ERCOT's Continuing Decline in Reliability

https://egpreston.com/ERCOT2.pdf

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ERCOT's reliability has declined to dangerously low levels and is continuing to decline due to the unusual interaction of transmission constraints with NERC reliability and ERCOT financing rules.

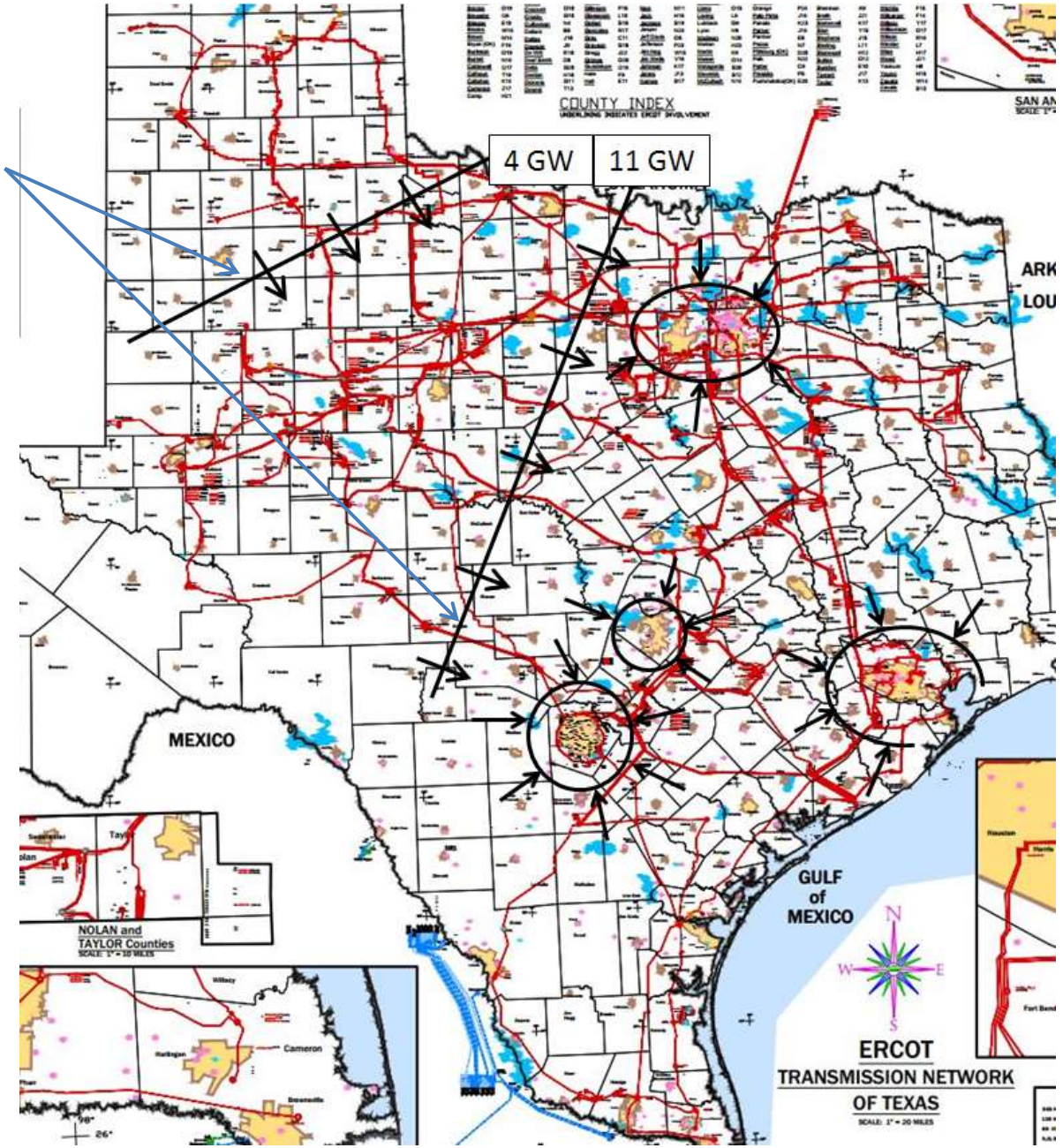
Transmission Constraints:

The generic transmission constraints (GTCs) are the straight lines now limiting new generation in West Texas.

The circles around large cities are power lines limiting power imported from remote sources. Retiring generation inside cities increases the local metro area blackout potential.

There are many constraints throughout ERCOT in which solar is dispatched ahead of the gas and coal plants. This causes these plants to lose revenue to the point they are retired. New gas plants are not earning enough revenue in the ERCOT market to stay in business even if a gas plant provides needed reliability.

[ERCOT just posted an update.]



