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Impact of Data Center Load Growth on Retail Electricity Prices

It could go either way: it's not preordained!

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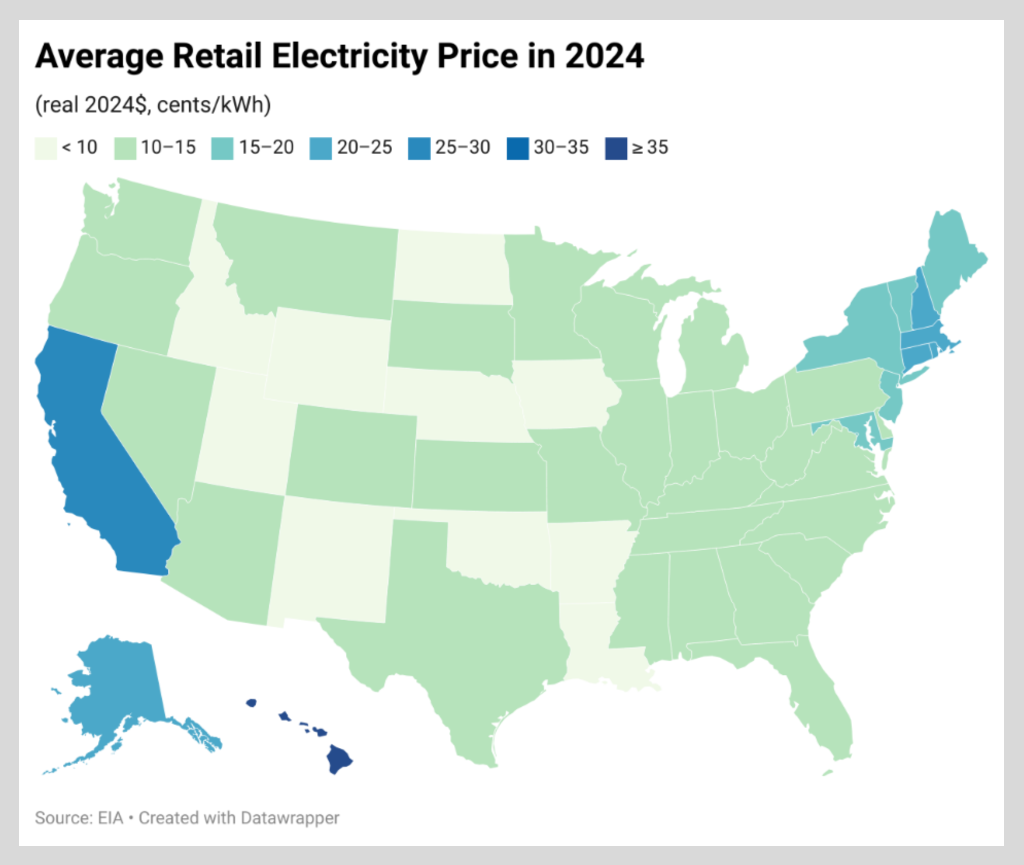
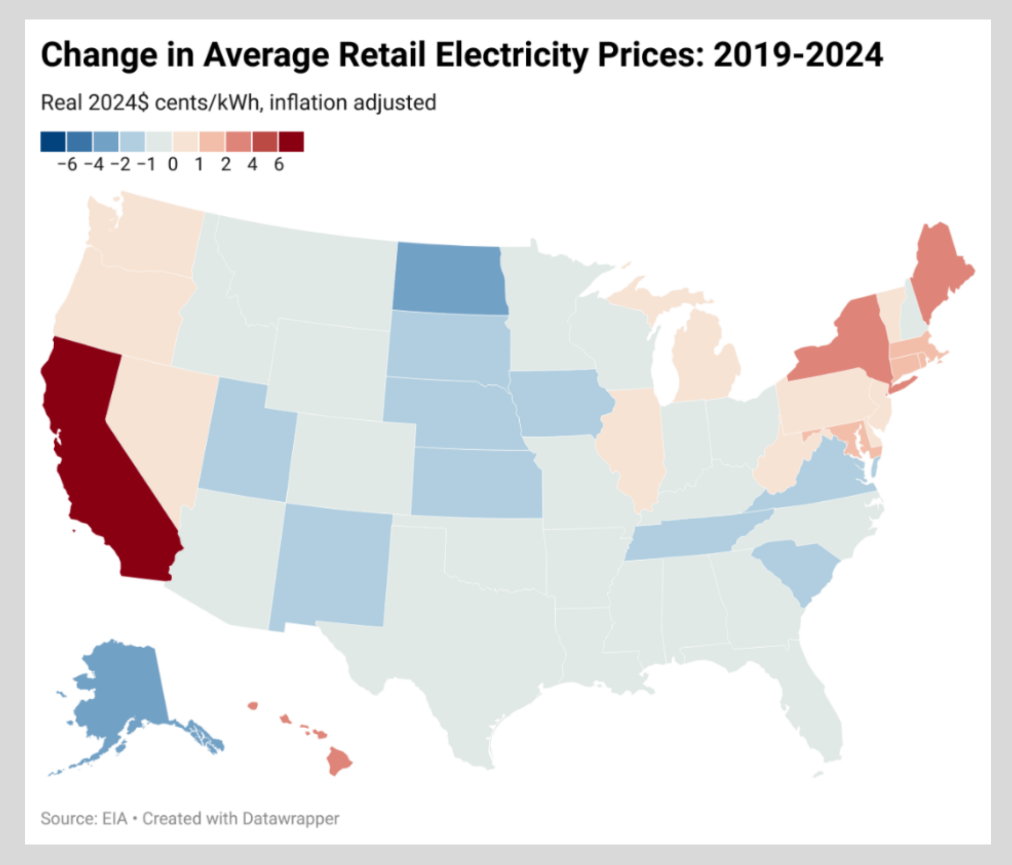
Image source: OpenAI DALL-E

