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Systems Analysis for Understanding Load Growth Drivers and Strategic Resource Planning

Electricity demand is on the rise both in the US and around the globe due to a combination of factors, including technology improvements, economic growth, consumer behavior, and weather conditions. Without proper planning for load growth, utilities risk impacts to grid reliability and security. However, load projections vary greatly by region and have significant uncertainties, challenging efforts to develop solutions to effectively and efficiently meet future demand. Researchers at Sandia National Laboratories are addressing this issue by studying load growth drivers and developing tools and methods to support decision-makers.

BACKGROUND

In the report "A Review of Load Growth Drivers & Associated Resource Planning Activities," Sandia researchers provide a comprehensive review of electricity load growth drivers, the challenges associated with these growth factors, and the proposed solutions for meeting increasing demand. The report, summarized here, also looks broadly at the US, with a case study focusing on the Southwest Region, to identify gaps in understanding that influence planning efforts.

LOAD GROWTH DRIVERS

The report focused on six load growth drivers: 1) data centers, 2) manufacturing, 3) electrification, 4) drinking water and wastewater, 5) population trends, and 6) extreme weather events. These drivers were chosen based on size of the load, stakeholder attention, and potential implications across multiple economic and social sectors. Each driver has its own set of challenges for projecting loads, but these challenges often overlap, as do the solutions being explored to meet future demand (Figure 1).

SOUTHWEST CASE STUDY

The report featured a case study of the Southwest U.S. to demonstrate how both load growth drivers and proposed solutions vary by region. Southwest U.S. utilities project demand to grow, especially from large industrial loads and electrification, but their ability to meet this growth is challenged by uncertainties in customer behavior, weather patterns, and market dynamics. Moreover, utilities in the same region experience variability in the magnitude and timing of different load growth drivers, as well as in how they assess and plan for these changes. For example, utilities may be contemplating a broad range of candidate resources for expanding capacity but only some have started weatherizing their generation resources to better ensure performance under extreme conditions. Insights from the case study are visualized in Figure 2.

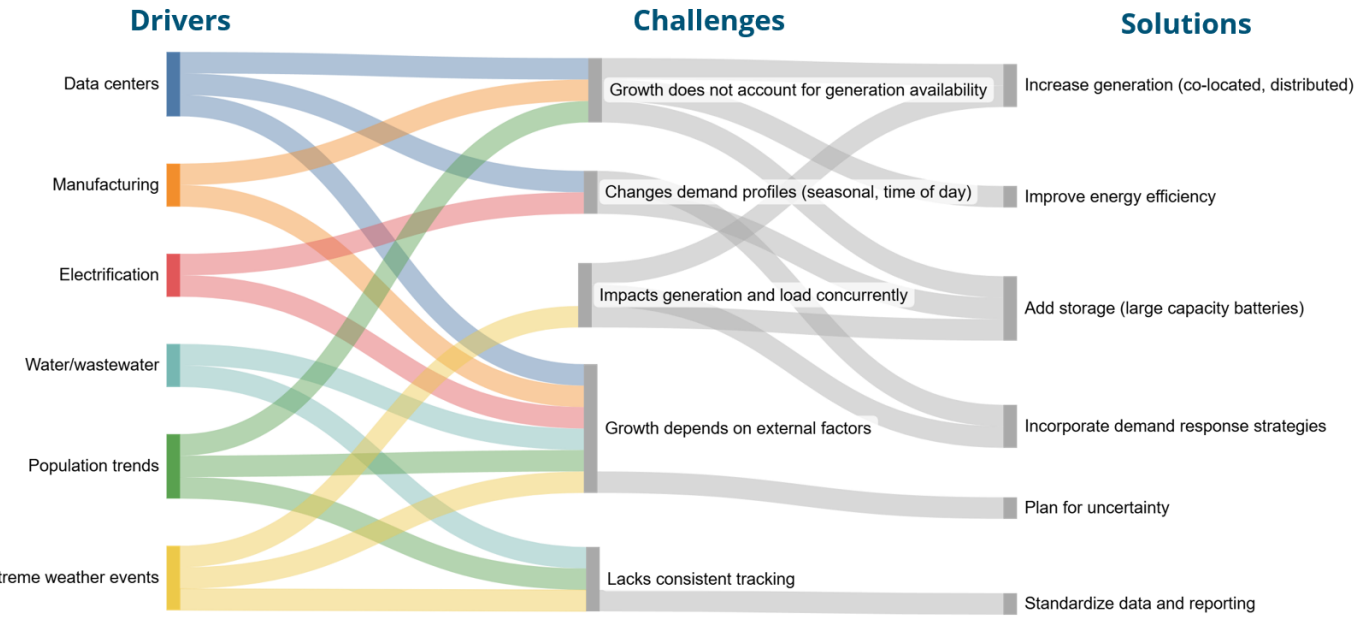


Figure 1. Similar challenges are associated with the different load growth drivers and proposed solutions.

