# Efficiency vs Resilience

Texas Energy Systems 2021 Market Failure

Zachary Kobban, Hank Thomas, Jack Reisler

Economics of Regulation

Kenyon College

Near the end of January 2021, meteorologists at the Electric Reliability Council of Texas (ERCOT), began to worry about how the growing winter storm Uri would affect the reliability of the Texas power grid. The volatility inherent in predicting weather patterns meant that the imminent risk to Texas power was not fully realized until it was too late (UT Austin, 2021). Every year ERCOT releases the Seasonal Assessment of Resource Adequacy (SARA) report (Ercot, 2021). This under normal circumstances scenario predicted no issues in the reliability of Texas energy. The report also outlined an extreme circumstance simulation. Even this, still expected 1,352 MW of operating reserves (Figure 2). These were catastrophic miscalculations that lead to cascading failures and an astounding loss of life. All told, the strength of the winter storm combined with numerous failures on multiple levels of the energy sector and the Texas government lead to 246 deaths and an estimated total social cost between $80 billion to $130 billion (Donald, 2021). At peak levels, demand exceeded supply by 28,345 megawatts, leading to blackouts that affected 69% of Texans and stopped water distribution to 49% of Texans (Figure 3)(Donald, 2021). Before Uri, the Texas power grid was hailed as an example of how market mechanisms could be used in conjunction with technology to create a new, more efficient, and resilient power system (NBC News, 2022). This scale of this crisis brings up many questions about our energy future. How can we protect our energy system from the increasing severity and frequency of extreme weather events? Why did the market mechanisms fail? These questions bring us to an analysis of the existing power other power systems in the US and power systems in Texas. The catastrophic failures of the Texas power grid in winter storm Uri show that there exists a need for regulation in the Texas electrical market because the societal costs associated with market levels of grid resiliency are not fully internalized in the power generation market.

The American electricity grid is a network of power generators, transmission lines, and distribution systems that includes direct inputs to end users such as homes and businesses. The grid can be subdivided into three main regions: the Eastern Interconnection, the Western Interconnection, and the Texas Interconnection (Figure 4). From an economic perspective, these interconnection zones can be considered their markets. There exist very few interactions between each of these subdivisions. The generation companies in each region create electricity which is transformed into high-voltage power and distributed across power lines before it is transformed back down into low-voltage power and consumed by end users. The actual distribution network (made up of transformers, power lines, poles, etc.) is typically owned by either the utility company or the municipality (Cane 2022). The Eastern and Western Interconnections are regulated, natural monopolies with only one supplier and distributed for an area. The Texas division, however, is designed to operate as a competitive market with customers being able to choose between many suppliers and distributors. Management of the grid as a whole is controlled by regional transmission organizations and independent system operators that coordinate the flow of electricity to ensure that supply is always sufficient to meet and exceed demand (EIA, 2022). Because under-supply in electric markets creates much more catastrophic consequences than over-supply, the grid is intended to always keep capacity above the current demand.

The Texas energy grid is unique in its use of market mechanisms to theoretically increase efficiency and resilience in the energy market. As early as 1941, the Texas state government and local electricity corporations created a power generation system that functioned independently of the rest of the US (Koerner, 2003). The system's small size has allowed it to create a fundamentally unique approach to regulation. The approach allowed electricity providers to compete for customers and allowed customers to choose their electricity provider based on their preferences and budget. The Texas system was also designed to implement market mechanisms to increase resilience. The Real-Time Reserve Price Adder is a system that allows the prices faced by consumers to increase in real-time once reserves fall below 2,300 MW. Wholesale real-time prices may increase up to a $9,000/MWh cap (UT Austin, 2021). To face massive payouts in low probability scenarios where other generators start to fail or demand spikes, firms supposedly have strong economic incentives to protect their electricity generation from failure. This system can be seen in action during storms as wholesale electricity prices quickly increased to reach the cap. Texas also emphasizes efficiency by allowing competition in the energy generation market. This means that energy generation firms plugged into the grid only compete to produce electricity at the lowest possible cost. Because these firms don't incur the fixed cost of electricity distribution, the electricity generation market is generally competitive. Although it leads to a trade-off in resilience, this dramatically increases the efficiency of electricity generation. As we see in the analysis of the systems 2021 failure, these market systems do not always provide the desired outcome. The Texas system uses price gouging and market competition to theoretically create efficient and resilient market incentives.