State-level retail electricity prices vary dramatically as do recent changes: 2024 average (left) and 2019-2024 change (right)

- Retail prices in 2024 varied widely: 90% of lower-48 landmass and 75% of population had average prices <15 ¢/kWh, but prices were much higher in California and the Northeast, and in HI & AK
- In nominal terms, almost all states experienced price increases from 2019-2024, but in real terms most experienced price decreases; largest increases in CA, HI, states in the NE, West, Great Lakes



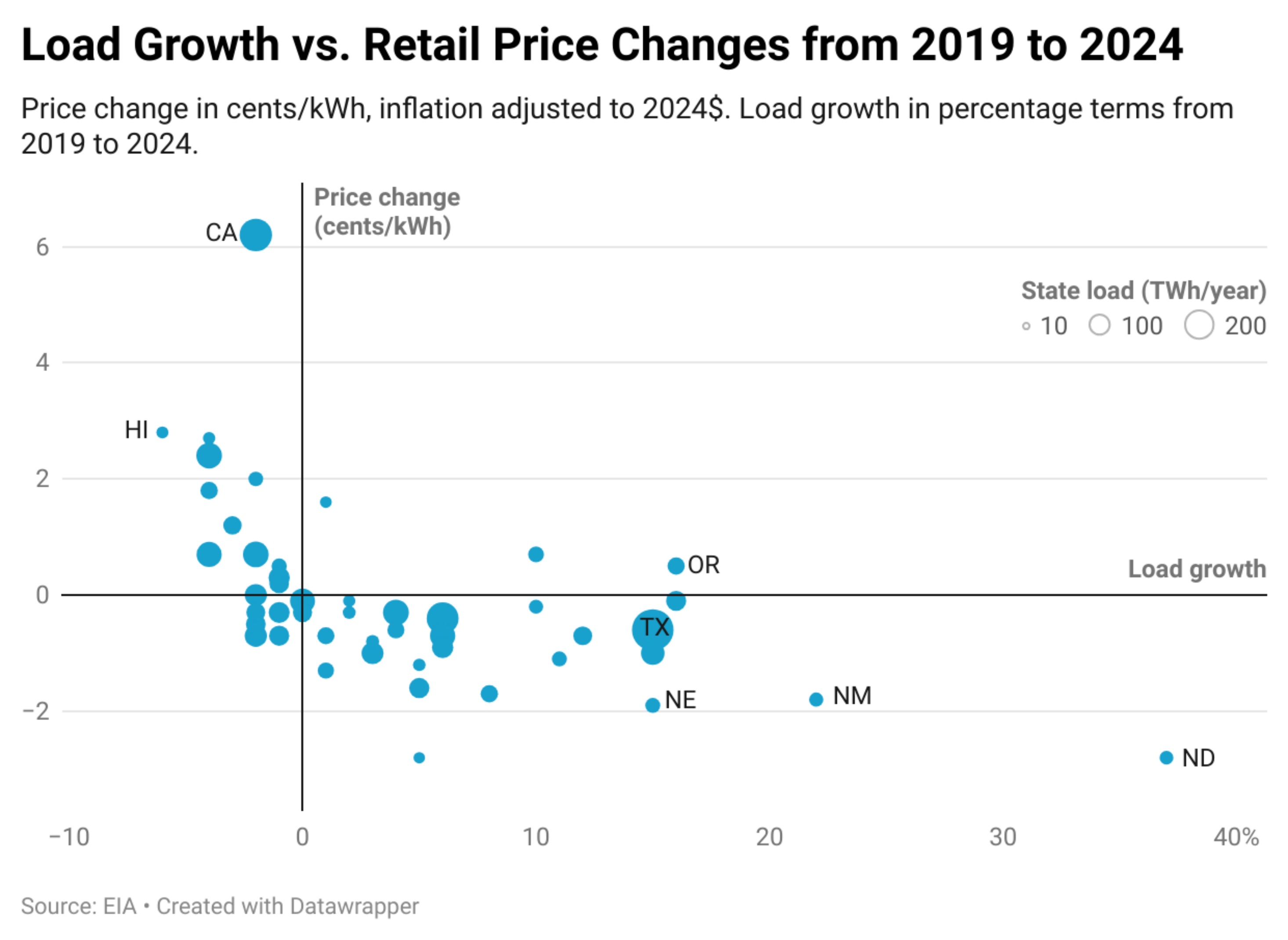


Multiple reasons for increases in inflation-adjusted retail prices from 2019 to 2024… <u>none of which are load growth</u>

Price Driver	Maximum Size	Geographic Breadth	Discussion
Replacement & hardening of aging distribution (and transmission)	medium	Large	Likely under 0.5 ¢/kWh in majority of states, but reasonably widespread impact given scale of distribution investments and supply-chain constraints.
Extreme weather & wildfires: recovery and mitigation	larger	Medium	As much as 4 ¢/kWh in California, but impacts of 0.5-1.5 ¢/kWh in a number of states in the West, and on the East and Gulf coasts.
Natural gas price variability	larger	Large	As much as over 2 ¢/kWh increase through 2022-2023, with subsequent decrease; most acute impacts in Northeast, NV, FL, PA, etc.
State Renewables Portfolio Standard policies	medium	Medium	As much as ~1 ¢/kWh in a few Mid-Atlantic and New England states; lower and varied impacts in many other states with RPS programs.
Net energy metered solar	larger	Small	As much as ~2 ¢/kWh in California and over 1 ¢/kWh in small number of other high-growth states especially in the Northeast; low impacts in most states.

