WECC

Year 20 Extreme Heat Event Study

June 2024

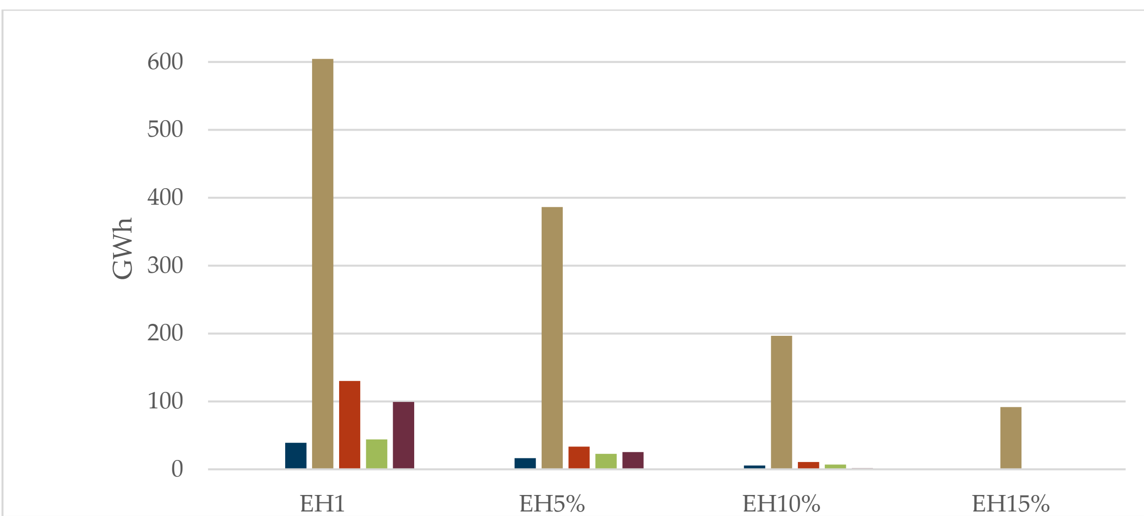
Executive Summary

Extreme heat events stress the bulk power system by simultaneously causing increased demand and reduced generation output, as well as changes to transfer capability. The frequency and intensity of extreme heat events is increasing, and some are more widespread and longer lasting than in the past. WECC conducted this assessment to begin to understand the potential effects an extreme heat event may have on the power system in 2042. To do this, WECC modeled an extreme heat event like the August 2020 heat wave set in 2042.

WECC used its Year 20 Foundational Case (Y20 FC) as a starting point and then added transmission, load, wind, and solar assumptions to simulate a 2042 heat event and create a base scenario. The simulation of the base scenario resulted in high levels of unserved load in all subregions except Alberta and British Columbia. To determine what kind of load reduction would mitigate the unserved load, WECC ran three additional load-reduction scenarios for a total of four scenarios:

- Extreme heat event base scenario (EH1)
- Extreme heat event with 5% load reduction (EH5%)
- Extreme heat event with 10% load reduction (EH10%)
- Extreme heat event with 15% load reduction (EH15%)

Reducing the load helped mitigate the unserved load but was not able to eliminate it.



Comparison of Unserved Load by Subregion (2042)

In all four scenarios, there was unserved load between 1:00 a.m. and 7:00 a.m., an unusual time for load loss. WECC believes this is due to the way its model simulates battery storage.

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Introduction

Extreme heat events stress the bulk power system by simultaneously causing increased demand and reduced generation output, as well as changes to transfer capability. The frequency and intensity of extreme heat events is increasing, and some are more widespread and longer lasting than in the past. Current projections of climate change indicate that heat events will likely increase over the coming decades. Long-term bulk power reliability relies on an understanding of how future heat events might affect the power system. Understanding today how these events may affect the system 20 years from now can help industry design and build the system the West will need in the future.