The systems set in place to regulate the Texas energy market are structurally insufficient. Traditionally, electric utilities use cost-benefit analysis when considering investment decisions. Cost-benefit analysis often fails to determine the most efficient course of action when planning for disaster because of the uncertainty when calculating the degree of harm, and probability of a disastrous event. While these utility companies struggle to come up with quantification for the benefit of fortification, they have no struggles determining the cost. This places these utility companies in a position where “they know the price of everything and the value of nothing."(Svitek, 2022). Although this method is considered to be marginally unreliable given its reliance on future assumptions, the Federal reserve bank of Dallas estimated the social benefit of winterizing the equipment for gas plants using the value of lost load (VOLL) as the measurement. Using VOLL, the Federal Reserve Bank of Dallas estimated that the total social benefit is over $4.3 billion while winterizing the equipment of all 162 natural gas-fired generation units would cost just $9 million. (Svitek, 2022). This shows how market mechanisms failed to create resiliency and directly lead to the system's collapse.

The Texas government relied on the energy market to be self-correcting after the storms, however, there was little incentive for these companies to make any change at all. Texas assumed that these companies would recognize an opportunity for profit in the market of winterized generators. This was not the case, however, as these companies refused to meet the demand in the market (Pan & Li, 2022). These markets failed to self-correct due to assumptions about how weather-resistant equipment would sell in the power generator market. Conventionally, extreme cold weather was considered a small probability event, the upgraded generation units with higher operating costs may become less competitive in the market most of the time.

Another problem regarding Texas' response to infrastructure failures is the fact that it primarily focuses on being prepared for disastrous events of the past as opposed to disastrous events of the future. As climate change is a continuously worsening problem, future natural disasters are guaranteed to be worse than past natural disasters. Texas utility companies are too focused on upgrading their infrastructure to withstand past natural disasters, however, these upgrades are theoretically insufficient to protect the power grid from future, more intense, natural disasters (Journal, 2021). One of the solutions recommended by the Texas Commission is to use flood-plain designations provided by Fema, however, these plans fail to incorporate climate change projections. That being said, the Texas Commission did urge local governments to add a margin of safety, or "freeboard." to projects within flood zones as a way to "future-proof" them (Svitek, 2022). Yet there is no specification of how much freeboard is appropriate or what data should be used in making the determination. Although the technology is improving, power companies are going to need better predictions to allow markets to self-correct to worsening natural disasters.

The Texan power grid must make resiliency a higher priority even though it comes at the expense of market efficiency. Because electricity is such a necessity with life-threatening impacts, there must be regulation to ensure power systems are operating at optimal resiliency as dictated by the market. We know from our Viscusi text that both resiliency and human life have a real market value (Viscusi 2018). Currently, the market failure exposed by the winter storm Uri is a result of an inefficient level of resiliency and therefore safety provided by the market. Just the damages and inconveniences of the situation caused anywhere from $10 to $ 20 billion worth of impact on the economy. This, compounded with the human cost of 246 lives is a staggering toll (Texas Tribune 2022). As we have discussed in class, Kip Viscusi has helped push the valuation of human life to a more realistic $10 million (Viscusi 2018). Therefore, another $2.46 billion can be added to the ledgers in terms of the cost of this grid failure. This does not take into account the moral and ethical damages. Given that the market is producing a level of resilience below the socially optimal level, there is a need for regulation in the Texas electricity market. To internalize the societal costs of power generation failures, the government must enforce economic penalties on suppliers for performance-based failures.

Market forces have been used to move the electricity market, but because its reliability is intrinsically tied to human safety and the functioning of the whole economic system, the massive cost of its potential failure must be accounted for. At first glance, a market approach for electricity as Texas has implemented, is understandable. Customers choose from the available options of providers and, if they are disappointed by one, can switch to another. However, this is not the case in extreme circumstances. A market system means that companies are allowed to fail, and in so doing only face the consequences of lost profits. But for a necessity like electricity, this cannot be the case because it does not incentivize strongly enough companies to be reliable. In any normal market situation, if there was a shortage of some goods which had many substitutes, then customers would simply increase their consumption of those substitutes. But in this case, even though there are multiple suppliers, there is only one grid. Therefore, when it fails, there is no recourse for customers. As a result, regulation should be used to mandate resiliency in the form of performance standards for companies to stay in the market. Performance standards will be the best way of enforcing these regulations because they allow the company to be creative in how it meets demand and resiliency standards. These mandates will retain the benefit of the firm's creativity while protecting the human lives that require electricity. This regulation will address the implications of the natural monopoly of electricity generation and distribution while still allowing the market to play to its strengths.