In recent years and decades, load growth at the state level has tended to <u>depress</u> retail electricity prices

- Over the past 5 years, states with the highest load growth generally saw retail prices decline in real terms
  - **Over 1 ¢/kWh price reduction in highest-growth states**
  - Those states where load declined often experienced price increases
- *Reason:* cost growth was mostly for maintenance costs and—with prevailing rate structures—greater load leads to fixed costs being spread over more demand, reducing per unit costs[1]
- Commercial sector led load growth, was largest beneficiaries of reductions



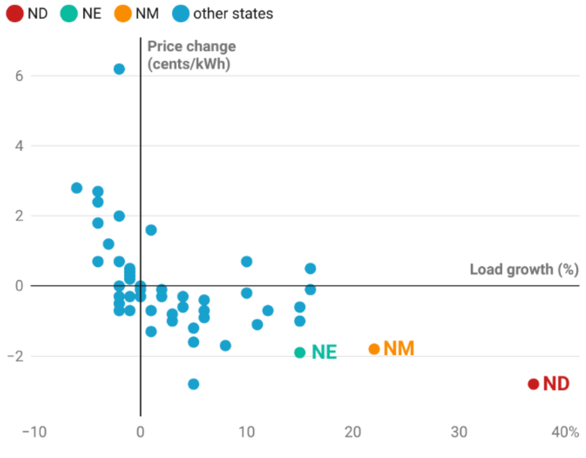
Sources: [1] Fares and King (2017)

Case Study: North Dakota, New Mexico, Nebraska

Managing load growth while reducing inflation-adjusted retail prices

1 Three states have significantly increased load while reducing inflation-adjusted retail prices

Load Growth vs. Price Change: 2019-2024

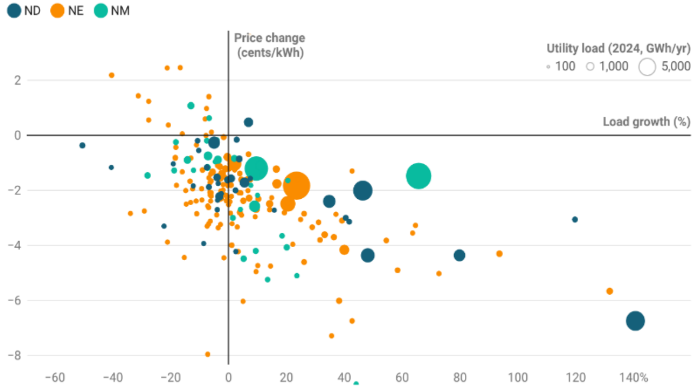


Source: EIA • Created with Datawrapper

2 Utilities with the greatest load growth generally experienced the largest reduction in prices

Impact of Load Growth on Utility-Level Average Retail Price Changes from 2019-2024: North Dakota, Nebraska, New Mexico

Price change in cents/kWh, inflation adjusted to 2024$. Load growth in percentage terms from 2019 to 2024. A few small-utility outliers are excluded due to the y-axis scale.



Source: EIA • Created with Datawrapper

3 Utilities with sizable C&I growth lowered C&I prices; residential customers were not harmed

ND, NE, NM: Impact of Utility- and Sector- Specific Load Growth on Retail Price Change from 2019-2024

Price change in cents/kWh, inflation adjusted to 2024$.

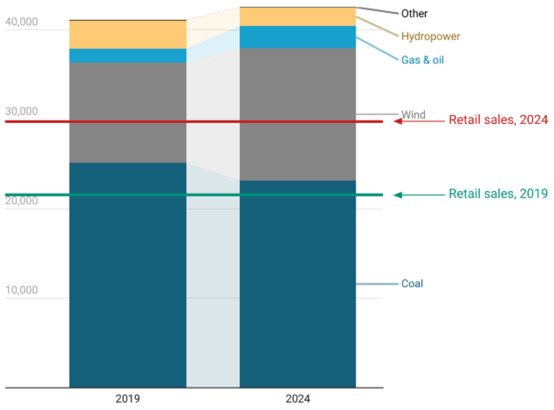
Utility Grouping	Residential Load Growth	Residential Price Change	C&I Load Growth	▲ C&I Price Change
High Load Growth: >20%	−1%	-1.3	64%	-2.7
Low Load Growth: 0-20%	4%	-1.3	10%	-1.4
Load Contraction: shrinking	−2%	-0.9	−10%	-0.9

Created with Datawrapper

4 Load growth matched with abundant, low-cost energy enabled positive outcomes

- Substantial C&I growth enabled fixed costs to be spread over more load
- Abundant, low-cost energy enabled load to be served at low incremental cost

