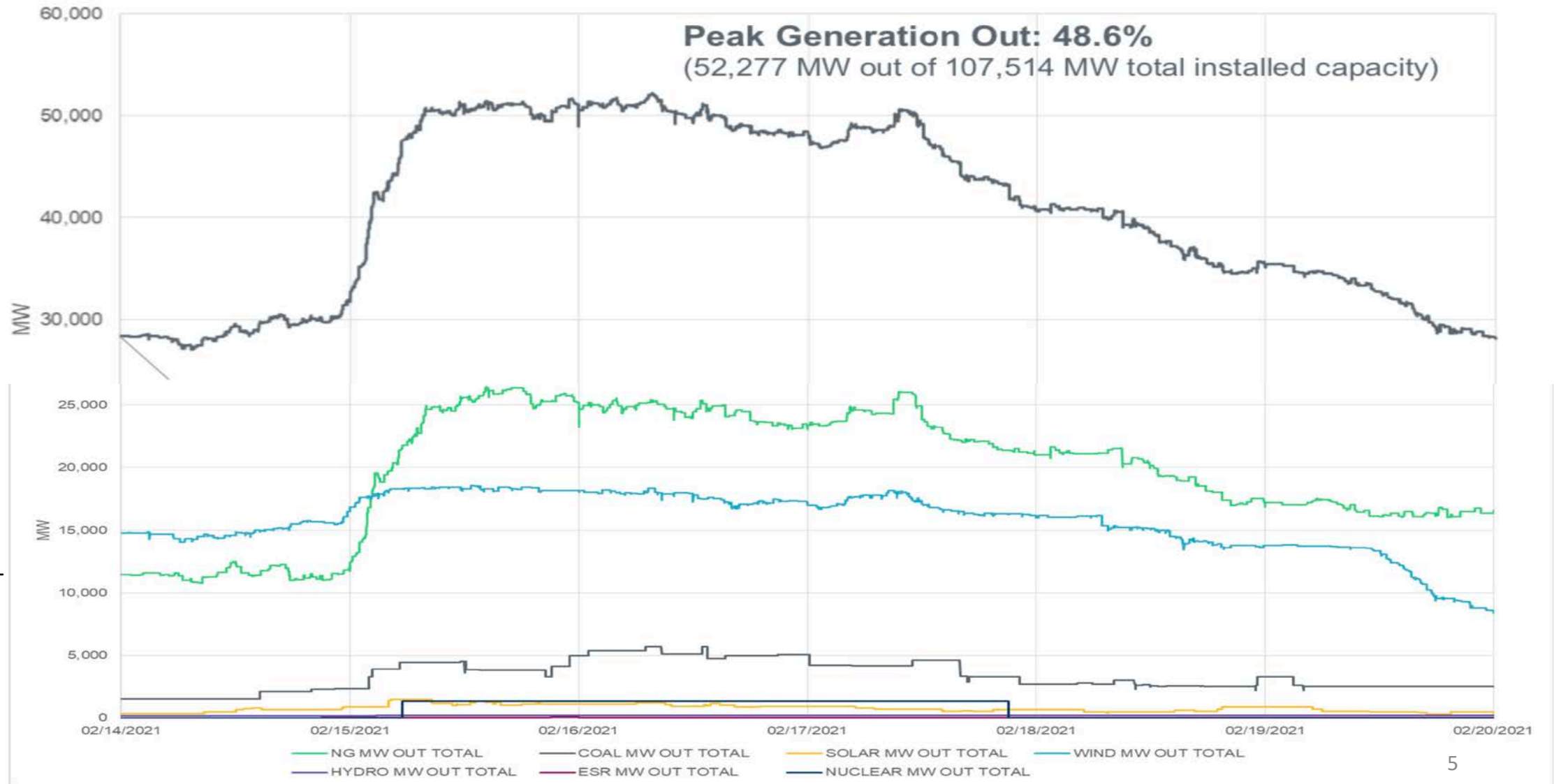


Generation capacity out during freeze event

25,000 MW out on forced outage

- 14,000 MW of wind & solar froze or inaccessible due to Tx deliverability, but expected winter storm output at about 6-10% CF
- 2,800 MW of planned outages incl seasonal mothball