## Tables and Figures:

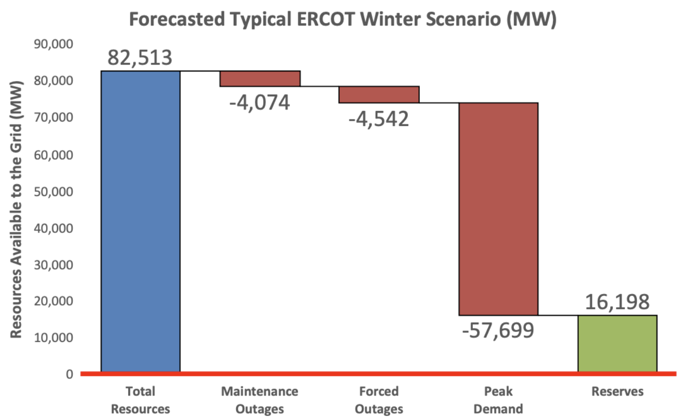


Figure 2.a. Waterfall chart of the ERCOT "Forecasted Season Peak Load" Winter 2020/2021 SARA scenario showing the total amount of Resources assumed for ERCOT as well as expected plant outages and peak demand. This scenario indicated that ERCOT would have over 16,000 MW of reserves, sufficient capacity to match supply and demand.

Figure 1 (UT Austin, 2021)

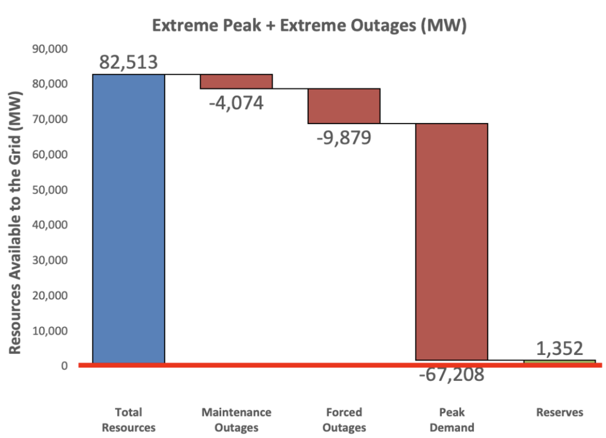


Figure 2.b. Waterfall chart of the ERCOT "Extreme Peak Load / Extreme Generation Outages During Extreme Peak Load" Winter 2020/2021 SARA scenario. This scenario indicated that ERCOT would have only 1,352 MW of reserves, insufficient capacity to prevent an Energy Emergency Alert.

Figure 2 (UT Austin, 2021)

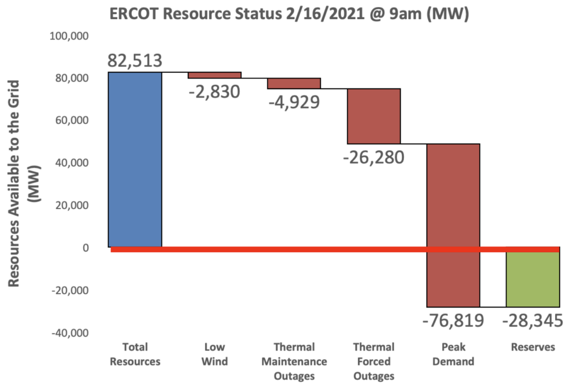


Figure 2.c. Waterfall chart of the actual resource availability at the time of peak demand (February 16, 2021 at 9 am) indicating a shortage of 28,345 MW in capacity due to lower than forecasted wind output, a higher capacity offline for maintenance, and over 26,000 MW of capacity triggered offline as instigated by the weather conditions.[14]

Figure 3 (UT Austin, 2021)

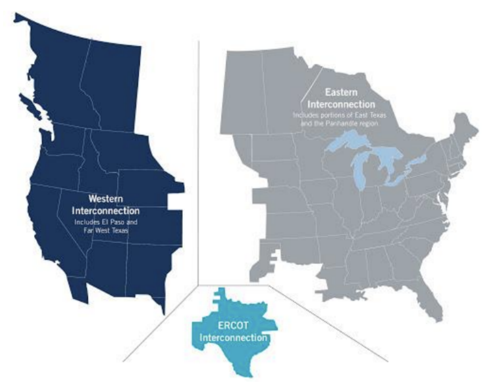


Figure 1.a. ERCOT in relation to the other two grid interconnections in the U.S. and Canada.[8]

Figure 4 (UT Austin, 2021)

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