North Dakota Generation and Retail Sales (GWh)



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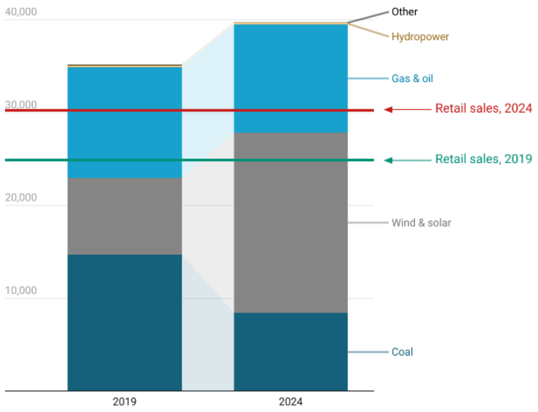
New Mexico Generation and Retail Sales (GWh)



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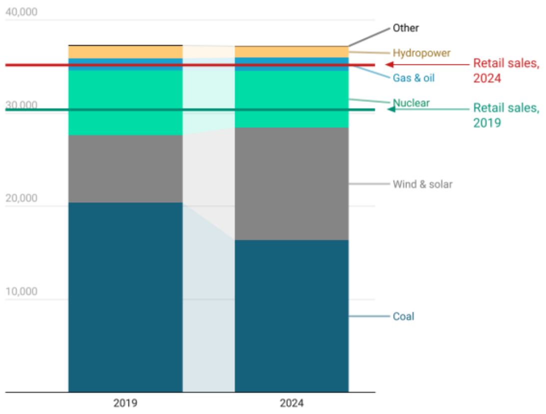
Nebraska Generation and Retail Sales (GWh)



Source: EIA • Created with Datawrapper

The past need not be prologue…

as recent PJM capacity prices demonstrate

In some regions, it's a new era: one in which accelerated and uncertain load growth collides with supply & delivery constraints

- ~100 GW of additional data center load is possible by mid 2030s
- Adds to other drivers of load growth: onshoring, electrification
- Load growth likely to concentrate, but across many states and regions
- Beginning to run into real constraints in affordable supply and delivery

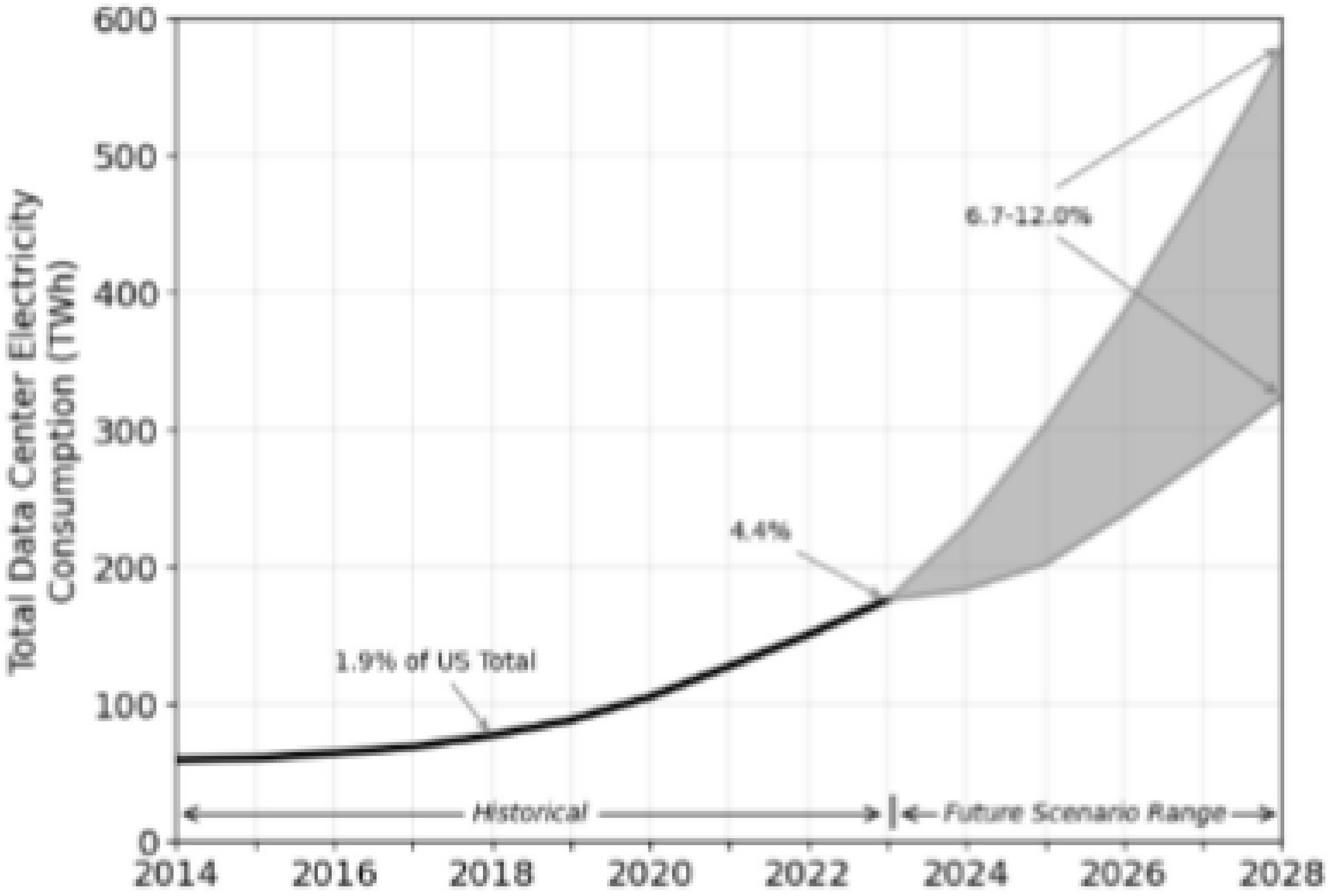


Figure ES-1. Total U.S. data center electricity use from 2014 through 2028.