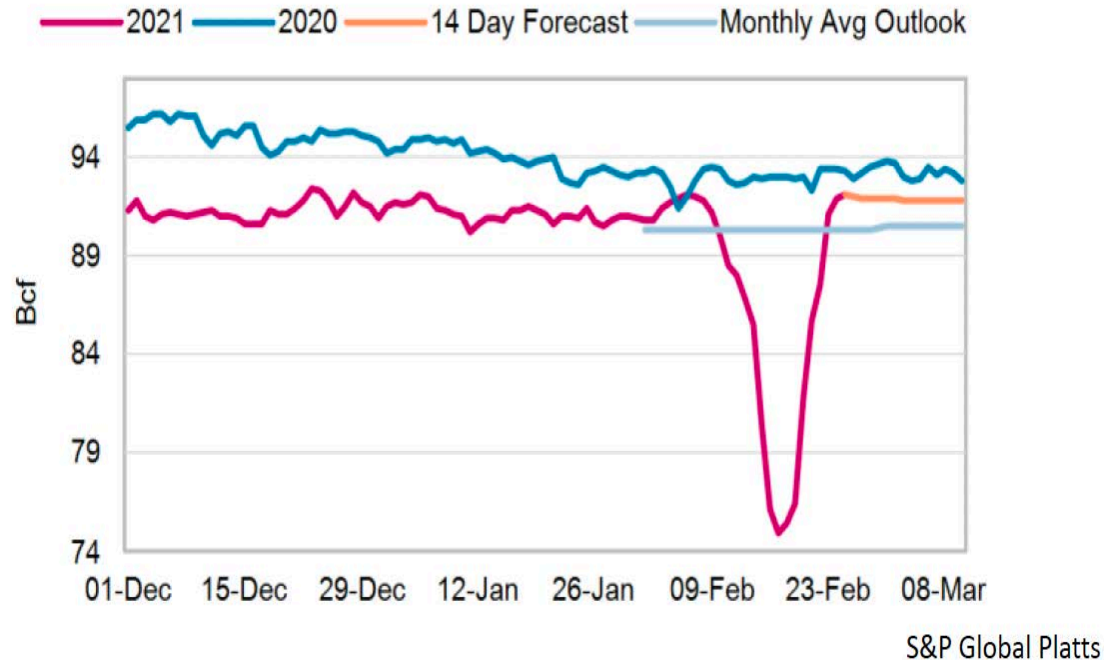
Generation Capacity Out



Source – ERCOT
Note -- two graphs pasted together

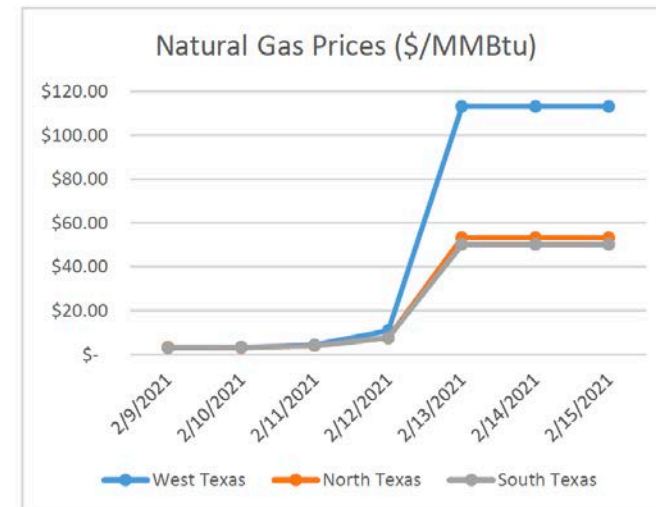
Natural gas

TOTAL U.S. DRY GAS PRODUCTION



Texas production about 40% of U.S. production – see e.g., https://www.eia.gov/naturalgas/weekly/archivenew_ngwu/2021/02_18/