Extreme heat events have various effects on the power system depending on temperature, duration, geography, infrastructure, load characteristics, and resource portfolios. The challenges associated with these events include:

- Increased loads, particularly due to increased air conditioning,
- Decreased transmission capacity,
- Diminished natural gas generation due to high ambient temperatures and supply constraints,
- Decreased wind generation due to low wind speeds from high pressure systems and high temperatures, and
- Increased drought, wildfire, and dust storms.

Compounding these challenges is the fact that each extreme heat event is unique, which complicates how the West models, plans for, and operates the system.

WECC conducted this assessment to begin to understand the potential effects an extreme heat event may have on the power system in 2042. To do this, WECC modeled an extreme heat event set in 2042 like the August 2020 heat wave. WECC applied a discrete set of assumptions to look at a specific potential future among myriad potential futures. As such, the results of this initial study help identify areas of potential concern that merit additional exploration.

Approach

WECC used a deterministic model with probabilistic load and renewable resource forecasts for this assessment. Using a nodal production cost model, WECC created several scenarios to compare and identify potential risks. The starting point was the Year 20 Foundational Case (Y20 FC), which was built to serve as a possible future with no unserved load. From there, WECC built the 2042 extreme heat event scenarios. WECC started with actual hourly load, wind, and solar data from the August 14–19, 2020 extreme heat event and probability forecasts from the 2020 NERC Summer Reliability Assessment.

Initially, WECC created a transmission-constrained base scenario that mimicked the conditions of the August 2020 heat wave, extrapolated to 2042. This included load, wind, and solar shapes. From there, WECC planned to create sensitivity scenarios to test different transmission derates, as well as thermal and hydro generation reductions to simulate conditions where natural gas generation is derated due to higher ambient temperatures and hydro generation is reduced due to drought. However, the base scenario resulted in significant unserved load, and comparing the results to the sensitivity scenarios would not have produced meaningful results.

In response, WECC changed its approach and created scenarios in which it reduced load incrementally to determine the level of load reduction necessary to eliminate the unserved load in the base scenario. This yielded more meaningful results and lessons about how WECC's model simulates battery storage.

Scenarios

Using the Y20 FC as a starting point, WECC created five scenarios:

- **Extreme heat event base scenario (EH1):** August 2020 heat event load, wind, and solar extrapolated to 2042.
- **Extreme heat event with 5% load reduction (EH5%):** base scenario with the load decreased by a flat 5% across all hours.
- **Extreme heat event with 10% load reduction (EH10%):** base scenario with the load decreased by a flat 10% across all hours.
- **Extreme heat event with 15% load reduction (EH15%):** base scenario with the load decreased by a flat 15% across all hours.

Subregions

WECC divided the interconnection into seven subregions.

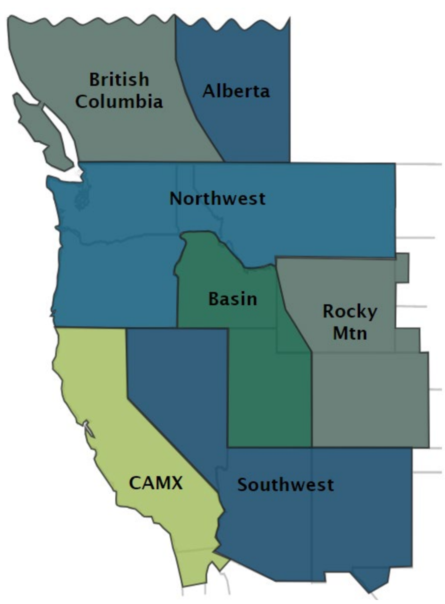


Figure 1: WECC Subregions and Balancing Authorities

Data and Assumptions

Year 20 Foundational Case

WECC built the Y20 FC on its 2032 Anchor Data Set Production Cost Model (2032 ADS) with a focus on updating the business-as-usual future loads and resources to reflect possible conditions in 2042. Some case elements—such as future technologies, transmission, and pricing—were not updated and remain the same as the 2032 ADS. The 2032 ADS only includes transmission that is in service in 2032 and does not include transmission that is under construction, planned, or necessary beyond 2032. To compensate for this in the Y20 FC, WECC placed new generation assets near load centers, so new transmission lines were not needed. The Y20 FC includes a 5% transmission derate inherited from the 2032 ADS.