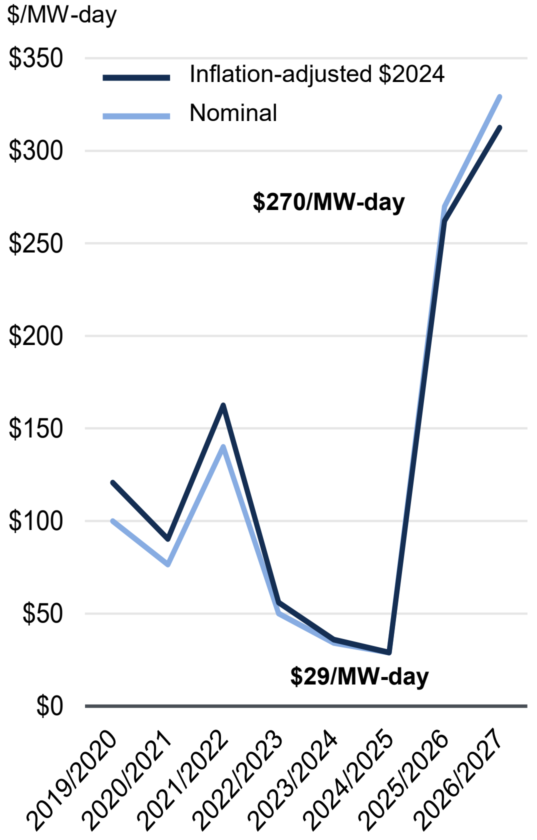
Source: LBNL

Case Study: PJM Capacity Auction

Accelerated load growth combined with supply and delivery constraints leads to significant price increases

1 Significant increase in PJM capacity prices

PJM: Capacity Auction Clearing Price History



Data from PJM compiled by NRG with inflation data from the Bureau of Labor Statistics (BLS)

2 PJM's capacity prices increased due to multiple factors, including load growth

Data Center Load Growth

174% increase in auction revenues

Summer Capacity Ratings for CC/CTs

23 - 118% increase in auction revenues

Demand Curve Price Cap

68% increase in auction revenues

Adoption of ELCC Method

49% increase in auction revenues

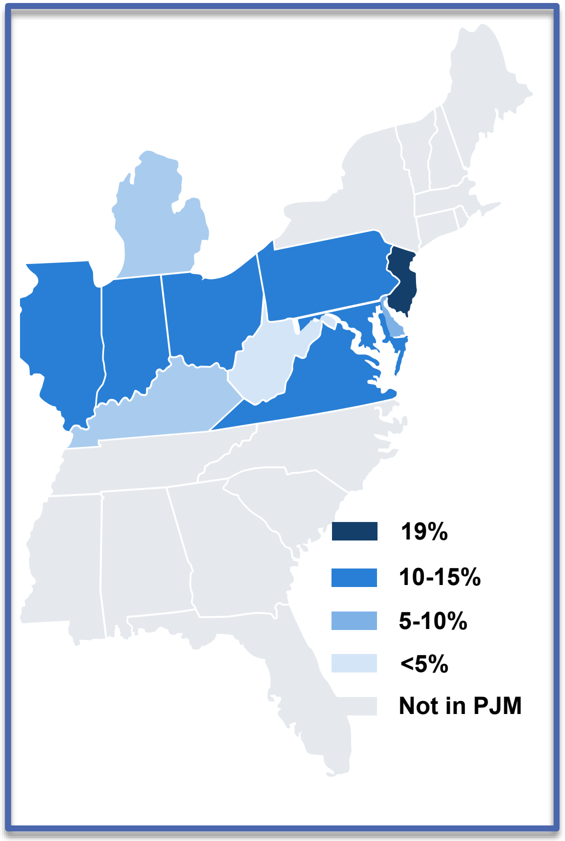
Capacity prices are one but not the only contributor to price increases

Other major drivers included the exclusion of Reliability Must Run units from the auction supply curve and the withholding of exempt capacity. The resulting auction outcomes signal a need for new resources to meet the growing demand of the region. One can therefore also interpret the rapid increase in clearing prices as indicative of prices that were too low in previous auctions.