- Texas nat gas production falls over 10 Bcf/day during Feb 8-17. Wellheads, gathering lines and processing facilities not winterized, get freeze-offs (water & liquids in produced gas freeze at wellheads or in line, blocking flow), then loss of electricity for pumping
- Strong heating demand & lower production drive large spot gas price increases at Waha Hub (\$206/mmBtu), Houston Ship Channel (\$400/MMBtu), Oneok (\$1,192/MMBtu) starting before blackouts
- LNG exports limited by fog and extreme winter weather limiting ship movements, but gas still flowed to LNG terminal



Available Generation and Estimated Load Without Load Shed



Available Generation shown is the total HSL of Online Resources, including Quick Starts in OFFQS. The total uses the current MW for Resources in Start-up, Shut-Down, and ONTEST.

Source -- ERCOT

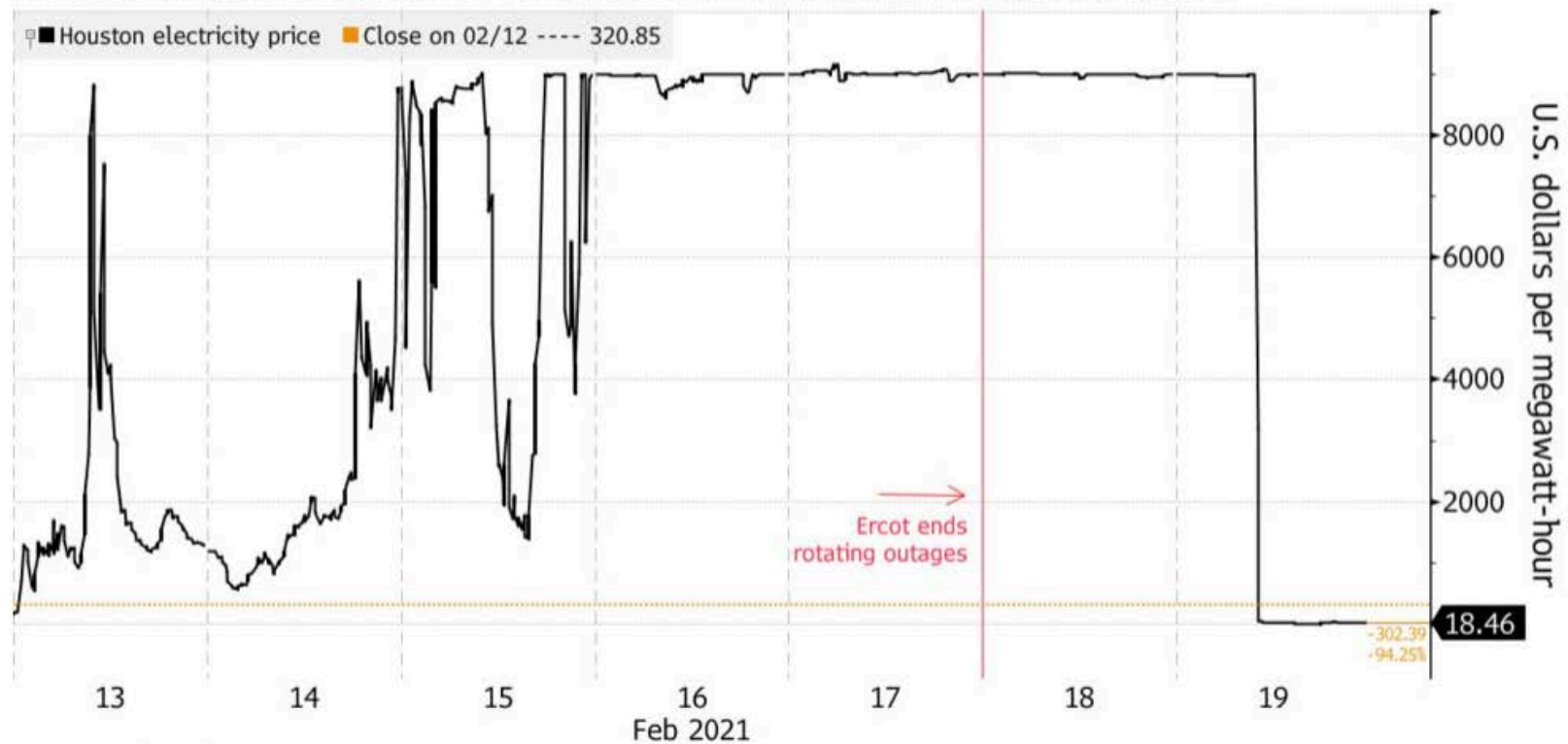
	Feb 10 W	Feb 11 Th	Feb 12 F	Feb 13 Sa	Feb 14 Su	Feb 15 M	Feb 16 Tu	Feb 17 W	Feb 18 Th	Feb 19 F
Weather Temps for Dallas	28-34 F NWS Arctic weather warning, arctic across WTX-OK	25-30 F Cold starts, ice storm, bad roads	25-28 F	21-36 F Snowstorm starts	10-21 F Sleet & snow, icy roads state-wide	7-14 F Icy roads, minimal transportation	3-21 F Snow, ice storm overnight, roads dicey, stores closed	19-28 F More snow, minimal travel	21-30 F Roads clear 	16-43 F
Gas system		DCP Midstream, Targa Resources pipelines shut	Nat gas pipes and processing plants start shutting. TRRC order prioritizes gas for human needs customers	Gas production starts falling	Gas production keeps falling due to freeze-offs	Power cut to many nat gas fields, pipeline compressor stations, processing plants	TX gas production down 30% (7% of total US production)			