Load

WECC used a probabilistic approach to develop the hourly load forecast for this assessment. This new method compared the actual load from the August 2020 heat event to the probability of that load occurring. Annually, WECC creates probability curves for each hour's load, as well as solar, wind, and hydro generation. These curves help show the probability of the load levels experienced in the West.[1] WECC used that probability in developing load assumptions for 2042. For example, at 4:00 p.m. on August 18, 2020, interconnection-wide load was 162,017 MW. This was at the 80th percentile, meaning there was a 20% possibility of seeing load at or above that level. Expected load probability is at the 50th percentile, meaning there is a 50% chance of occurrence. So, the load levels in the 2020 heat event were less probable. During some hours of the 2020 heat event, the interconnection-wide load was at the 99.9th percentile, meaning there was less that a 1-in-1,000 likelihood it would have occurred.

WECC determined the difference between the expected load and the actual load for each hour of the August heat event. It then applied that difference to the expected load in 2042 from the Y20 FC. Figure 2 shows the change in loads from the Y20 FC by hour and subregion for the study period. For example, at 2:00 p.m. August 16, 2042, WECC set the CAMX subregion's load level at 62% above the Y20 FC.

[1] WECC provides probabilistic load, solar, wind, and hydro information to NERC for its Reliability Assessments.

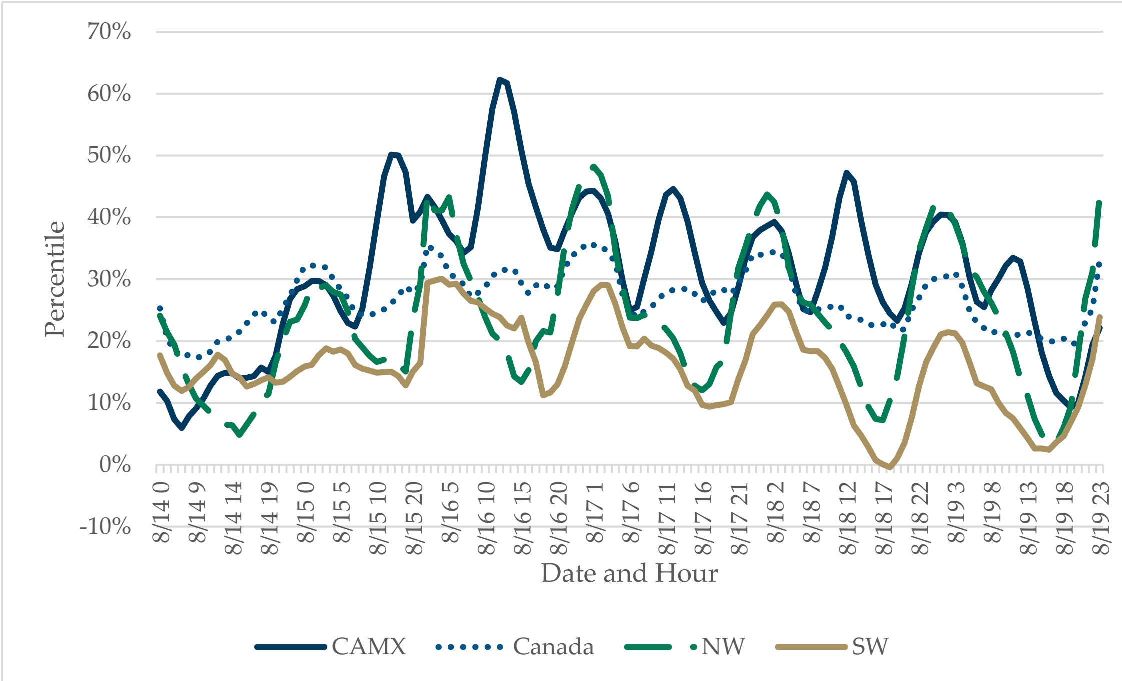


Figure 2: 2042 Hourly Percentile Adjustment to Loads by Subregion

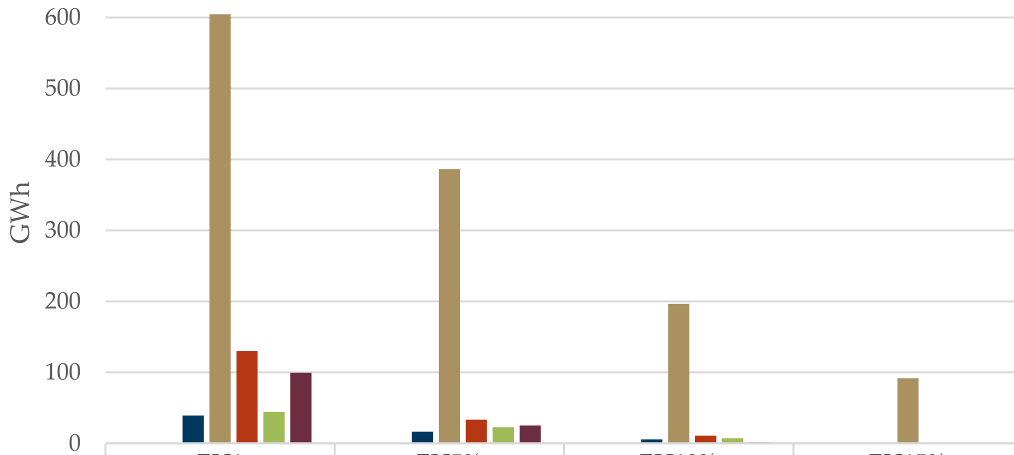
Wind and Solar Generation Availability