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NEEDS AND OPPORTUNITIES

In addition to connections between the challenges and solutions, load growth drivers are also interconnected and changes to one driver can impact another (Figure 3). For example, both extreme weather events and electrification increase the amount of electricity needed for heating and cooling. Increased cooling needs require both more water and electricity to pump that water. These interactions are usually not accounted for in current models and approaches for load forecasting.

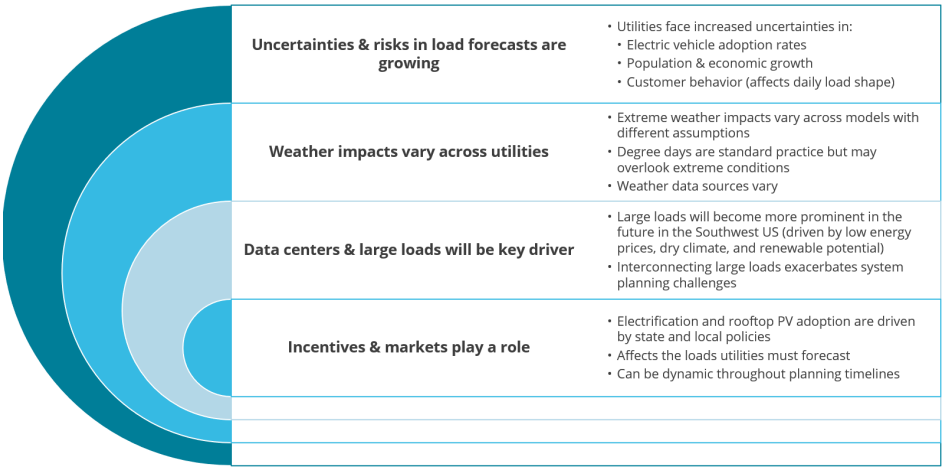


Figure 2: Key insights derived from Southwest U.S. utility Integrated Resource Plans (IRPs).

Load forecasting plays a critical role for supporting planning activities by both power and grid stakeholders as it enables them to predict future electricity demand and ensure sufficient generation capacity to meet that demand. There is an opportunity to create new methodologies for load forecasts that can incorporate information about new loads from real estate and permitting activities, as well as by using behind-the-meter strategies and stranded power. In data sparse settings, alternate approaches (e.g., system dynamics modeling) could also be explored to develop improved understanding of factors and their associated interactions, especially in qualitative data and stakeholder engagement settings.

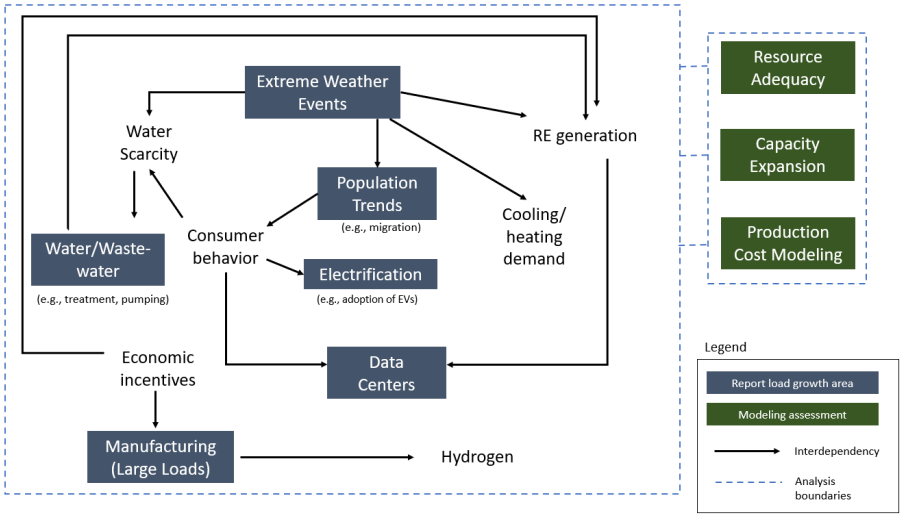


Figure 3: A systems analysis approach to understanding electricity demand would better elucidate possible interactions between key load growth drivers.

In addition to improving the forecasts themselves, more attention is needed to define how to incorporate forecasts into planning tools. Model designs that include supply-load-scenario interactions would enable better capture of physical, technology, and social factors that can concurrently influence outcomes at different time scales. These approaches could draw from other domains that have advanced propagation of uncertainty across models and decision-making under deep uncertainty.

For more information

Follow the QR code to access the full report "A Review of Load Growth Drivers & Associated Resource Planning Activities."

For questions, please contact Brian Pierre, Electric Power Systems Research Manager, bjpierr@sandia.gov.

SANDIA CAPABILITIES

Sandia has several grid planning and modeling capabilities that could help fill the gaps associated with load growth forecasting and model integration. Examples include:

- North American Energy Resilience Model (NAERM) – this multi-lab system can simulate multiple critical infrastructures
- QuEST Planning – this open-source software can identify cost-optimal energy storage, generation, and transmission investments.

Sandia also works to characterize and predict impacts from natural disasters and intentional threats on critical infrastructure systems, including the electric grid.

U.S. DEPARTMENT of ENERGY NNSA National Nuclear Security Administration

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