Wakeup Call Trends:

1) The natural gas system is not reliable in cold weather: ref 1, ref 2, ref 3, ref 4, ref 5.
2) Future climate change regulations discourage the building of new fossil fuel plants.
3) ERCOT has the authority to uplift new transmission costs for conventional generation based on NERC reliability tests, but not for the variable power from renewables.
4) Renewables are taking away all the available transmission for coal and gas plants.
5) **Combining 1) – 4) above implies that fossil fuel capacity will continue to decline, possibly at an increased rate after the 2022 surge in new solar plant capacity.**
6) The capacity decline in fossil fuel plants is causing an increase in emergency events.
7) The price spikes from emergency events might be a basis for investing in more fossil fuel plants to reduce the yearly number of emergency events; however, the constraints imposed by 1), 2), and 4) are roadblocks to the building of new fossil-fuel plants.
8) The energy market does not provide enough revenue to support high capital cost projects such as large energy with high capacity battery storage, new nuclear plants, or CCS (carbon capture and storage) gas plants.
9) There is a recent rise in Generic Transmission Constraints which limit new generation.

Winter Storm Uri Impact on ERCOT and SPP (Southwest Power Pool):

10) Wind output drops in cold weather: ref 1, ref 2 (lost 47% of expected wind), ref 3.

11) Lost one nuclear unit due to a water in-take sensor (hopefully now winterized).

12) Lost about half the gas capacity thought to be firm capacity in SPP and ERCOT.

13) Despite loss of half the gas capacity, SPP had 30 GW more remaining firm capacity than ERCOT did during Uri; **ERCOT's dependency on renewables and gas is too high**:

Fuel	**ERCOT** p24	**SPP**
Type	MW	MW
Coal	14,703	22,899
Natural Gas	64,202/2 = 32,101	36,310/2 = 18,155
Nuclear	5,268	2,061
Other	1,268	5,115
Tie Lines	0	6,000
Available	53,340	54,230
Peak Demand	76,819	47,000
Reserve	**-23,479**	**7,230**

Climate Change Impact on Reliability:

High and low pressure weather systems today are larger, more frequent, and can cover a large geographical area for longer than a week. When large high and low pressure systems form alternately in a stream around the world, the jet stream is observed to zigzag, which creates a blocking event.