Source: Data from Monitoring Analytics' IMM Analysis of the 2025/2026 RPM Base Residual Auction Parts A through G

3 Significant increase in state-level retail prices

Average Increase in Retail Prices Between July 2024 & July 2025[7]



Notes and source: States with vertically integrated utilities are shielded to some extent from capacity auction price spikes because utilities can self-supply instead of purchasing capacity from PJM: from EIA Electricity Monthly Update July 2025

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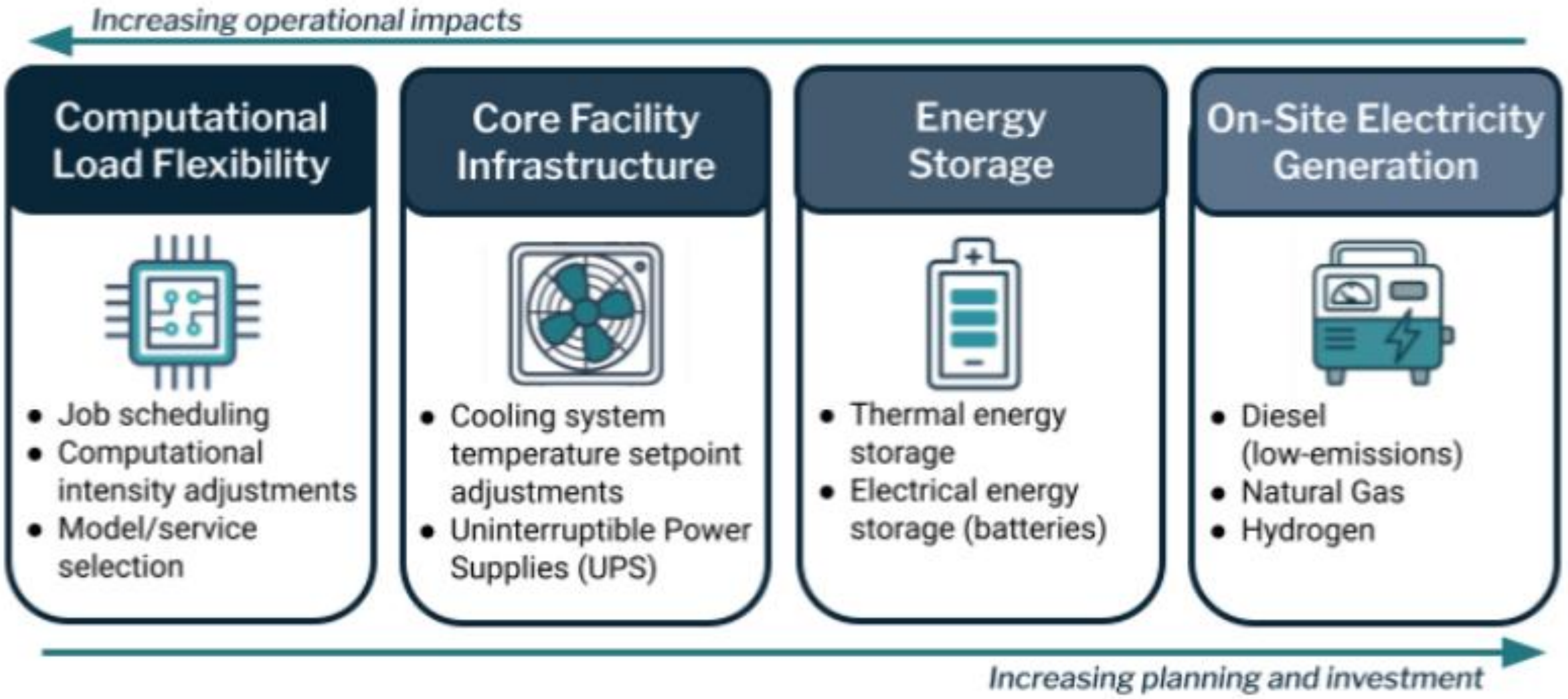
A “3-step” plan to minimizing the risk of data-center buildout for other electricity customers

1. Reduce system-level supply and delivery constraints
2. Reduce system-level needs from new data center buildout
3. Large load tariffs (+ other tools) to ringfence impacts from data centers

1 Reduce system-level supply and delivery constraints to minimize the risk of accelerated cost growth

Immediately: get the most out of the existing electricity system	• Demand flexibility, DERs, storage, grid-enhancing technologies, regional trade
Careful, proactive risk-aware planning	• Forward-looking planning to minimize cost of new generation and delivery needs
Eliminating log-jams for new supply and delivery infrastructure	• All-source procurement, interconnection reform, efficient permitting, market design

