LADWP Climate Assessment and Transmission Resilience Analysis

Highlights

OCTOBER 2021

Key Research Questions

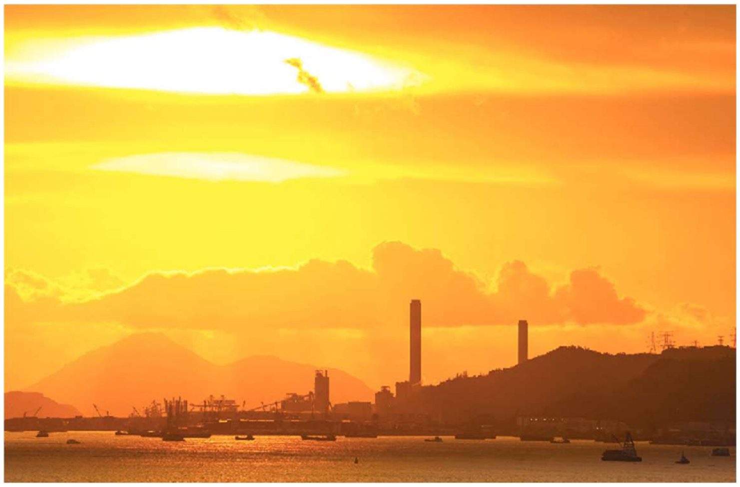
- What are the potential consequences of the increasing frequency and intensity of extreme weather and climate-related events on the LADWP electric system?
- Which of three possible scenarios for addressing the impacts of extreme contingency events provide the most potential resilience?

Research Overview

To better prepare and plan for potential extreme events, the Los Angeles Department of Water and Power (LADWP) worked with the Electric Power Research Institute (EPRI) to conduct a synthesis climate assessment (SCA). The purpose of the SCA is to assess current and future climate conditions in the Los Angeles region, including extreme weather events, and to identify vulnerabilities relevant to LADWP's power system.

EPRI also performed a transmission resilience assessment (TRA) for three possible future scenarios of the LADWP system in the year 2030. The team used the risk-based Resilient System Investment Framework (RSIF) to assess the impacts of extreme contingency events and quantify the resilience of the scenarios.

Findings: Synthesis Climate Assessment



- Rising temperatures in Los Angeles County are a primary driver of climate-related risk to LADWP's transmission system. Heat waves, wildfire, and drought, all of which are at least partially driven by increases in temperature, can directly affect the capacity and availability of transmission assets. In turn, this can reduce the power system's ability to transmit electricity, increase system stress in areas where power needs to be redirected, and impact generation output, efficiency, and availability.
- By midcentury in Los Angeles County, climate models project an increase in the number of extreme heat days and an extension of extreme heat events into spring and fall. By midcentury, in a medium emissions scenario, the city of Los Angeles is projected to experience up to ten such days, compared to the historical average of two days.
- LADWP asset vulnerability to increasing sea levels, storm surge, and flooding includes direct damage to equipment through flooding of substations, generators, control rooms, and other utility facilities; corrosion resulting from saltwater flooding; impaired facility access from transportation network disruptions; and generation outages (e.g., at coastal units) from direct or indirect flooding effects that could result in resource shortages across the power system.
- In a medium emissions scenario, the mean area burned in California wildfires is projected to increase, with greater increases in forested northern regions of the state than wildfire-prone regions in Southern California. In a high emissions scenario, multiple studies project increases in annual burned area in Southern California.

Findings: Climate-Informed Contingency Analysis

- Already located in areas of elevated wildfire risk, a small fraction of LADWP's high voltage transmission lines in the inland areas face the greatest near-term wildfire risk, particularly in a high emissions scenario. The riskis increasing in areas where historical wildfires have occurred.
- Currently applied 10-year timeframes for transmission planning models are not adequate for characterizing climate change-related risk in transmission systems. Consideration of plausible transmission system configurationsfor 20-30 year timeframes is recommended for future analyses.

Findings: Transmission Resilience Analysis

- EPRI evaluated three scenarios for the retirement and replacement of five once-through-cooling (OTC) plants located atthe Harbor, Haynes, and Scattergood stations.

Scenario 1	Scenario 2	Scenario 3
All once-through-cooling (OTC)plants are retired by their deadlines: • Scattergood (2024) • Haynes and Harbor (2029) All planned transmission system upgrades are completed. *Total Gen:* *7325 MW and 1732 MVAr*	In this scenario, Haynes Units 8,9, and 10 are converted to wet cooling and the remaining OTC units at Scattergood, Harbor, and Haynes are retired on the same schedule as described in Scenario 1. *Total Gen:* *7952 MW and 1741 MVAr*	This scenario is identical to Scenario 2; however, an additional 336 megawatts (MW) of peaking generation willbe considered at Scattergood (236 MW) and Haynes (100 MW). *Total Gen:* *8196 MW and 1760 MVAr*

- Scenario 3 provides the most resilient response when impacted by various contingency events. The risk of load lossduring the event was the lowest primarily due to additional in-Basin generation.
- Increased in-Basin generation (Scenario 3) provides critical support to the largest load centers in the LADWP operatingarea. As this generation is reduced (Scenario 2) or completely decommitted (Scenario 1), the risk of load loss significantly increases, and the resilience of the system is reduced.