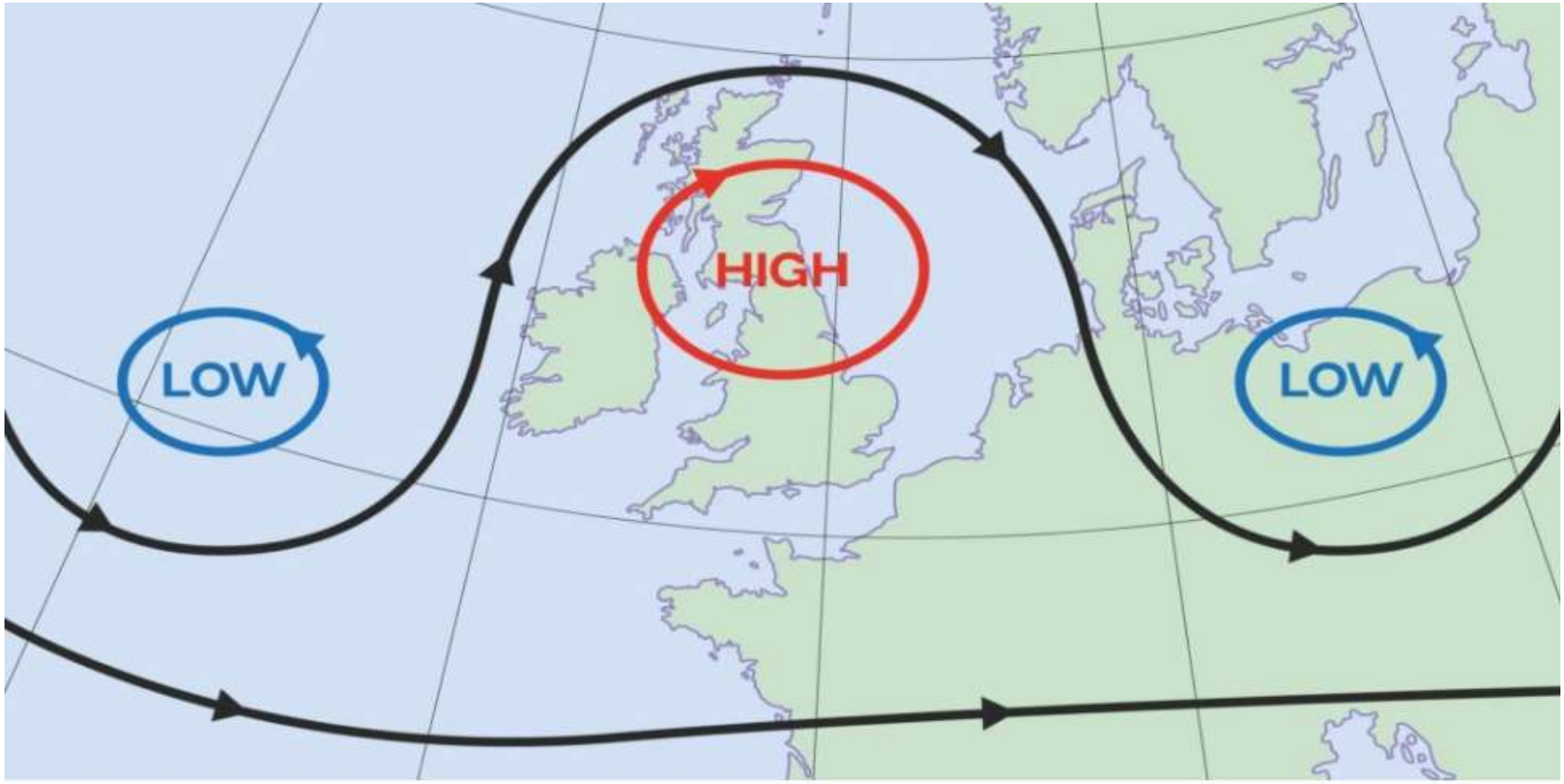


Illustration of an omega block over the UK. Credit: Met Office

The movement of the highs and lows eastward slows down and the heat wave and/or cold wave persists because of the blocking event. In 1970 I was planning the Austin system to meet peak demands at temperatures 102 F and 20 F. Today temperatures in the range of 115 F summer to 5 F in the winter seem possible. Deregulation interrupted the long range planning process. Texas ignoring climate change has caused a lack of preparation for dealing with the extreme temperatures.

Long Range Generation Planning 1970-1995:

In 1973 the primary fuel in Texas was natural gas. However the cold winter of 1973 with gas shortages and burning of oil at gas plants around the clock revealed natural gas was not dependable in very cold weather.

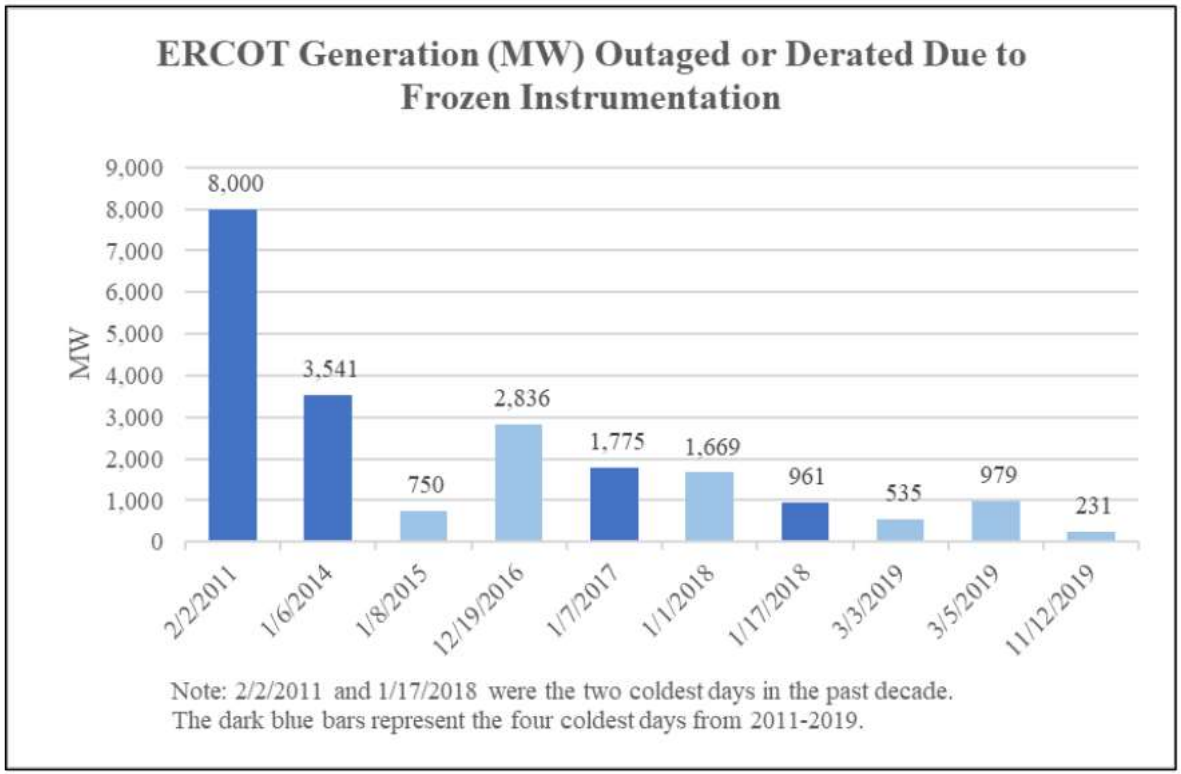
Oil tanks were added at many gas plants in Texas at that time about 47 years ago. A need to diversify the fuel sources led to several new coal and nuclear plants being planned and constructed. These coal and nuclear plants served us well through the 2011 cold spell, preventing load shedding from being necessary, even when gas supplies are limited.