2 Reduce system-level needs from new data center buildout, through operational flexibility and BYOG



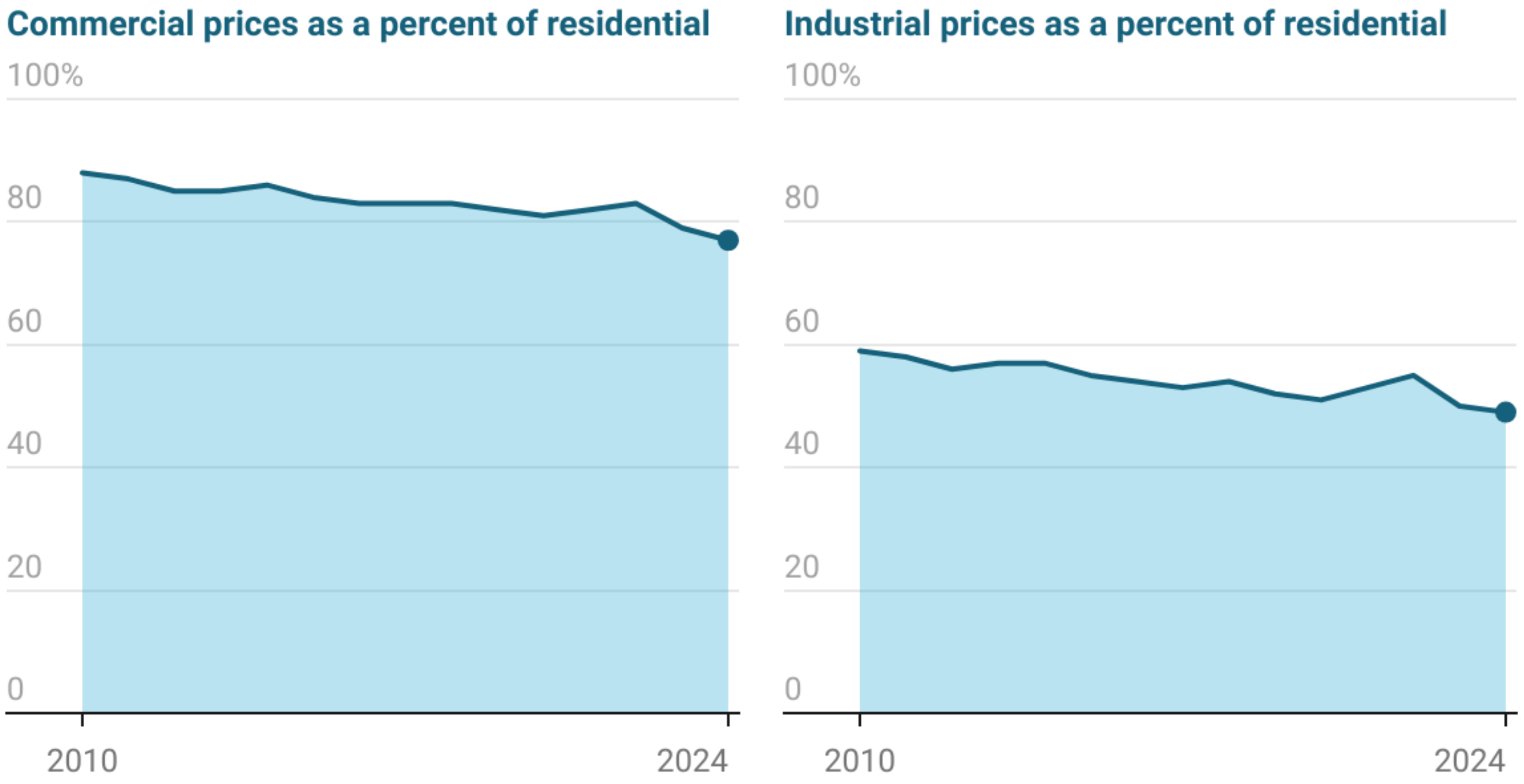
- And… potentially enabling data centers to "bring-their-own" <u>offsite</u> generation, storage, or demand-side flexibility

See: https://datacenters.lbl.gov/

3 Make sure data centers pay their own freight… and perhaps also contribute to embedded electric-system fixed costs

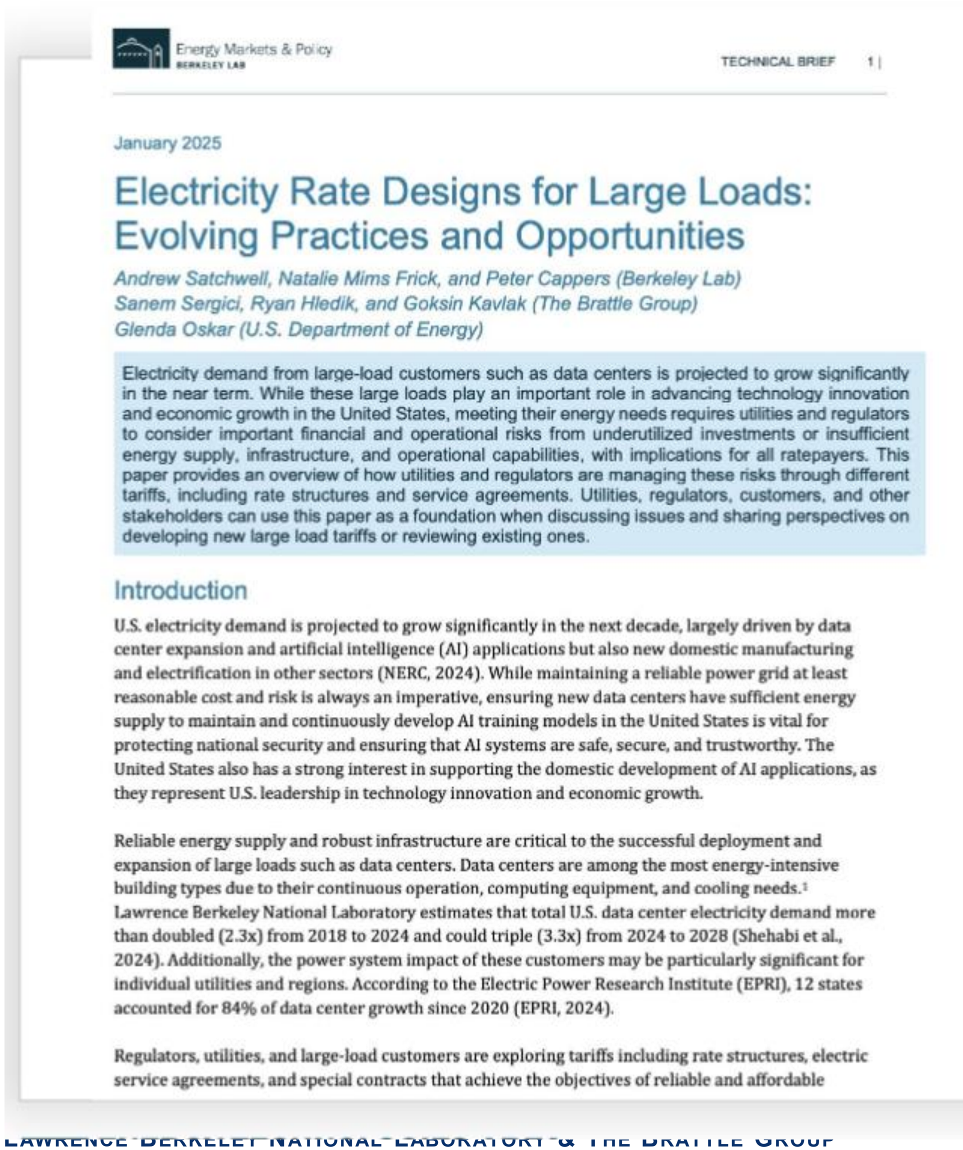
- Over the last 15 years, residential electricity prices have increased faster than C&I prices
  - Gap has grown between residential prices and C&I prices
- C&I customers were generally less expensive to serve, and there were policy reasons to support the economic development that such customers bring to a state

