ELECTRIC SYSTEM LOAD SHEDDING

PRACTICES AND CONSIDERATIONS AMID INCREASED EXTREME WEATHER EVENTS

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ABOUT THIS REPORT

The authors of this report set out with the intent to encourage contemplation of how utilities and regulators can reconsider load shed protocols and practices to be better prepared for changing weather patterns. Our research was primarily focused on how utilities were challenged during the winter storm events of 2021. The report and its conclusions are based in part on interviews with utility personnel and after-action reports released by regulators and utilities.

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Special thanks to Laurie Gregg, Manager of System Operations for Lincoln Electric System and Thomas Pierpoint, former Vice President of Engineering for Austin Energy for their time and insight.

This material is based upon work supported by the Department of Energy under Award Number DE-CR0000012.

INTRODUCTION TO LOAD SHEDDING

Load shedding is a process to address situations when electrical demand approaches or exceeds supply levels. In these situations, it is sometimes necessary to temporarily interrupt the delivery of electricity to maintain the integrity of the electric grid and to prevent catastrophic grid failures and extended outages for customers.

Shedding load may be necessary if there is a shortage of electricity supply or if power lines are at risk of being overloaded. Factors that can necessitate load shedding include: extreme weather, sharply increased electric demand, unplanned generation plant outages, transmission constraints, damage to equipment, unavailability of purchased power, or a combination of these conditions.

Shedding load is always a last resort, but, when necessary, can prevent prolonged power outages or extensive damage that could severely affect the reliability of the power grid for weeks or even months.

COMMON CONCEPTS AND APPROACHES

For system level load sheds, typically, a regional system operator monitors and acts to balance demand and supply.

When demand approaches or exceeds supply, the system operator, if other actions are insufficient, can initiate load shedding. Typically, regional load serving entities (i.e. Utilities) act upon such orders and execute the actual load shedding upon request from the system operator. Load serving entities typically attempt to mitigate the impact of the outages by rotating the outages across numerous customers, hence the term, "rolling blackouts."

NEW CHALLENGES AND EXTREME WEATHER EVENTS

The general utility industry consensus is that the ever-evolving climate crisis is a leading factor in increased average temperatures in summer months, increased frequency of significant cold weather events, and stronger storms, including severe weather events like tornadoes and tropical cyclones.

Drought conditions and severe high wind events are also causing increased risk of wildfires across the country.

All these events can precipitate the need for load shedding practices. Increased temperatures drive increased electrical demand. Extreme cold temperatures increase winter electrical demand and can increase the risk of shortages in the natural gas supply and generation. During load shedding events, utilities face challenges in meeting various stakeholder (customers, regulators, elected officials, etc.) expectations, whether that is in meeting efficiency targets; mitigating the effect of outages on customers' health, safety, and economic potential; or providing accurate and timely communication.

Outside of load shedding, utilities also must determine how to maintain system reliability within acceptable cost ranges during extreme weather events.

CASE STUDIES

AUSTIN ENERGY
GREATER AUSTIN AREA, TEXAS

Winter Storms of 2021

In February of 2021, the combined impact of three severe winter storms resulting from a polar vortex caused one of the worst energy infrastructure failures in the state's history. More than 4.3 million homes and businesses were left without power at the height of the event's impact (Sullivan & Malik, 2021). Austin Energy is a public power utility that serves more than 400,000 residential customers and nearly 50,000 commercial customers in the greater Austin, Texas, area (Austin Energy by the Numbers, 2022).

According to Thomas Pierpoint, Austin Energy's vice president of engineering at the time of the event, prior to the 2021 storms, Austin Energy had a thorough emergency management and load shed plan in place, including a load shed list partially determined after a severe winter storm in 2011. Ultimately, the utility's response was informed by its predetermined procedures, but with contemporaneous modifications made to accommodate the magnitude of load shed required to keep the entire system from failing. The load shed procedure included designations for critical load separated into two categories: critical load 1 (CL1) and critical load 2 (CL2), with CL1 having priority status for preservation of power. As described by Pierpoint, the critical load lists were "frequently and well-scrubbed."

Austin Energy's load shed operation is governed by an automated system supported by manual inputs. It was expected that the system would be able to manage the storm event using automated scheduling of 15 minutes on and 10 minutes off for non-critical loads. Prior to the event, the Electric Reliability Council of Texas (ERCOT) had signaled concern about generation meeting demand. Although it forecast that the demand curve would exceed the generation curve, it had made similar predictions during summer peak events that often didn't materialize, so there was still uncertainty about how severe the impact of the storms would be.

"We were staffed for the worst, but the worst was worse," Pierpoint said.

A combination of factors would result in a greater system strain than predicted and calls for load shed began to come in the earliest hours of February 15, 2021. Austin Energy heeded the initial calls from ERCOT using its preexisting protocols and software, but the calls continued to come for further load shed. At times, calls were coming in 30-minute intervals. It did not take long for the preloaded load shed list to be exhausted. Austin Energy was forced to make adaptive, real-time decisions beyond anything previously contemplated.

One of the challenges that Austin Energy faced was that the network grid feeding downtown Austin could not be de-energized without significant complications. It also had to consider certain commercial and industrial customers that had identified sensitivities to any extended periods of disconnection.

Austin Energy ultimately avoided a system-wide collapse by taking the following measures:

- Meeting the ERCOT requested load shed amounts.
- After exhausting the predetermined load shed list, manually shed circuits configured for cycling under frequency load shedding.
- Requesting that businesses served by the downtown network grid curtail their consumption. Many businesses proved eager to help and were able to comply with the request.
- Giving advance warning to industrial customers with extreme sensitivities before dropping their load.