Deregulation laws in the late 1990s removed the ability of Texas to perform long range generation planning because these alternative sources of power are more expensive than natural gas, but necessary for diversification. We did not know the impact that climate change would have on the power system when deregulation laws were passed and the current energy market was set up.

The Early Years of Deregulation 2000-2011:

After deregulation there was a rapid growth toward high efficiency combined cycle gas generators with about 14 GW of new plants being installed in a few years after deregulation. As these new plants were being added, and before older gas and coal plants were retired, there was quite a large amount of excess capacity. Wind grew rapidly as a result of the new CREZ lines. By the cold spell of 2011 there was plenty of capacity. However, that cold spell did reveal problems with weatherizing power plants. The Uri NERC report graph shown here suggests ERCOT was improving the weatherization of its power plants.

Figure 15: ERCOT Generation (MW) Outaged or Derated Due to Frozen Instrumentation



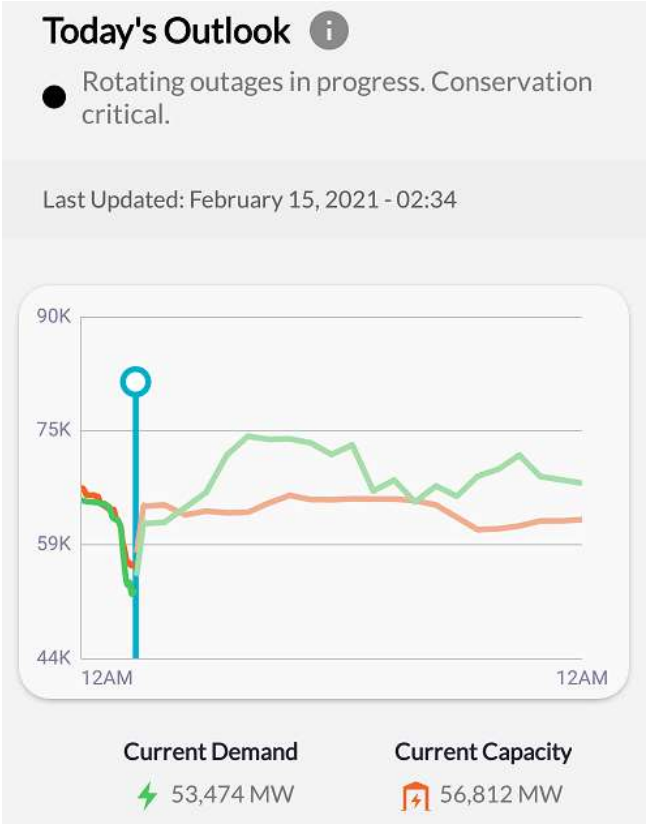
Years 2011-2021 Before Winter Storm Uri:

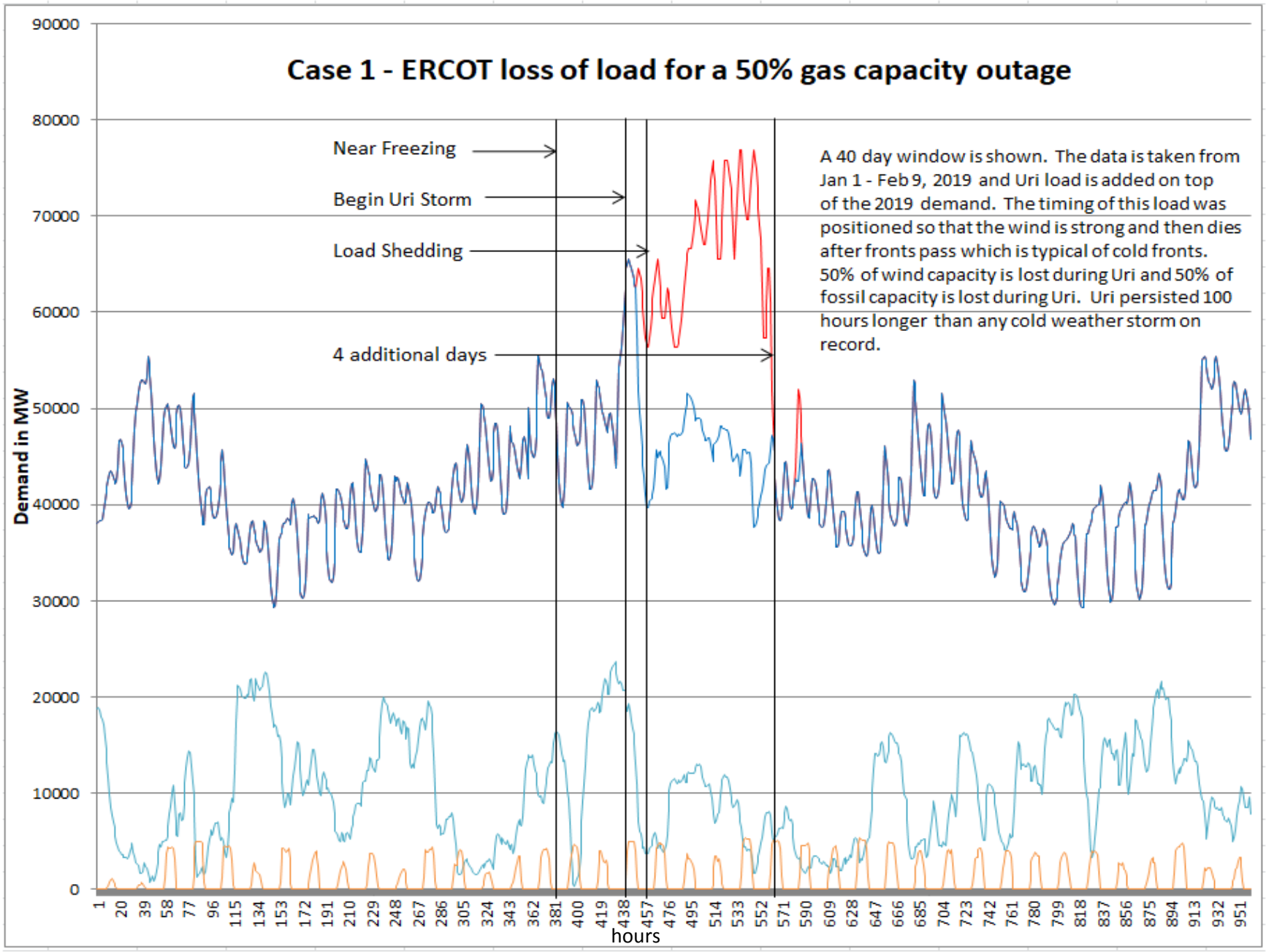
By 2018 the combination of low gas prices and growth in wind resources in ERCOT was having a negative impact on the economic viability of the coal plants and older gas plants. About 6 GW of coal plants were retired in the 2018 time frame that had not been predicted by Potomac Economics in 2018. ERCOT was showing signs of capacity deficiency in its power flow data which I reported to the IEEE Resource Adequacy Working Group in August 2020. I made a similar presentation to the ECH with an opening remark about a need to focus on keeping the lights on. I reported that emergency load curtailments could increase to 54 days of shortfall in 2027. The 2020 Potomac Economics State of the Market Report warned ERCOT on page 76 the nuclear plants may be operating at a loss in 2020. Recently I have added to my solar client studies a *harmers/helpers* analysis that shows how a solar plant can cause gas plants to be displaced by the solar plant's power injection. It might be 100 miles away and still cause a gas plant to decrement power. This drop in power keeps the grid reliable in meeting the N-1 line outage test but eventually this could cause a financial failure of the gas plant(s) leading to solar increases causing gas capacity decreases.

Winter Storm Uri:

Austin's freezing weather began on February 11 and continued through February 20. Uri ran for 100 hours longer than the 2011 storm and the coldest part of Uri appeared in that last 100 hours. If the temperature had not dropped so low and the storm had ended 100 hours earlier, there is a good chance the load shedding would have been minimal in ERCOT. This is what ERCOT expected and had planned for. ERCOT did appeal for load reduction. Climate change may be responsible for the extra duration due to the jet stream dragging cold air south and remaining in place longer.

I captured an image on my cell phone just as ERCOT was approaching a blackout. ERCOT was expecting a peak demand of about 67 GW but the low 7 F for an extended period caused the projected peak demand to rise 10 GW higher to 77 GW if there had been no load shed. ERCOT did not have sufficient reserves to serve a 77 GW load even if it had not had any storm-related forced outages.




