Poster Title

Long-term peak electricity demand forecasts under climate change to inform urban infrastructure efficiency planning and delivery system reliability planning throughout Los Angeles County

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Abstract

The goal of this research is to (A) advance long-term electricity demand forecasting methods so that cities can better manage urban infrastructure development and maintain reliable electric power services, and (B) provide actionable insights into where and why changes in peak demand might occur in Los Angeles County specifically. Peak demand is a critical operational constraint on infrastructure development, as supply and delivery capacity must be adequate throughout the system to meet the peak demand, plus redundancies in the event of outages, or else there will be service interruptions. Long-term driving factors of peak demand include population growth, changes in technology, and use of those technologies, which are significantly uncertain due to human behavior and weather—and weather patterns are also changing as climates are changing. Los Angeles County was chosen as a case study region because of its large diverse geography, expansive and aging infrastructure, large and still growing population, significant historical climate issues, and projected increases in extreme heat events, for which the cumulative effects are that electric power service reliability is at risk due to limitations in local delivery infrastructure. There are no resolute long-term forecasts for Los Angeles considering climate change.

Using the latest high-resolution climate and residential and commercial building energy models calibrated for Los Angeles specifically, we answer the following three research questions: (1) what is a reasonable range of future peak demand to plan for throughout the county at census block group resolution to 2060? (2) are there any regions where peak demand is forecast to significantly increase more so than other regions and why? (3) what amount of peak load shedding (or shifting) will be necessary to maintain current levels of peak demand in established census block groups per geographic area or overall per capita? To answer these questions we consider, (A) daily maximum temperature projections at 2x2 km resolution under representative carbon pathway scenarios RCP 4.5 and 8.5, (B) population growth projections from both the California Finance Office as well as the Southern California Association of Governments, (C) building turnover rate, (D) change in AC penetration rates as all new residential buildings are assumed to have central AC, (E) a range of new housing density varying from low-efficiency single family detached units to high-efficiency multifamily apartment style units, and (F) the load performance of different types of AC technology at high temperatures. Our findings are that peak hour electricity demand could increase in total for the county by 10% to 130% (1 to 10 GWh) depending upon the reference weather conditions for the peak demand, the amount of population

growth realized, and the energy efficiency/management measures implemented. Peak demand was forecast to increase more inland than near the coast for climate change as that temperatures are projected to rise more further from the ocean, more in the north with new buildings for population, and more in the central regions with building turnover and densification to accommodate additional population. Peak demand per capita was modeled at a base range of 1.5—3.1 kWh per capita depending on housing type, or an average of 1-1.3 kWh per capita for the entire county, that could increase to 1.35-1.5 kWh per capita. Under the lowest population growth, slowest building turnover, highest energy efficiency, and lowest climate change scenario, peak demand per capita decreased in central established area by as much as 40%; however, total increase in new buildings due to new population in hotter regions resulted in a net increase in peak demand per capita. If Los Angeles's long-term goal is to accommodate demand for housing and build more high-density residences in central areas, then additional distributed energy resources will be necessary at the neighborhood level to prevent peak loads from exceeding current levels on the aging delivery infrastructure systems already in place.