TEXAS FREEZE DISASTER
February 12-19, 2021

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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
Extreme Weather, Extreme Outages Pushed Texas into Blackouts

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

80GW

Electricity demand breaks previous winter record of 66GW on Sunday afternoon.

ERCOT begins blackouts at 1:25AM on Monday to prevent grid collapse.

Load forecast

Without blackouts, ERCOT could have broken all-time electricity demand records.

Load shedding ends on Friday.

Actual load

Load plummets below forecast as blackouts begin.

Thermal plant outages

ERCOT expects 14GW of thermal outages in its 'extreme' planning scenario. By Monday morning, more than 30GW of plants are offline.

ERCOT plans for just 2GW of renewables in its extreme winter scenario.

Temperature drops into the single digits. Gigawatts of coal, nuclear, and gas plants begin to rapidly trip offline.

Wind + Solar

Power picks up as plants return from outage.

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

- Entered EEA 3 1,000 MW Load-shed Ordered
- 35,343 MW Generation Capacity Out as of 1:23 am
- 1,418 MW Generation Outages 1:26am – 1:42am
- 248 MW Generation Outages
- 329 MW Generation Outages
- Additional 1,000 MW Load-Shed Ordered (Total 2,000 MW)
- 606 MW Generation Outages
- 688 MW Generation Outages
- 511 MW Generation Outages
- Additional 3,000 MW Load-Shed Ordered (Total 5,000 MW)
- Below 59.4 Hz for 4m 23s
  More Gen Units would have tripped if below 59.4 for 9m or more
- Additional 2,000 MW Load-Shed Ordered (Total 10,500 MW)
- 594 MW Generation Outages
- 843 MW Generation Outages
- 841 MW Generation Outages
- Additional 3,500 MW Load-Shed Ordered (Total 8,500 MW)
- Min Frequency 59.302 Hz
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

Source – ERCOT
Note -- two graphs pasted together
Natural gas

- 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

Texas production about 40% of U.S. production – see e.g., [https://www.eia.gov/naturalgas/weekly/archivenew_ngwu/2021/02_18/](https://www.eia.gov/naturalgas/weekly/archivenew_ngwu/2021/02_18/)
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.
<table>
<thead>
<tr>
<th><strong>Weather Temps for Dallas</strong></th>
<th>Feb 10 W</th>
<th>Feb 11 Th</th>
<th>Feb 12 F</th>
<th>Feb 13 Sa</th>
<th>Feb 14 Su</th>
<th>Feb 15 M</th>
<th>Feb 16 Tu</th>
<th>Feb 17 W</th>
<th>Feb 18 Th</th>
<th>Feb 19 F</th>
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<tbody>
<tr>
<td></td>
<td>NWS Arctic warning, arctic across WTX-OK</td>
<td>Cold starts, ice storm, bad roads</td>
<td>Snowstorm starts</td>
<td>Sleet &amp; snow, icy roads state-wide</td>
<td>Icy roads, minimal transportation</td>
<td>Snow, ice storm overnight, roads dicey, stores closed</td>
<td>More snow, minimal travel</td>
<td>Roads clear</td>
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| **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 failing | Gas production keeps falling due to freeze-offs | Power cut to many nat gas fields, pipeline compressor stations, processing plants | TX gas production down 50% (7% of total US production) |

| **Electric system** | | ERCOT starts conservation alerts 8:30 am. 35K gen 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 electrical 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 commns. 390k outages also in LA, OK, MX, stores closed | Deaths from CO poisoning, hypothermia | Dozens of deaths reported from storm, outage |
ERCOT electric prices/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=ODUwLVRBQS01MTEAAAFF7rQjvL7a-5X78FWYiz_q1XGRYro5xi-YNY67dpjQCMKaf2CaQ8PfdrsveHaoloi_9q_jXOAegk2d4b4zpa-SYql4ynlzqUzLOjPA7m64UqLU