National Average Commercial and Industrial Retail Prices Relative to Residential Prices



Source: EIA • Created with Datawrapper

3 Rapid data center buildout plus supply & delivery constraints can increase costs ➡ interest in new tariffs to ringfence impacts



Energy Markets & Policy
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TECHNICAL BRIEF 1 |

January 2025

Electricity Rate Designs for Large Loads: Evolving Practices and Opportunities

Andrew Satchwell, Natalie Mims Frick, and Peter Cappers (Berkeley Lab)
Sanem Sergici, Ryan Hledik, and Goksin Kavlak (The Brattle Group)
Glenda Oskar (U.S. Department of Energy)

Electricity demand from large-load customers such as data centers is projected to grow significantly in the near term. While these large loads play an important role in advancing technology innovation and economic growth in the United States, meeting their energy needs requires utilities and regulators to consider important financial and operational risks from underutilized investments or insufficient energy supply, infrastructure, and operational capabilities, with implications for all ratepayers. This paper provides an overview of how utilities and regulators are managing these risks through different tariffs, including rate structures and service agreements. Utilities, regulators, customers, and other stakeholders can use this paper as a foundation when discussing issues and sharing perspectives on developing new large load tariffs or reviewing existing ones.

Introduction

U.S. electricity demand is projected to grow significantly in the next decade, largely driven by data center expansion and artificial intelligence (AI) applications but also new domestic manufacturing and electrification in other sectors (NERC, 2024). While maintaining a reliable power grid at least reasonable cost and risk is always an imperative, ensuring new data centers have sufficient energy supply to maintain and continuously develop AI training models in the United States is vital for protecting national security and ensuring that AI systems are safe, secure, and trustworthy. The United States also has a strong interest in supporting the domestic development of AI applications, as they represent U.S. leadership in technology innovation and economic growth.

Reliable energy supply and robust infrastructure are critical to the successful deployment and expansion of large loads such as data centers. Data centers are among the most energy-intensive building types due to their continuous operation, computing equipment, and cooling needs.[1] Lawrence Berkeley National Laboratory estimates that total U.S. data center electricity demand more than doubled (2.3x) from 2018 to 2024 and could triple (3.3x) from 2024 to 2028 (Shehabi et al., 2024). Additionally, the power system impact of these customers may be particularly significant for individual utilities and regions. According to the Electric Power Research Institute (EPRI), 12 states accounted for 84% of data center growth since 2020 (EPRI, 2024).

Regulators, utilities, and large-load customers are exploring tariffs including rate structures, electric service agreements, and special contracts that achieve the objectives of reliable and affordable

- Large-load tariff report, article, database
- Four themes of large load tariffs
  - Fairly allocate electricity system costs
  - Mitigate utility and customer financial risks
  - Mitigate operational and resource adequacy risks
  - Accommodate needs of large-load customers
- Examples of types of provisions
  - Payments consistent with cost causation
    - Plus… sometimes embedded costs
  - Min duration & demand/payment, exit fees, reassignment
  - Upfront commitments, collateral, credit
  - Size, ramp times, load factor, BTM resources
- Other available "ringfencing" levers
  - Interconnection, cost allocation + rate classes, load forecasting, information sharing, third-party gen, etc.

Our work on recent retail electricity price trends and drivers

For more information, contact: Ryan Wiser (rhwiser@lbl.gov)

Peer-reviewed journal article	**Data visualization tool**	**Detailed presentations**
Highlights a subset of the trends, with a focus on statistical analysis of broad drivers	Allows users to explore some of the data that underpins the journal article	Summarizes the article and provides additional material beyond that included here

These products can all be found at: https://eta-publications.lbl.gov/publications/factors-influencing-recent-trends

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