Wind and solar can have significantly different output patterns during extreme heat events from expected predictions. In particular, wind generation can be diminished due to low wind speeds caused by high pressure systems. To create wind and solar inputs for this assessment, WECC compared actual wind and solar generation from August 14–19, 2020, to the expected (50th percentile) forecast. WECC then used the hourly generation probabilities for the respective generation types to apply hourly adjustments to the Y20 FC expected hourly generation to reflect the conditions experienced in 2020.

Findings

Unserved Load

The base scenario, EH1, resulted in unserved load across all but the Alberta and British Columbia subregions. (See Figure 3.) Reducing the load in each of the load reduction scenarios reduced the unserved load across the remaining subregions, but in no scenario was unserved load eliminated. Unserved load was greatest in the CAMX subregion in each of the scenarios because the August 2020 heat event was primarily focused there. The unserved load in the simulation was due to assumptions used in the Y20 FC and this assessment, such as generation additions.



	EH1	EH5%	EH10%	EH15%
Alberta	0	0	0	0
BC	0	0	0	0
Basin	39,161	16,356	5,621	816
CAMX	604,494	386,410	196,562	91,648
Northwest	130,016	33,349	10,795	656
Rocky Mtn.	44,108	22,783	7,053	1,079
Southwest	99,306	25,277	1,527	57

Figure 3: Comparison of Unserved Load by Subregion

In terms of timing, load loss only occurred on days three through seven of the eight-day heat event (August 16–20, 2042). In the EH1 and EH5% scenarios, load loss occurred across multiple hours during the day. (See Figure 4.) However, in all four scenarios, load loss also occurred at night, between 1:00 a.m. and 7:00 a.m. The overnight load loss is likely due to how WECC's model simulates battery storage. The model optimizes energy storage on a 24-hour cycle, which means the energy storage charges and discharges in each 24-hour period. This modeling limitation does not reflect actual operational practices, which charge and discharge energy storage units over several days. The limitation skews the results—the unserved load pattern would likely change with different energy storage operation and cycling.