Case 1 - ERCOT loss of load for a 50% gas capacity outage
Near Freezing
Begin Uri Storm
Load Shedding
4 additional days
A 40 day window is shown. The data is taken from Jan 1 - Feb 9, 2019 and Uri load is added on top of the 2019 demand. The timing of this load was positioned so that the wind is strong and then dies after fronts pass which is typical of cold fronts. 50% of wind capacity is lost during Uri and 50% of fossil capacity is lost during Uri. Uri persisted 100 hours longer than any cold weather storm on record.
Demand in MW
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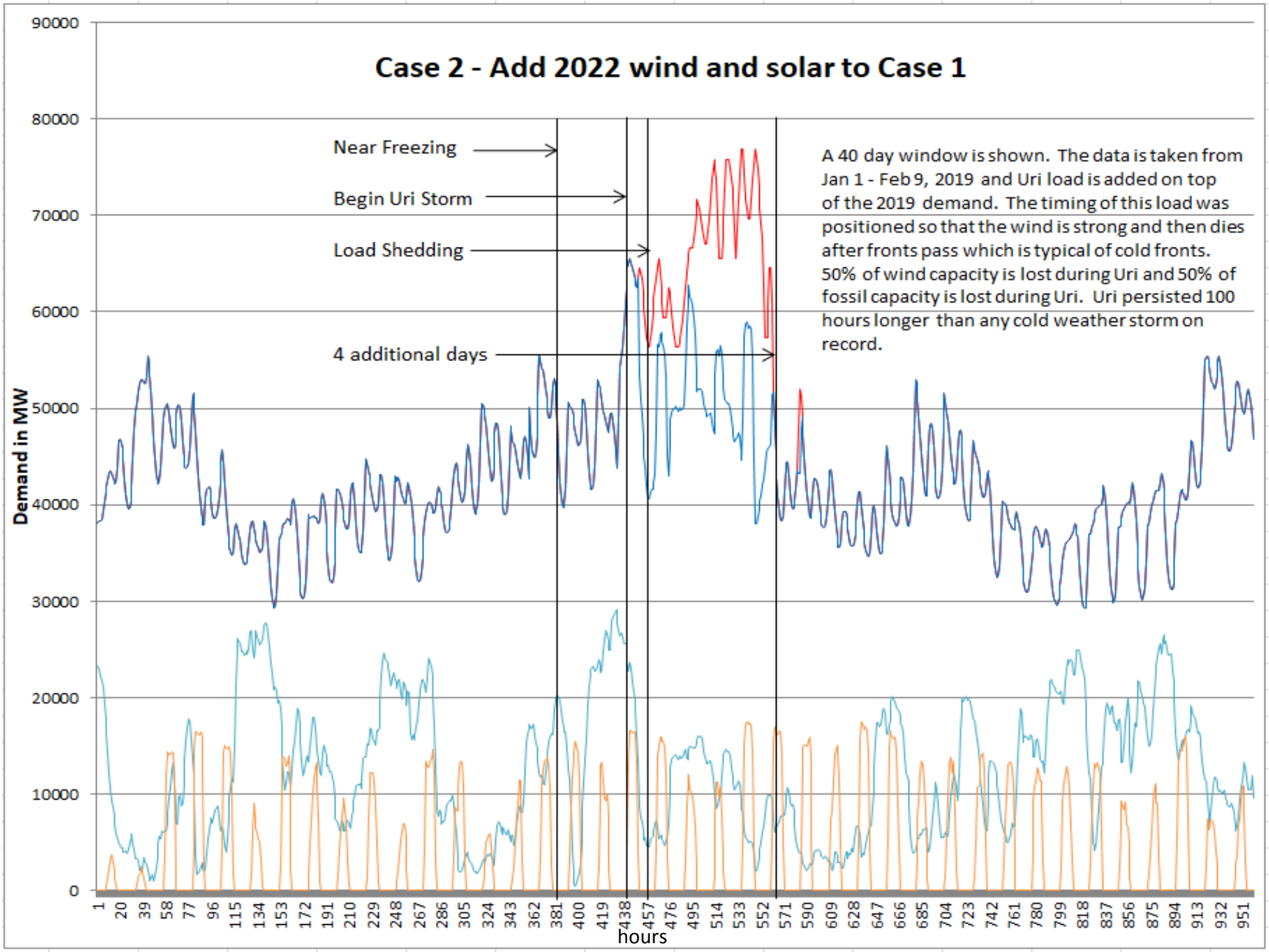
Case 2 - Add 2022 wind and solar to Case 1
Near Freezing
Begin Uri Storm
Load Shedding
4 additional days
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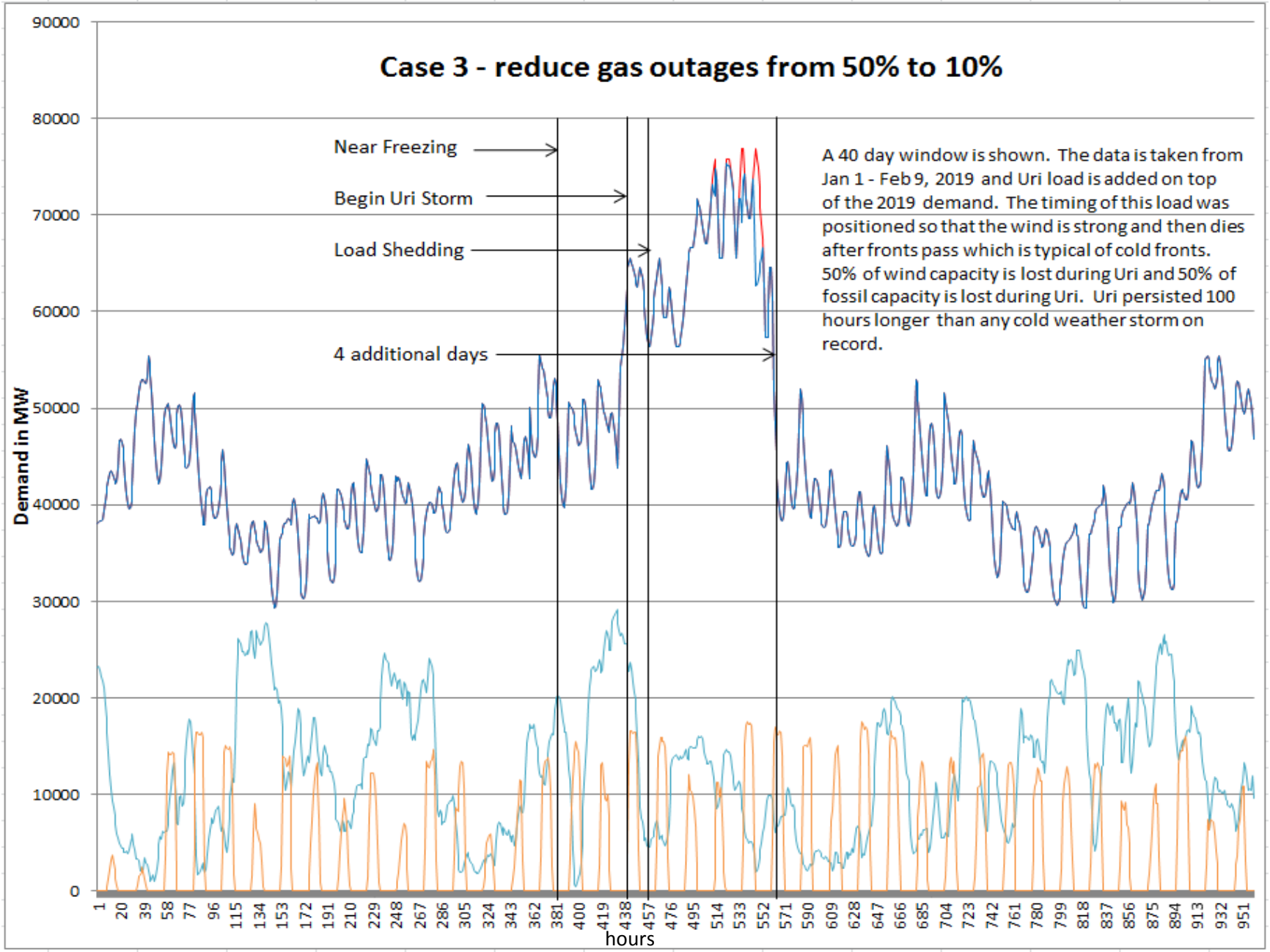
Case 3 - reduce gas outages from 50% to 10%
Near Freezing
Begin Uri Storm
Load Shedding
4 additional days
A 40 day window is shown. The data is taken from Jan 1 - Feb 9, 2019 and Uri load is added on top of the 2019 demand. The timing of this load was positioned so that the wind is strong and then dies after fronts pass which is typical of cold fronts. 50% of wind capacity is lost during Uri and 50% of fossil capacity is lost during Uri. Uri persisted 100 hours longer than any cold weather storm on record.
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What have we learned?

