EPRI ELECTRIC POWER RESEARCH INSTITUTE

P201 Back Pocket Insights

KEY INSIGHTS

- **Decarbonization entails widespread end-use electrification and lowering electricity supply emissions**.

- **Studies disagree on the rate and extent of electricity load growth** implied by net-zero goals—from small decreases to quadrupling demand. The highest growth scenarios come from studies that assume extensive electrolytic hydrogen use and limited energy efficiency.

- **Electrification and the production of electricity-derived fuels (e.g., electrolytic hydrogen) increase demand**, which is partially offset by efficiency gains.

This brief is based on the paper "Roadmaps to Net-Zero Emissions Systems: Emerging Insights and Modeling Challenges" published in *Joule* (2021)

The Role of the Electric Sector in Net-Zero-Emissions Systems

by John Bistline

New research reviews insights from emerging studies on net-zero-emissions systems, including the key roles of the power sector and end-use electrification.

Understanding net-zero-emissions systems is important, given the increasing number of national, subnational, and company net-zero targets. This study summarizes similarities and differences in these emerging studies across countries, models, and assumptions.

There are several robust "low regrets" strategies:

- Rapid reduction of coal and expansion of renewables in the power sector;
- Electrification of end uses especially in transport;
- Lower fossil fuel use;
- End-use efficiency improvements;
- Research, development, and deployment to buy down learning curves for emerging technologies.

Studies find that **decarbonization implies widespread electrification**—the adoption of electric end-use technologies for a given service—across transport, buildings, and industrial sectors (Figure 1). Although nearer-term trends are similar, **pathways exhibit variation as net-zero goals are approached**. There are disagreements across studies about the rate and extent of electrification for different sectors, aggregate load growth, and load shape flexibility.

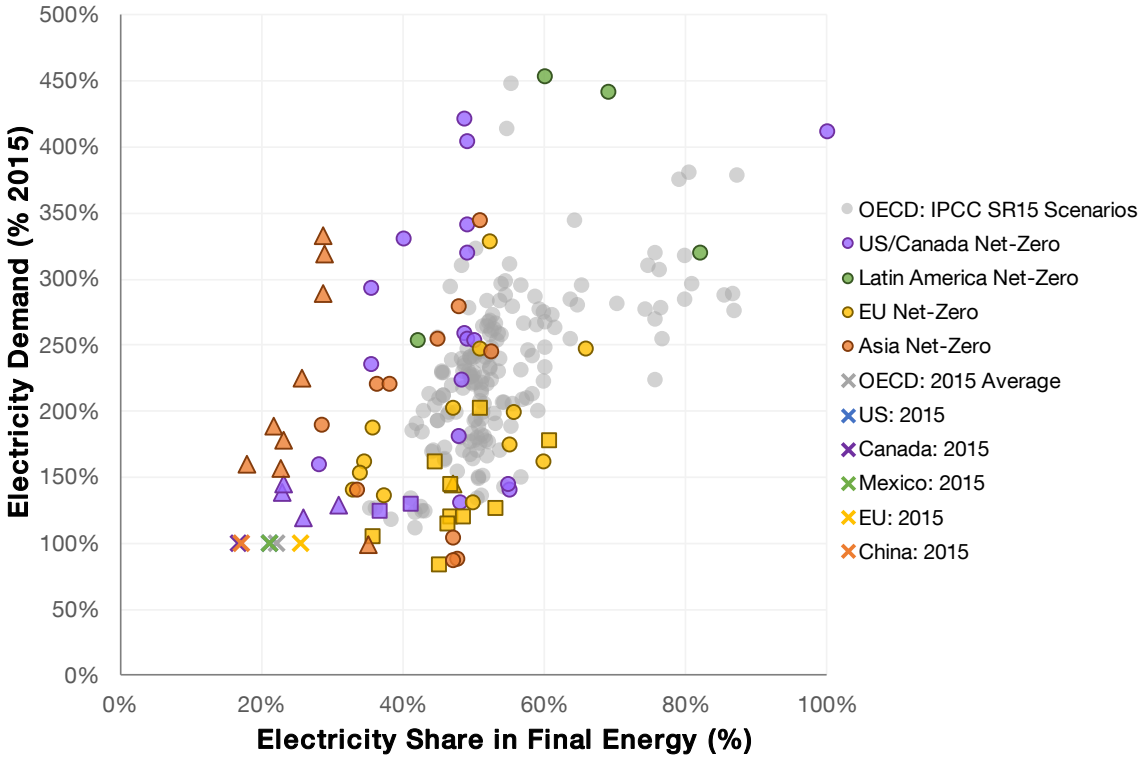

Figure 1. Scenarios illustrate differences in electrification across net-zero-emissions scenarios. Points represent individual scenarios with shapes corresponding to emissions levels (triangle, reference scenario in 2050; square, deep decarbonization in 2050; circle, net zero in 2050), and colors correspond to different analysis regions. Detailed descriptions are provided in Bistline (2021).

Electricity's share of final energy across net-zero scenarios in 2050 spans a wide range, typically between 30% and 60% (Figure 1).

Electricity demand generally increases with higher electrification rates, but **load growth exhibits a broad range of outcomes**—from decreasing 12% in relation to 2015 levels to increasing 353%—depending on direct electrification, the value of electricity-derived fuels, and contributions from efficiency and conservation. Improvements in energy intensity partially offset increases from electrification, but the magnitudes of these **effects vary by country, study, and scenario**.

The highest electricity demand scenarios among those surveyed feature lower direct electrification, a large role for electrolytic hydrogen as a scenario input, and more limited contributions from energy efficiency. The use of electrolytic hydrogen for difficult-to-electrify end-uses contributes to increases electricity consumption even when electricity's final energy share is relatively constant. This is due to lower roundtrip efficiencies associated with electrolytic hydrogen and similar fuels (compared to direct electrification).

For more information about deep decarbonization scenarios in EPRI's Regional Economy, Greenhouse Gas, and Energy (REGEN) model, see https://esca.epri.com/usregen

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FOR MORE INFORMATION

Explore the EPRI Energy Systems and Climate Analysis website at **esca.epri.com**