Findings: Contingency Analysis

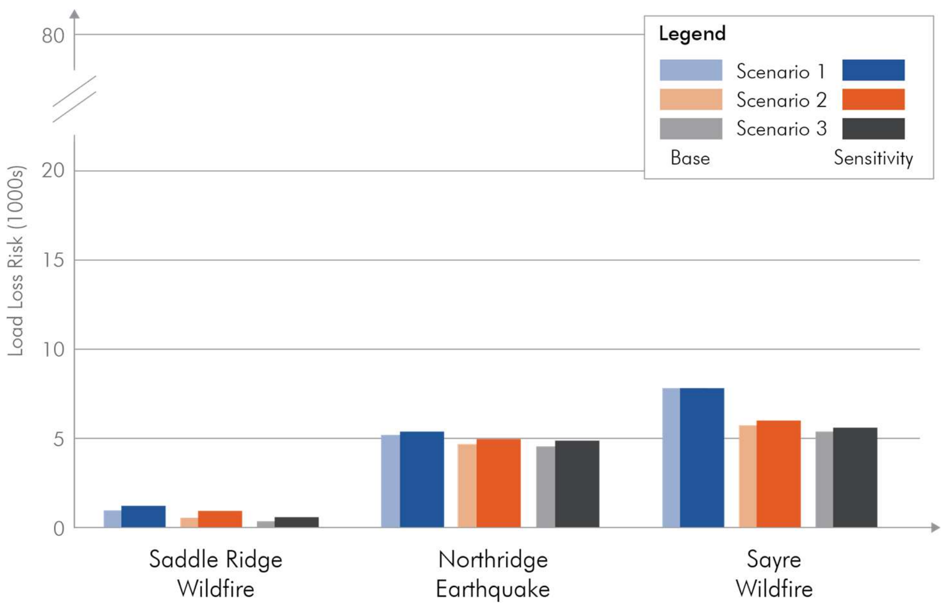
Set II
• Northridge Earthquake • Saddle Ridge Fire • Sayre Fire

- Of the 12 contingency events applied to the three scenarios, five extreme events tested resilience of the system. They resulted in significant levels of load loss and drove several layers of cascading failure across the LADWP system.

- The Sayre Fire, Saddle Ridge Fire, and Northridge Earthquake pose the largest threat to LADWP system resilience. These events consistently resulted in high load loss at the initiating event stage and led to system collapse when faced with additional cascading failures. All three events led to loss of a major transmission line and impacted reserve generation that are required to stabilize the electric grid. The risk of system failure decreases as more in-Basin generation is online (Scenario 3), which isolates in-Basin load following the event.

- Network upgrades improve LADWP system resilience. One sensitivity scenario explored unavailability of a planned underground transmission upgrade project. Without this cable in service, system resilience was reduced in all three scenarios forall studied contingency events.

- The chart at right compares the cumulative impact of the three Set II events that have the most significant impact on the LADWPsystem. Risk is compared across all identified cascading paths andis a measure of the severity and the likelihood of the cascades.



Implications and Next Steps

- Scenario 3 provides the most resilient response to the studied set of climate and non-climate-related events.

- Some type of dynamic generation support in-Basin is needed, especially given that several potential threats to theLADWP system could result in loss of needed generation in-feeds to in-Basin loads.

- A transmission segment was identified as critical in supporting the flow of generation in-Basin, across most of the extreme events studied. However, a system-wide and detailed modeling is needed in the future to assess the relative impact of each transmission segment.

- Projections of wildfire risk in various future climate scenarios indicate that wildfire probabilities in vulnerable locations may increase. Contingency analysis using historical wildfire events indicates that a lack of in-Basin generation exposesthe LADWP system to greater load loss risk.

The Electric Power Research Institute, Inc. (EPRI, www.epri.com) conducts research and development relating tothe generation, delivery and use of electricity for the benefit of the public. An independent, nonprofit organization, EPRIbrings together its scientists and engineers as well as experts from academia and industry to help address challenges inelectricity, including reliability, efficiency, affordability, health, safety and the environment. EPRI also provides technology,policy and economic analyses to drive long-range research and development planning, and supports research in emerging technologies. EPRI members represent 90% of the electricity generated and delivered in the United States withinternational participation extending to nearly 40 countries. EPRI's principal offices and laboratories are located in Palo Alto, Calif.; Charlotte, N.C.; Knoxville, Tenn.; Dallas, Texas; Lenox, Mass.; and Washington, D.C.

Together…Shaping the Future of Energy™

Electric Power Research Institute
3420 Hillview Avenue, Palo Alto, California 94304-1338 • PO Box 10412, Palo Alto, California 94303-0813 • USA 800.313.3774 • 650.855.2121 • askepri@epri.com • www.epri.com