Electric system					ERCOT starts conservation alerts 8:30 am. 35K gen capy out by 1:23am 2/15. Shed first 10.8 GW at 1:20am 2/15	1:25 am – another 10.5 GW load shed, 4.5 mil customers. 52,277 MW gen (48.6%) unavailable	No outage rotations, same customers stay out. More gen drops as other comes back	Still 511k customers out of power. Forecast ERCOT peak was 75,056 MW	Still some customer outages due to storm damage on T&D	ERCOT return to normal system ops
Water systems						Abilene shuts city water due to elec outages. Public boil water notices start	House pipes start freezing	Water systems call for conservation	13 mil Texans under boil water notice. House pipes start breaking	15 mil people (189 counties, 1,300 public water systems) under boil water.
People		130-vehicle pile-up in Ft. Worth	Scattered power outages from storm damage to T&D			4.5 mil in ERCOT w/o power. Roads icy & dangerous	Loss of cell service, minimal govt comms. 390k outages also in LA, OK, MX, stores clos	Deaths from CO poisoning, hypothermia		Dozens of deaths reported from storm, outage

ERCOT electric prices/Mwh

PUCT orders ERCOT to hold price cap at \$9,000/Mwh

Price Error?

Ercot kept power prices at \$9,000 cap after grid emergency ended



Source: Bloomberg

https://www.bloomberg.com/news/articles/2021-03-04/texas-watchdog-says-power-grid-operator-made-16-billion-error?mkt_tok=ODUwLVRBQS01MTEAAAF7rQjvL7a-5X78FWYiz_q1XGRYro5xi-YNy67dpjQCMKaF2CaQ8PfdrsveHaoloi_9q_jXOAegk2d4b4zpa-SY-ql4ynlzqUzLOjPA7m64UqLU