1) The expectation that gas alone will provide reliability fails. This was the problem 47 years ago.
2) The expectation that wind, solar, and gas will provide a reliable source of energy also fails.
3) The SPP problems with wind and gas supplies are nearly identical with ERCOT's experience.
4) Low reserve margins in ERCOT lead to rolling outages (or worse) in extremely cold weather.
5) Load shedding beyond contracted interruptible load constitutes a **failure to meet the NERC requirement** of one day in ten years loss of load. This means that during <u>one day</u> once every ten years there will occur a loss of load for a few hours.
6) The solution is the same now as it was 47 years ago. **Diversify generation to reduce dependency on unreliable energy sources, which probably means add more nuclear power.**

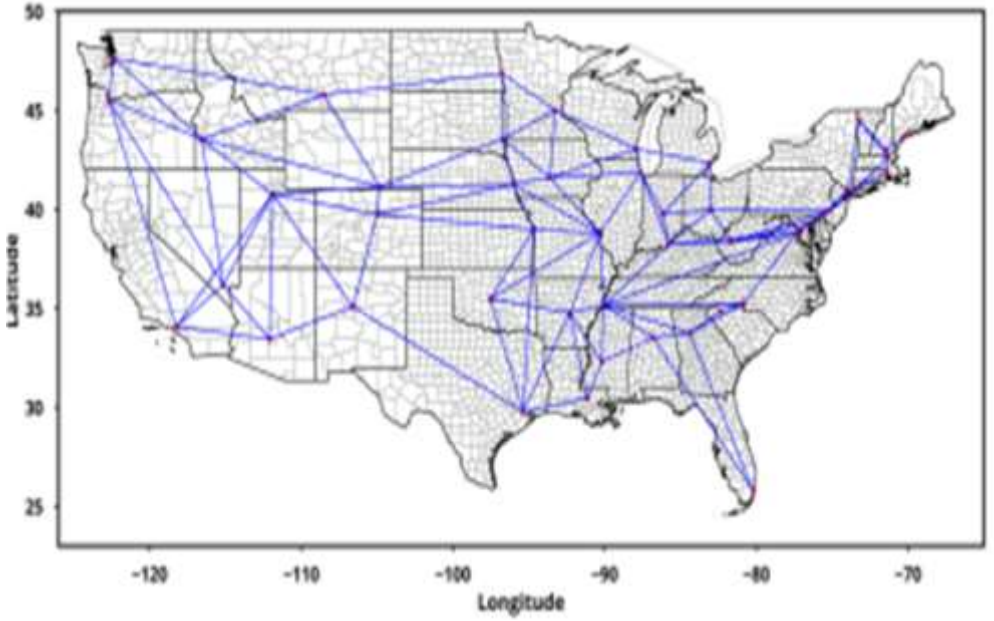
What are the solutions?