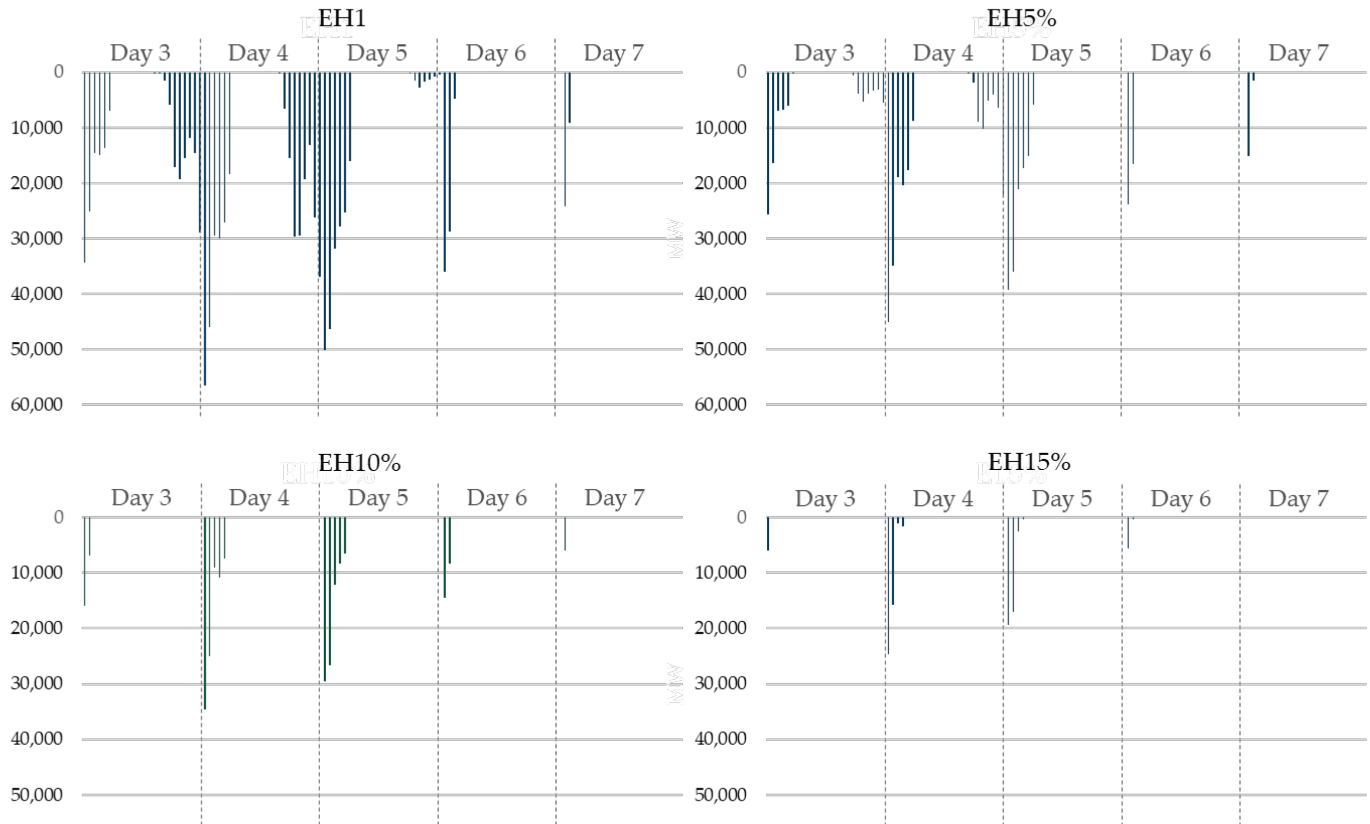


Figure 4: Western Interconnection Unserved Load Magnitude and Timing (MW)

Resource Adequacy

The unserved load in the base scenario was the result of a lack of available generation, not transmission constraints. Figure 5 shows path utilization and unserved load in the EH1 scenario on August 17, 2042, during the time of greatest unserved load, around 1:00 a.m. Path utilization was low with no paths loaded more than 75% of their limit.[2] There was moderate to high unserved load in the U.S. subregions (Alberta and British Columbia experienced no unserved load in the simulation). Since there were no transmission constraints, the unserved load in the simulation was due to a lack of available generation within and between subregions. Unserved load is worst in the CAMX subregion. During the simulated event, the regions around CAMX also experienced resource constraints and were unable to provide enough energy to CAMX to cover the load in that subregion.