While Austin Energy executed its load shed process well, it completed an after-action review, which identified numerous opportunities to further develop its processes. https://austinenergy.com/go/aar2021

CASE STUDIES

LINCOLN ELECTRIC SYSTEM
LINCOLN, NEBRASKA

Winter Storm Uri, 2021

Lincoln Electric System (LES) is a public power utility serving the city of Lincoln, Nebraska. In February of 2021, LES faced the most significant load shed event in its history in response to the impacts from a severe winter storm, informally named, Uri (The Weather Channel February 14, 2021). Approximately 47,000 LES customers were affected by the storm, which resulted in an unprecedented winter peak load that exceeded the forecasted load by more than 90 megawatts (Message from CEO Kevin Wailes, n.d.).

Laurie Gregg, Manager of System Operations for LES, and a 40-year veteran of the utility industry, shared that although LES had thorough protocols in place, Uri forced the utility to make additional adjustments on the fly. Although utility staff had trained extensively for this type of event, this preparation was truly put to the test. LES uses a primarily manual system to implement load shed procedures.

According to Gregg, there were some preparations that helped LES to cope with this unprecedented event once the load shed requests began to come from the Southwest Power Pool (SPP), the regional reliability operator. In the years prior to the arrival of Uri, LES surveyed customers to identify which were served by backup generators and kept a well-maintained critical load list that was separated into CR1 and CR2 designations. Once it began to implement load shed procedures, LES relied heavily upon communication to manage customer expectations.

Lincoln Electric System was able to mitigate the customer impact of the unprecedented load shed event caused by Winter Storm Uri using the following "on the fly" measures during the rotating blackout period:

- Reducing load cycling periods from two hours to one hour, modifying a procedure to minimize the negative impact of the severe cold on customers.
- Quickly putting together mass notifications online, on TV, and on local radio stations to inform customers what was happening, the reasons why it was happening, and to ask them to conserve energy as much as possible. Getting customers to understand why load shedding was necessary went a long way towards achieving customer buy-in.
- Notifying large electric customers prior to load shed to allow for them to shut down "normally."
- Shedding load at the feeder level and using its geographic information system (GIS) database to identify and communicate with affected residential and small business customers prior to shut down through its online outage map.

Lincoln Electric System Critical Load Definitions & Categorization

1.0 Purpose

1.1 To designate the customer loads that shall have a higher priority placed on them during outage restoration and in load shedding schemes, both manual and automatic.

1.2 The decision as to if a facility is placed on this list is based on a "best judgment" estimate using the guidelines listed in the Definitions section and, when available, on input from the controlling agency.

2.0 Definitions

2.1 Tier 1 Critical Load – a facility that provides or supports fundamental public services that have a substantial impact on public welfare and/or safety. A sustained loss of service (over two hours) could result in potentially serious consequences. Service should be restored as soon as possible.

2.2 Tier 2 Critical Load – a facility that provides or supports important public services and impacts public welfare and/or safety but would not have the same immediate, potentially detrimental impact as a Tier 1 facility, should it be without power.

2.3 Automatic Underfrequency Load Shed (UFLS) – Loads that are set to trip when the system frequency reaches certain levels to protect the bulk power grid from collapse (NERC standard PRC-006). For LES, these stages are set to automatically trip 10% of LES total load at each of three frequency levels.

General types of loads we consider for Critical Loads are the following:

- Communications (to communicate with and among emergency response organizations, as well as to communicate to our customers)
- Emergency response (fire, police, military, etc.)
- Emergency restoration (pipeline pumping stations to feed gas to generating units, service and data centers for electric utilities and gas utilities)
- Government (correctional facilities, State Capitol, city/county government)
- Hospitals and surgical centers
- Nursing homes (although state licensing laws require them to have an emergency generator to feed at least a portion of their electrical load)
- Other medical (blood banks, dialysis centers, etc.)
- Transportation (City transportation centers, airport runway lights and airport)
- Wastewater lift stations and sewage treatment plants
- Water pumping stations and well water

SUMMARY AND CONCLUSIONS

Extreme weather events will likely drive increased reliance on load management practices, including load shedding, in the years to come. Entities throughout the energy industry have a role in confronting the challenges affiliated with increased frequency of load shed events.

- Regulatory agencies, including the Federal Energy Regulatory Commission and many regional utility commissions, are monitoring changes in weather and taking actions to manage impact on electric utility operations.
- Comprehensive load shed processes exist across the electric utility sector, but many will require continuous evaluation to adapt to new weather patterns.
- Regional system operators and utility personnel are aware of the importance of load shedding and have processes in place to maintain proficiency.
- In the U.S., load shedding processes are comprehensive, but plans are infrequently used. The importance of such plans is evident, the "players" are proficient, and improvements to help meet stakeholder expectations are likely available.
- Strong computer and software packages can significantly aid in efficiency of executing a load shed event, even if additional manual measures are required to respond to events.
- Stakeholder interest in protecting critical customers remains strong.
- FERC led a thorough review of the Winter 2021 event and made numerous recommendations.
- After-action reviews are a useful tool for better preparing for subsequent events. Austin Energy implemented a thorough after-action review of the Winter 2021 event and created a report that provided numerous recommendations.

Recommendations

- Utilities should look for ways to further exercise their load shed processes, such that load shed execution is efficient and customer focused, despite infrequent use of the plans. Broad involvement in drills, simulations, and table-top exercises (full organization, customers, elected officials, etc.) can help assure that "players" are "game-ready."
- Utilities should evaluate their existing load shed computing and software packages to identify any enhancements that would better support load shed execution and meet customer expectations.
- Utilities should ensure that they have a regular and rigorous process for identifying and updating critical customer lists, including critical gas supply customers.
- Utilities should familiarize themselves with the FERC report on the Winter 2021 event and review other after-action reports, including Austin Energy's comprehensive review.

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