1) - A purely 100% wind and solar plus batteries plan is out of the question because there are not enough transmission lines to handle the 80 GW to 100 GW each for wind and solar. The battery storage capital cost would be over one trillion dollars.

2) - A plan with 40 GW each of solar, wind, and nuclear looks attractive because the amount of new transmission is less, and the overall plan cost is much less costly than a renewables plus large battery plan.

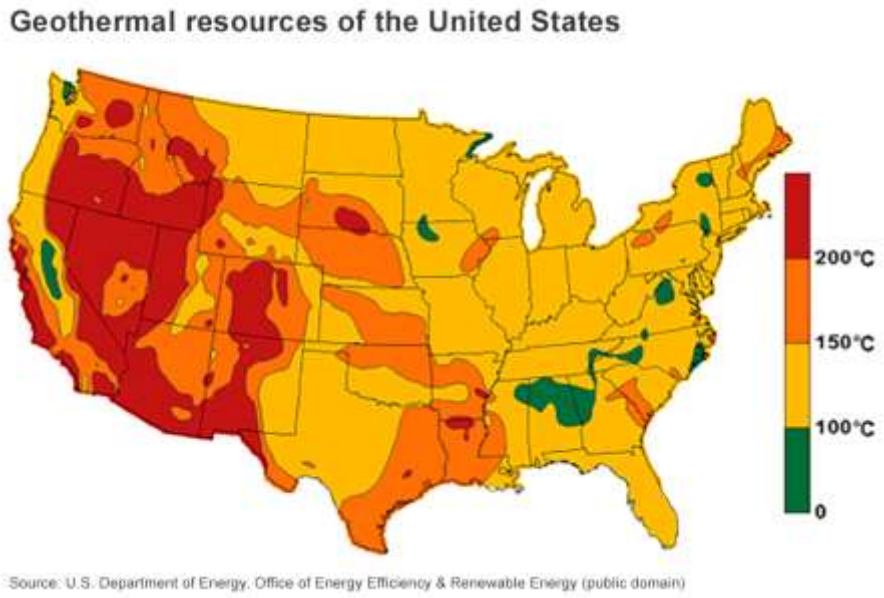
The new nuclear plants are designed for safety. NRC approval is needed as soon as possible for these new nuclear plant designs so we can effectively deal with climate change and grid reliability. ERCOT needs new rules that allow and promote the building of new nuclear power plant designs.

3) - Another possibility is to produce a gas (e.g., hydrogen) from clean power and pump it via pipe lines to load centers. This is an excellent way to ship large amounts of energy long distances. This concept should replace the national backbone electric grid proposed in the Green New Deal. Local substations scattered across the US can use the hydrogen gas to fill large 18 wheeler trucks or convert the hydrogen into electricity using fuel cells for charging EVs and powering the grids. The national development of a hydrogen fuel economy can be powered by all the non CO2 sources -- wind, solar, and nuclear. Pipelines vs Electric Grid



4) - A less attractive option is to build new gas plants using CCS (carbon capture and sequestration). The University of Texas Bureau of Economic Geology needs to formally identify suitable sites in Texas for storing CO2 so the generator developers will have a basis for designing new power plants that can utilize the CCS technology in applicable locations. This study shows earthquakes may be caused by large volumes of injection. CCS might have a few acceptable locations to pump CO_2.

5) - Geothermal energy is a possibility; however, the best sites are in the western US.



6) - Hydro resources are not applicable to Texas because there is not sufficient rainfall.

More wind generators on the Texas coast have a host of environmental problems as well as the possibility of damage from hurricanes. Twenty miles offshore the winds are too low and costs too high to make offshore wind feasible for ERCOT.

The current wind-solar-battery expansion plans relying on an unreliable gas supply and aging gas plants with little oil burning capability is a recipe for frequent power outages. We need to work together to fix this reliability problem and we need to do this as soon as possible.