[2] WECC measures transmission path utilization with three metrics: U75, U90, and U99. For a given path, the metrics reflect the percentage of time in which path flows meet or exceed the path's rating. For example, U75 represents the percentage of time that the path flows meet or exceed 75% of the path limit(s).

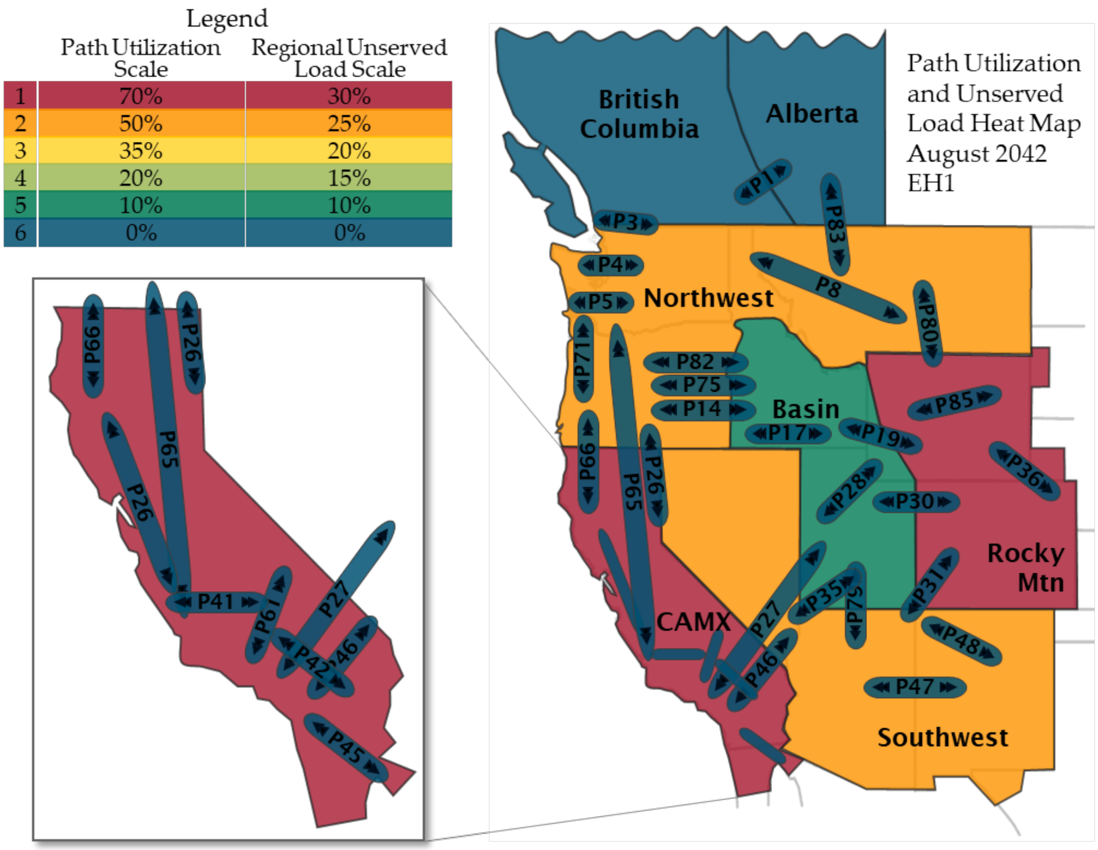


Figure 5: Path Utilization and Subregional Unserved Load Heat Map
August 17, 2042, EH1